UNIVERSITY OF RAJASTHAN

JAIPUR

SYLLABUS

M.SC. CHEMISTRY

Semester Scheme

I/II Semester Examination 2016-2017
III/IV Semester Examination 2017-2018

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M.Sc. CHEMISTRY Syllabus based on Credit-based Semester System (four semesters in two years) with continuous assessment.

- As per Academic Council decisions, to acquire a Master degree in Chemistry, a candidate is required to earn minimum of 120 credits with grade E or higher out of total 144 credits.
- Registration of candidate in the First and subsequent Semesters after the prescribed last date shall not be permitted.
- Credit registration at least once in all Compulsory Credit Course (CCC) shall be binding, however earning all credits for accumulation of the prescribed minimum credit with grade E or higher grade in all CCC will be binding.

SCHEME OF EXAMINATION:

- Each Semester shall have continuous assessment which shall include internal assessment in theory and practical by internal examination/seminar/oral examination/viva-voce etc, besides assessment of candidate's regularity and performance in the class.
- A candidate has to pass in the internal continuous assessment as well as EoSE (End of Semester Examination) paper separately.
- Each theory paper EoSE shall carry 100 marks. The EoSE will be of 3 hours duration.
- Candidate has to attempt five (05) questions in all. All questions carrying equal marks.
- Question no. 1 (Part 'A') of the theory paper covering whole syllabus shall contain 10 Short Answer Questions of 20 marks, based on knowledge, understanding and applications of the topics/texts covered in the syllabus. Each question will carry two (02) marks for correct answer.
- Question nos. 2 to 5 (Part 'B') of the theory paper will be framed by taking one question from each unit of 20 marks each with internal choice. The limit of answer will be five pages.
- Each Laboratory EoSE will be of six hours durations and involve laboratory experiments/exercises, record and viva-voce examination with weightage in ratio of (75:25).
- The Practical examination will be conducted by board of examiners consisting of one internal (to be appointed by the Head of Department) and one external examiner (to be appointed by the University).
- The medium of instruction and examination shall be English only.

COURSE STRUCTURE

- The curriculum of a programme shall not have more than 60% of minimum credit required as compulsory core course (CCC).
- The Credit Courses of a programme has been classified as below:

  CCC: Compulsory Core Course
  ECC: Elective Core Course
  SSC: Self Study Course
  PRJ: Project Work

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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-1	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-1	ECC	6	0	0	9	0	9

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The details of the courses with code, title and the credits assigned are tabulated below -

THIRD SEMESTER

S. No.	Subject Code	Course Title	Course Category	Credit	Contact hours / week			EoSE Duration (hrs)	
					L	T	P	Th	P
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	Bio-Physical Chemistry	CCC	4	4	0	0	3	0
4.	CHE 911	Chemistry Core Laboratory – 3	CCC	6	0	0	9	0	6
5.		Theory Elective – 1	ECC	4	4	0	0	3	0
6.		Theory Elective – 2	ECC	4	4	0	0	3	0
7.		Theory Elective – 3	ECC	4	4	0	0	3	0
8.		Elective Laboratory – 3	ECC	6	0	0	9	0	6

- Theory elective papers 1-3 to be opted from one of the three elective groups offered.
- Elective Laboratory -3 will be according to the opted Elective Theory group

FOURTH SEMESTER

S. No.	Subject Code	Course Title	Course Category	Credit	Contact hours / week			EoSE Duration (hrs)	
					L	T	P	Th	P
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	CCC	4	4	0	0	3	0
4.		Theory Elective – 1	ECC	4	4	0	0	3	0
5.		Theory Elective – 2	ECC	4	4	0	0	3	0
6.		Theory Elective – 3	ECC	4	4	0	0	3	0
7.		Elective Laboratory – 4	ECC	6	0	0	9	0	6
8.		Elective Laboratory – 5	ECC	6	0	0	9	0	6
9.		Project Work * (With an option of Project work of 12 credits in place of two Elective labs)	PRJ	12	0	0	18		

- Theory elective papers 1-3 to be opted out of one of three elective groups offered
- Elective Laboratory - 4 will be according to the opted Elective Theory group
- The students will have choice to opt project work (12 Credits) or two elective laboratory courses of 6 credits each.

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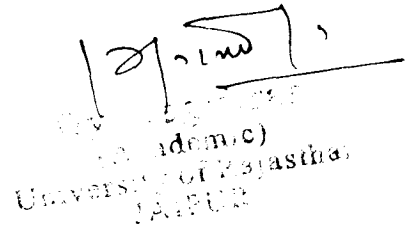
III & IV Semester

Elective Core Courses (ECC) Groups

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

S. No.	Elective Course Code	Paper Title	Prerequisite	Course available in Semester
1.	CHE A02	Bioinorganic Chemistry	-	III
2.	CHE A03	Supramolecular Chemistry	-	III
3.	CHE A04	Inorganic Polymers	-	III
4.	CHE A05	Advanced Bioinorganic Chemistry	CHE A02	IV
5.	CHE A06	Materials and Industrial Chemistry	-	IV
6.	CHE A07	Photoinorganic Chemistry	-	IV
7.	CHE B03	Heterocyclic Chemistry – I	-	III
8.	CHE B04	Natural Product – I	-	III
9.	CHE B05	Medicinal Chemistry – I	-	III
10.	CHE B06	Heterocyclic Chemistry – II	CHE B03	IV
11.	CHE B07	Natural Product – II	CHE B04	IV
12.	CHE B08	Medicinal Chemistry – II	CHE B05	IV
13.	CHE C02	Advanced Electrochemistry – I	-	III
14.	CHE C03	Advanced Chemical Kinetics – I	-	III
15.	CHE C04	Chemical Analysis	-	III
16.	CHE C05	Advanced Chemical Kinetics – II	CHE C02	IV
17.	CHE C06	Advanced Electrochemistry – II	CHE C03	IV
18.	CHE C07	Advanced Nanoscience and Nanotechnology	-	IV
19.	CHE A11	Elective laboratory – 3	-	III
20.	CHE B11	Elective laboratory – 3	-	III
21.	CHE C11	Elective laboratory – 3	-	III
22.	CHE A12	Elective laboratory – 4	-	IV
23.	CHE B12	Elective laboratory – 4	-	IV
24.	CHE C12	Elective laboratory – 4	-	IV
25.	CHE D13	Elective laboratory – 5	-	IV
26.	CHE D21	Project Work – PRJ	-	IV

- Elective Laboratory 3 & 4 Courses will be offered according to the Elective Theory Papers in respective semesters.
- In semester IV, the student will have choice to opt project work (12 Credits) or two elective laboratory courses of 6 credits each.



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.

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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

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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).

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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

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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.

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

SECOND SEMESTER June 2017 Exam.

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 and Molecular 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-2	ECC	6	0	0	9	0	9

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SEMESTER –II

CHE 801: ADVANCED INORGANIC CHEMISTRY– II
(Group theory, Molecular rearrangement processes and Reactivity mechanisms)

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

Symmetry and Group Theory in Chemistry

Symmetry elements and symmetry operation, multiplication of symmetry operations, definition of group, subgroup, conjugacy relation and classes. Point symmetry group. Schonflies symbols, multiplication table of C_{2v} Point group, representations of groups by matrices (representation for the C_{nh}, C_{nv}, etc, group to be worked out explicity). The great orthogonality theorem (without proof) and its importance. Relation between reducible and irreducible representation. Derivation of character table for C_{2v} and C_{3v} point group. Symmetry aspects of molecular vibrations of H_2O molecule.

UNIT-II

Molecular Rearrangement Processes

Electron transfer reactions (outer and inner sphere), HOMO and LUMO of oxidant and reductant, chemical activation. Precursor complex formation and rearrangement, nature of bridge ligands, fission of successor complexes, Two-electron transfers, Synthesis of coordination compounds using electron transfer reactions, mixed valence complexes and internal electron transfer.

UNIT-III

Inorganic Reaction Mechanism- I

Basic principles; lability, inertness, stability and instability of coordination compounds; general principles; Labile and inert Octahedral complexes according to CFT and MOT; potential energy diagrams, transition states and intermediates, isotope effects, Berry's pseudo rotation mechanism, Swain-Scott equation.

UNIT-IV

Inorganic Reaction Mechanism- II

Substitution reactions of octahedral complexes; nature of substitution reactions; Theoretical approach to substitution mechanisms; mechanism of substitution reaction of complexes of cobalt; acid hydrolysis and base hydrolysis of Co (III) complexes.

Substitution reactions of square planar complexes; reaction of Pt (II) complexes; trans effect and its applications to synthesis of complexes; theories of trans effect; mechanism of substitution - kinetics of substitution of Pt(II) complexes; factors affecting the reactivity of square planar complexes.

SUGGESTED BOOKS AND REFERENCES

1. Inorganic Chemistry, Principles of Structure and Reactivity, 4thEdition, James E. Huheey: Ellen 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. Introductory Quantum Chemistry, A.K. Chandra (Tata McGraw Hill)
6. Chemical Applications of Group Theory, F.A. Cotton.

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CHE 802: STEREOCHEMISTRY, PHOTOCHEMICAL AND PERICYCLIC REACTIONS AND MOLECULAR REARRANGEMENTS

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

Stereochemistry

Optical activity and chirality, elements of symmetry, specification of configuration - molecules with more than one chiral center. D/L, R/S and Threo/Erythro nomenclature.

Prochirality, Homotopic and Heterotopic ligands and faces, Enantiotopic groups and faces, Re/Si Nomenclature. Stereospecific and stereoselective reactions.

Optical activity in the absence of chiral carbon (biphenyls, allenes, spiranes, ansa compounds). Chirality due to helicity. Chirality in the compounds containing N, S and P.

Geometrical isomerism in cyclic and condensed systems, Conformational analysis of cycloalkanes, decalins, effect of conformation on reactivity.

Cram's, Prelog's and Horeau's rules. Circular birefringence, CD, ORD, Octant rule, Cotton effect. The axial haloketone rule. Determination of configuration (absolute and relative) and conformation.

UNIT II

Organic Photochemistry

Photochemical excitation – interaction of electromagnetic radiation with organic molecules, types of excitations, fate of excited molecules - Jablonskii diagram, intersystem crossing, energy transfer, photosensitization, quenching, quantum yield, Frank-Condon principle.

Photochemical reactions of ketones – Norrish type I cleavage, Norrish type II cleavage; photo reductions; Paterno-Buchi reactions; photochemistry of α,β-unsaturated ketones, β,γ-unsaturated ketones.

Photochemistry of alkenes: intramolecular reactions of the olefinic bond – cis-trans isomerisation (stilbene), cyclization reactions.

Photochemistry of aromatic compounds: photochemical rearrangement, photostationary state, isomerizations.

UNIT III

Pericyclic Reactions

Characteristics and Classification of pericyclic reactions, thermal and photochemical reactions. Molecular orbital symmetry. Woodward-Hoffmann selection rules, Fukui's FMO approach. Woodward-Hoffmann's conservation of orbital symmetry and correlation diagrams and PMO method.

Electrocyclic reactions: conrotatory and disrotatory motions, 4n, 4n+2 π electron and allyl systems. Valence Tautomerism.

Cycloadditions: antarafacial and suprafacial additions, 4n and 4n+2 π electron systems. Diels-Alder reaction – stereoselectivity (endo, exo), and regioselectivity; normal and inverse electron demand Diels-Alder reactions; asymmetric Diels-Alder reactions; retro-Diels-Alder reactions; 2+2 addition of ketenes, 1,3-dipolar cycloadditions. Cheletropic reactions.

Sigmatropic rearrangements: suprafacial and antarafacial shifts of C-H and C-C bonds. Retention & inversion of configuration. 3,3- and 5,5-sigmatropic rearrangements. Claisen, Cope and aza-Cope rearrangements. Fluxional tautomerism. Ene reaction.

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UNIT IV

Molecular Rearrangements

Mechanistic aspects, nature of the migration, migratory aptitudes, memory effects. A detailed study of the following rearrangements: Benzil-benzilic acid rearrangement, Favorskii rearrangement, Neber rearrangement, Beckmann rearrangement, Hoffmann rearrangement, Curtius rearrangement, Lossen rearrangement, Wolff rearrangement, Wittig rearrangement, Fritsch-Buttenberg-Wiechell rearrangement, Stevens rearrangement, Chapman rearrangement, Wallach rearrangement.

Photochemical rearrangements: rearrangement of 1,4- and 1,5-dienes, di-π methane rearrangement. rearrangement of cyclohexadienone (conjugate and cross conjugate), Dienone-Phenol rearrangement.

SUGGESTED BOOKS AND REFERENCES

1. E. L. Eliel and Samuel H. Wilen, Stereochemistry of Carbon Compounds, Wiley-Interscience, 1994.
2. D. Nasipuri, Stereochemistry of Organic Compounds, Principles and Applications, New Academic Science Ltd., 2012.
3. P. S. Kalsi, Stereochemistry: Conformation and Mechanism, 7th edition, New Age International Publisher Ltd, New Delhi, 2009.
4. J. Clayden, N. Greeves, S. Warren and P. Wothers, Organic Chemistry, Oxford University Press, 2001.
5. Jerry March, Advanced Organic Chemistry: Reactions Mechanisms and Structure, McGraw Hill, 1977.
6. E. S. Gould, Mechanism and Structure in Organic Chemistry, Holt, Rinehart and Winston.
7. FA Carey and RJ Sundberg, Advanced Organic Chemistry Part-A, 5th Ed. Springer (2007).
8. Peter Sykes, A Guide Book to Mechanism in Organic Chemistry, Longman.
9. C.K. Ingold, Structure and Mechanism in Organic Chemistry, Cornell University Press.
10. R.T. Morrison and R.N. Boyd, Organic Chemistry, Prentice-Hall.
11. H.O. House, Benjamin, Modern Organic Reactions.
12. R O C Norman and J.M. Coxon, Principles of Organic Synthesis, Blackie Academic & Professional.
13. S.M. Mukherji and S.P. Singh, Reaction Mechanism in Organic Chemistry, Macmillan.
14. R. B. Woodward and R. Hoffmann, Conservation of Orbital Symmetry, Verlag Chemie: Weinheim (1970).
15. Ian Fleming, Pericyclic Reactions, Oxford Chemistry.
16. S. Sankararaman, Pericyclic Reactions- A Texthook, Wiley-VCH, Weinheim, 2005.
17. Gilbert A and Baggott J., Essentials of Molecular Photochemistry, Blackwell Scientific Publication.
18. Turro N.J., W.A. Benjamin, Molecular Photochemistry.
19. Cox A. and Camp T., Introductory Photochemistry, McGraw Hill.
20. Fleming I., Molecular orbitals and photochemical reactions,
21. Coxon J. and Halton B., Organic Photochemistry, Cambridge University Press.
22. Albright T., Burdet J and Whango M, Orbital interaction in chemistry, Wiley VCH

CHE 803: THERMODYNAMICS AND CHEMICAL KINETICS

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

Classical Thermodynamics

Brief resume of concept of laws of thermodynamics, free energy functions and their significance, Partial molar properties; partial molar free energy, chemical potential and entropies, partial molar volume and partial molar heat content and their significances. Determination of these quantities. Fugacity: effect of temperature and pressure, determination of fugacity.

Non-ideal systems: Excess functions for non-ideal solutions. Activity, activity coefficient and its determination. Debye-Huckel theory for activity coefficient of electrolytic solutions; Ionic Strength. Application of phase rule to three component systems; second order phase transitions.

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UNIT-II

Statistical Thermodynamics

Concept of distribution, thermodynamic probability and most probable distribution. Ensemble averaging, postulates of ensemble averaging. Canonical, grand canonical and microcanonical ensembles, corresponding distribution laws (using Lagrange's method of undetermined multipliers). Partition functions-translational, rotational, vibrational and electronic partition functions. Calculation of thermodynamic properties in terms of partition functions. Application of partition functions chemical potential and equilibrium constant in terms of partition functions.

Heat capacity behavior of solids, Fermi-Dirac statistics, distribution law and applications to metal. Bose-Einstein statistics distribution Law and application to helium.

UNIT-III

Chemical Kinetics - I

Methods of determining rate laws, Arrhenius equation and the effect of temperature on reaction rate.

Collision' theory of reaction rates, Modified collision theory and steric Factor, Activated complex theory, steady state kinetics, ionic reactions, kinetic salt effects, kinetic and thermodynamic control of reactions, enzyme catalysis.

UNIT-IV

Chemical Kinetics - II

Dynamics and features of chain reactions: (hydrogen-bromine reaction, pyrolysis of acetaldehyde, decomposition of ethane), photochemical reactions (hydrogen-bromine and hydrogen-chlorine Reaction). General features of fast reactions, study of fast reactions by flow method, relaxation method, flash photolysis and the NMR methods. Unimolecular reactions, Dynamics of unimolecular reactions, Lindemann, Hinshelwood and Rice-Ramsperger-Kassel-Marcus (RRKM) theories of unimolecular reactions.

SUGGESTED BOOKS AND REFERENCES

1. Physical Chemistry: P. W. Atkins, ELBS.
2. Chemical Kinetics, K.J. Laidler, McGraw Hill.
3. Kinetics and Mechanism of Chemical Transformation; J. Rajaraman and J. Kuriacose, Plenum.
4. Thermodynamics for Chemist, Samuel Glasstone, East West Press.
5. Introduction to Chemical Thermodynamics, R. P. Rastogi and R. R. Mishra, Vikash Publication House.
6. Principles of Physical Chemistry, Puri, Sharma and Pathaniya, Vishal Publication.

CHE 811: CORE LABORATORY

6 Credits (9 hrs/week)

Ex. 1 Preparation of the following selected inorganic compounds and their studies by IR spectra, Mössbauer, ESR and Magnetic susceptibility measurements:

i. Sodium tetrathionate $Na_2S_4O_6$
ii. $CuCl_2.2DMSO$
iii. N,N bis (salicylaldehyde) ethylenediamine, Salen H_2, Co (Salen)
iv. Copper glycine complex – *cis*- and *trans* bis (glycinato) Copper (II)
v. Linkage Isomers: Nitritopentaamminecobalt (III) Chloride, $[Co(NH_3)_5ONO]Cl_2$ and Nitropentaaminecobalt (III) Chloride, $[Co(NH_3)_5NO_2]Cl_2$
vi. *Cis*- and *trans*-dichlorobis(ethylenediammine)cobalt(III) chloride, $[Co(en)_2Cl_2]Cl$

Handling of air and moisture sensitive compounds under vacuum.

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Ex. 2 Two step Organic Synthesis

i. Aniline → 2,4,6-Tribromoaniline → 1,3,5-Tribromobenzene
i. Aniline → Diazoaminobenzene → *p*-Aminoazobenzene
ii. Phthalic anhydride → Fluorescein → Eosin
iii. Phthalic anhydride → Phthalimide → Anthranilic acid
iv. Acetanilide → p-Nitroacetanilide → p-Nitroaniline

The products may be characterized by m.pt / spectral techniques.

Ex. 3 A. Chemical Kinetics

i. Determination of the effect of (a) Change of temperature (b) Change of concentration of reactant and catalyst and (c) Ionic strength of the media on the velocity constant of hydrolysis of an ester/ionic reactions.
ii. Determination of the velocity constant of hydrolysis of an ester/ionic reaction in micellar media.
iii. Determination of the rate constant for the oxidation of iodide ions by peroxide studying the kinetics as an iodine clock reaction
iv. Flowing clock reaction (Ref: Experiments in physical Chemistry by Snowmaker).
v. Determination of the primary salt effect on the kinetics of ionic reactions and testing of the Bronsted relationship (iodide ion is oxidized by persulphate ion).
vi. Oscillatory reaction.

B. Thermodynamics

i. Determination of partial molar volume of solute (e.g. KCl) and solvent in a binary mixture.
ii. Determination of the temperature dependence of the solubility of a compound in two solvents having similar intramolecular interactions (benzoic acid in water and in DMSO-water mixture) and calculate the partial molar heat of solution.

CHE B02: BIOMOLECULES

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

Enzymes

Introduction and historical perspective, chemical and biological catalysis, remarkable properties of enzymes like catalytic power, specificity and regulation. Nomenclature and classification, extraction and purification. Fischer's lock and key and Koshland's induced fit hypothesis, concept and identification of active site by the use of inhibitors, affinity labeling and enzyme modification by site-directed mutagenesis. Enzyme kinetics, Michael's-Menten and Lineweaverburk plots, reversible and irreversible inhibition.

UNIT-II

Mechanism of Enzyme Action

Transition-state theory, orientation and steric effect, acid-base catalysis, covalent catalysis, strain or distortion. Examples of some typical enzyme mechanisms for chemotrypsin, ribonuclease, lysozyme and carboxypeptidase.

Reactions Catalysed by Enzymes

Nucleophilic displacement on a phosphorus atom, multiple displacement reactions and the coupling of ATP cleavage to endergonic processes. Transfer of sulphate, addition and elimination reactions,

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enolic intermediates in Isomerisations reactions, β-Cleavage and condensation, some isomerziation and rearrangement reactions. Enzyme catalyzed carboxylation and decarboxylation.

UNIT-III

Co-enzyme Chemistry

Cofactors as derived from vitamins, coenzymes, prosthetic groups, apoenzymes. Structure and biological functions of coenzyme A, thiamine pyrophosphate, pyridoxal phosphate, NAD^+, $NADP^+$, FMN, FAD, lipoic acid, vitamin B12. Mechanisms of reactions catalyzed by the above cofactors.

Enzyme Models

Host-guest chemistry, chiral recognition and catalysis, molecular recognition, molecular asymmetry and prochirality biometric chemistry, crown ether, cryptates, cyclodextrins, cyclodextrin-based enzyme models, clixarenes, ionospheres, micelles synthetic enzymes or synzymes.

UNIT-IV

Biotechnological Applications of Enzymes

Large-scale production and purification of enzymes, techniques and methods of immobilization of enzymes, effect of immobilization on enzyme activity, application of immobilized enzymes, use of enzymes in food and drink industry-brewing and cheese-making, syrups from crown starch, enzymes as targets for drug design. Clinical uses of enzymes, enzyme therapy, enzymes and recombinant DNA technology.

SUGGESTED BOOKS AND REFERENCES

1. Bioorganic Chemistry: A chemical Approach to Enzyme Action, Hermann Dugas and C. Penny, Springer Verlag.
2. Understanding Enzymes, Trevor Palmer, Prentice hall.
3. Enzyme Chemistry: Impact and Applications, Ed. Collin J Suckling, Chemistry.
4. Enzyme Mechanisms, Ed. M.I. Page and A Williams, Royal Society of Chemistry.
5. Bioorganic and Supramolecular Chemistry, P. S. Kalsi and J. P. Kalsi, New Age International Publication (2010).

CHE D01: SPECTROSCOPY-II

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

Ultraviolet and Visible Spectroscopy

Various electronic transitions (185-800 nm) Beer-Lambert law, effect of solvent on electronic transitions, ultraviolet bands for carbonyl compounds, unsaturated carbonyl compounds, dienes, conjugated polyenes. Woodward-Fieser rules for conjugated dienes and carbonyl compounds, ultraviolet spectra of aromatic compounds. Steric effect in biphenyls.

Infrared Spectroscopy

Characteristic vibrational frequencies of aromatic compounds, alcohols, ethers, phenols and amines. Detailed study of vibrational frequencies of carbonyl compounds (ketones, aldehydes, esters, amides, acids, anhydrides, lactones, lactams and conjugated carbonyl compounds). Effect of hydrogen bonding and solvent effect on vibrational frequencies, overtones, combination bands and Fermi resonance.

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UNIT II

Mass Spectrometry

Introduction, ion production - EI, CI, FD and FAB, factors affecting fragmentation, ion analysis, ion abundance. Mass spectral fragmentation of organic compounds common functional groups, molecular ion peak, metastable peak. McLafferty rearrangement. Ring rule, Nitrogen rule. High resolution mass spectrometery. Examples of mass spectral fragmentation of organic compounds with respect to their structure determination.

UNIT III

Proton Magnetic Resonance Spectroscopy

Chemically nonequivalent protons, 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 interaction between two, three, four and five nuclei (first order spectra). Stereochemistry, hindered rotation. Karplus curve-variation of coupling constant with dihedral angle. Simplification of complex spectra - nuclear magnetic double resonance, NMR shift reagents, solvent effects. Fourier transform technique, nuclear overhauser effect (NOE).

UNIT IV

Carbon-13 NMR Spectroscopy

General consideration, chemical shift (aliphatic, olefinic, alkyne, aromatic, heteroaromatic and carbonyl carbon), coupling constants. Two dimension NMR spectroscopy - COSY, NOESY, DEPT, INEPT, APT and INADEQUATE techniques.

Applications of Spectroscopy - Problems based on UV, IR, NMR spectroscopy and Mass spectrometry for structural elucidation of organic compounds.

SUGGESTED BOOKS AND REFERENCES

1. Spectrometric Identification of Organic Compounds, R.M. Silverstein. G.C. Hassler and T.C. Morrill, John Wiley.
2. Fundamentals of Spectroscopy by Banwell and McCash
3. Introduction to NMR Spectroscopy, R.J. Abraham, J. Fisher and P. Lofitus, Wiley.
4. Application of Spectroscopy of Organic Compounds, J.R Dyer, Prentice Hall.
5. Spectroscopic Methods in Organic Chemistry D.H. Williams, I. Fleming, Tata McGraw-Hill.
6. Organic Spectroscopy, William Kemp, Macmillan.

CHE D02: ENVIRONMENTAL 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

Atmospheric Chemistry

Atmospheric layers, Vertical temperature profile, heat/radiation budget of the earth atmosphere systems. Properties of troposphere, thermodynamic derivation of lapse rate. Temperature inversion. Calculation of Global mean temperature of the atmosphere. Pressure variation in atmosphere and scale height. Biogeochemical cycles of carbon, nitrogen, sulphur, phosphorus oxygen. Residence times. Sources of trace atmospheric constituents: nitrogen oxides, sulphur dioxide and other sulphur compounds, carbon oxides, chlorofluorocarbons and other halogen compounds, methane and other hydrocarbons.

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Tropospheric Photochemistry

Mechanism of photochemical decomposition of NO_2 and formation of ozone. Formation of oxygen atoms, hydroxyl, hydroperoxy and organic radicals and hydrogen peroxide. Reactions of hydroxyl radicals with methane and other organic compounds. Reactions of OH radicals with SO_2 and NO_2. Formation of Nitrate radical and its reactions. Photochemical smog, meteorological conditions and chemistry of its formation.

UNIT-II

Air Pollution: Air pollutants and their classifications. Aerosols-sources, size distribution and effect on visibility, climate and health.

Acid Rain: Definition, Acid rain precursors and their aqueous and gas phase atmospheric oxidation reactions, damaging effects on aquatic life, plants, buildings and health. Monitoring of SO_2 and NO_x, acid rain control strategies.

Stratospheric Ozone Depletion: Mechanism of ozone formation, Mechanism of catalytic ozone depletion, discovery of Antarctic ozone hole and role of chemistry and meteorology, control Strategies.

Green House Effect: Terrestrial and solar radiation spectra, major green house gases and their sources and global warming potentials. Climate change and consequences.

Urban Air Pollution: Exhaust emissions, damaging effects of carbon monoxide, monitoring of CO, control strategies.

UNIT-III

Aquatic Chemistry and Water Pollution

Redox chemistry in natural waters. Dissolved oxygen, biological oxygen demand, chemical oxygen demand, determination of DO, BOD and COD. Aerobic and anaerobic reactions of organic sulphur and nitrogen compounds in water, acid-base chemistry of fresh water and sea water. Aluminium, nitrate and fluoride in water, petrification, sources of water pollution, treatment of waste and sewage, purification of drinking water, techniques of purification and disinfection.

UNIT-IV

Environmental Toxicology

Toxic Heavy Metals: Mercury, lead, arsenic and cadmium, causes of toxicity, bioaccumulation, sources of heavy metals, chemical speciation of Hg, Pb, As, and Cd, biochemical and damaging effects.

Toxic Organic Compounds: Pesticides, classification, properties and uses of organochlorine and ionospheres pesticides, detection and damaging effects.

Polychlorinated Biphenyls: Properties, use and environmental continuation and effects.

Polynuclear Aromatic Hydrocarbons: Source, structures and as pollutants.

Soil and Environmental Disasters: Soil composition, micro and macronutrients, soil pollution by fertilizers, plastic and metals. Methods of re-mediation of soil. Bhopal gas tragedy, Chernobyl, three mile island, Minamata disease, Sevoso (Italy), London smog.

SUGGESTED BOOKS AND REFERENCES

1. Environmental Chemistry, Colin Baird, W.H. Freeman Co. New York, 1998.
2. Chemistry of Atmospheres. R.P. Wayne, Oxford.
3. Environment Chemistry, A.K. De, Wiley Eastern, 2004.
4. Environmental Chemistry, S.E. Manahan, Lewis Publishers.
5. Introduction to Atmospheric Chemistry, P.V. Hobbs, Cambridge.

CHE D12: ELECTIVE LABORATORY –2

6 Credits (9 hrs/week)

Ex. 1 A. Laboratory Estimations

i. Analysis of bauxite with respect to Aluminium (gravimetrically).
ii. Estimation of Fe^{2+} ions in rust.
iii. Estimation of Cr^{3+} ions in tannery waste.
iv. Estimation of available chlorine in bleaching powder.

B. Synthesis of following inorganic compounds and their characterization by IR spectra:

i. Sodium hexanitritocobaltate (III), $Na_3[Co(NO_2)]_6$
ii. Sodiumthiosulphate, $Na_2S_2O_3 \cdot 5H_2O$
iii. Pentaamminechlorocobalt(III) chloride, $[CoCl(NH_3)_6]Cl_2$
iv. Prussian Blue, $Fe_4[Fe(CN)_6]_3$
v. Hexaamminecobalt(III) chloride, $[Co(NH_3)_6]Cl_3$

Ex. 2 Organic Quantitative Analysis

i. Estimation of amines using bromate-bromide solution or acetylation method.
ii. Estimation of phenols using bromate-bromide solution or acetylation method.
iii. Determination of number of hydroxyl groups in an organic compound by acetylation method.
iv. Estimation of Sugars using Fehling solution method.
v. Determination of Neutralization Equivalent of given carboxylic acid.
vi. Determination of Iodine number and Saponification value of an oil sample.
vii. Estimation of Sulphur by Messenger or Fusion method.

Ex. 3 UV-Visible Spectroscopy

i. Determination of pKa of an indicator (e.g. methyl red) in (a) aqueous and (b) micellar media.
ii. Determination of stoichiometry and stability constant of Ferric-isothiocyanate complex ion in solution.
iii. Determination of rate constant of alkaline bleaching of Malachite green and effect of ionic strength on the rate of reaction

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UNIVERSITY OF RAJASTHAN

JAIPUR

(Faculty of Science)

M. Sc. Chemistry

III & IV SEMESTER (2017-2018)

M.Sc. CHEMISTRY

Syllabus 2017-18
Credit-based Semester System with continuous assessment.

To acquire a Master degree in Chemistry, a candidate is required to earn minimum of 120 credits with grade E or higher.

Credit registration at least once in all Compulsory Credit Course (CCC) and earning all credits for accumulation of the prescribed minimum credit with grade E or higher grade in all CCC will be binding.

SCHEME OF EXAMINATION:

- Each Semester shall have continuous assessment which shall include internal assessment in theory and practical by internal examination/seminar/oral examination/viva-voce etc, besides assessment of candidate's regularity and performance in the class.
- A candidate has to pass in the continuous assessment as well as EoSE (End of Semester Examination) paper separately.
- Each EoSE of theory paper shall carry 100 marks and will be of 3 hours duration. Candidate has to attempt five (05) questions in all. All questions carrying equal marks.
- Part 'A' of the theory paper shall contain 10 Short Answer Questions of total 20 marks, based on knowledge, understanding and applications of the topics/texts covered in the whole syllabus. Each question will carry two (02) marks for correct answer.
- Part 'B' of the theory paper will have total four questions of 20 marks each, framed by taking one question from each unit with internal choice. The limit of answer will be five pages.
- Each Laboratory EoSE will be of six hours durations and involve laboratory experiments/exercises, record and viva-voce examination with weightage in ratio of 75:25.
- The Practical examination will be conducted by board of examiners consisting of one internal (to be appointed by the Head of Department) and one external examiner (to be appointed by the University).
- The medium of instruction and examination shall be English only.

COURSE STRUCTURE

The Credit Courses of the programme have been classified as below:

- CCC: Compulsory Core Course
- ECC: Elective Core Course
- SSC: Self Study Course
- PRJ: Project Work

The details of the courses with code, title and the credits assigned are tabulated below -

THIRD SEMESTER

S. No.	Subject Code	Course Title	Course Category	Credit	Contact hours / week			EoSE Duration (hrs)	
					L	T	P	Th	P
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	Bio-Physical Chemistry	CCC	4	4	0	0	3	0
4.	CHE 911	Chemistry Core Laboratory – 3	CCC	6	0	0	9	0	6
5.		Theory Elective – 1	ECC	4	4	0	0	3	0
6.		Theory Elective – 2	ECC	4	4	0	0	3	0
7.		Theory Elective – 3	ECC	4	4	0	0	3	0
8.		Elective Laboratory – 3	ECC	6	0	0	9	0	6

- Theory elective papers 1-3 to be opted from one of the three elective groups offered.
- Elective Laboratory -3 will be according to the opted Elective Theory group

FOURTH SEMESTER

S. No.	Subject Code	Course Title	Course Category	Credit	Contact hours / week			EoSE Duration (hrs)	
					L	T	P	Th	P
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	CCC	4	4	0	0	3	0
4.		Theory Elective – 1	ECC	4	4	0	0	3	0
5.		Theory Elective – 2	ECC	4	4	0	0	3	0
6.		Theory Elective – 3	ECC	4	4	0	0	3	0
7.		Elective Laboratory – 4	ECC	6	0	0	9	0	6
8.		Elective Laboratory – 5	ECC	6	0	0	9	0	6
9.		Project Work * (With an option of Project work of 12 credits in place of two Elective labs)	PRJ	12	0	0	18		

- Theory elective papers 1-3 to be opted out of one of three elective groups offered
- Elective Laboratory - 4 will be according to the opted Elective Theory group
- The students will have choice to opt project work (12 Credits) or two elective laboratory courses of 6 credits each.

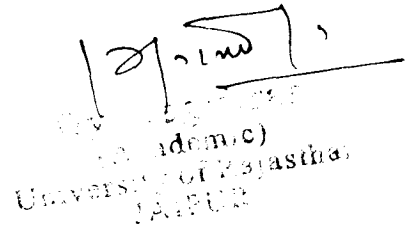
III & IV Semester

Elective Core Courses (ECC) Groups

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

S. No.	Elective Course Code	Paper Title	Prerequisite	Course available in Semester
1.	CHE A02	Bioinorganic Chemistry	-	III
2.	CHE A03	Supramolecular Chemistry	-	III
3.	CHE A04	Inorganic Polymers	-	III
4.	CHE A05	Advanced Bioinorganic Chemistry	CHE A02	IV
5.	CHE A06	Materials and Industrial Chemistry	-	IV
6.	CHE A07	Photoinorganic Chemistry	-	IV
7.	CHE B03	Heterocyclic Chemistry – I	-	III
8.	CHE B04	Natural Product – I	-	III
9.	CHE B05	Medicinal Chemistry – I	-	III
10.	CHE B06	Heterocyclic Chemistry – II	CHE B03	IV
11.	CHE B07	Natural Product – II	CHE B04	IV
12.	CHE B08	Medicinal Chemistry – II	CHE B05	IV
13.	CHE C02	Advanced Electrochemistry – I	-	III
14.	CHE C03	Advanced Chemical Kinetics – I	-	III
15.	CHE C04	Chemical Analysis	-	III
16.	CHE C05	Advanced Chemical Kinetics – II	CHE C02	IV
17.	CHE C06	Advanced Electrochemistry – II	CHE C03	IV
18.	CHE C07	Advanced Nanoscience and Nanotechnology	-	IV
19.	CHE A11	Elective laboratory – 3	-	III
20.	CHE B11	Elective laboratory – 3	-	III
21.	CHE C11	Elective laboratory – 3	-	III
22.	CHE A12	Elective laboratory – 4	-	IV
23.	CHE B12	Elective laboratory – 4	-	IV
24.	CHE C12	Elective laboratory – 4	-	IV
25.	CHE D13	Elective laboratory – 5	-	IV
26.	CHE D21	Project Work – PRJ	-	IV

- Elective Laboratory 3 & 4 Courses will be offered according to the Elective Theory Papers in respective semesters.
- In semester IV, the student will have choice to opt project work (12 Credits) or two elective laboratory courses of 6 credits each.



SEMESTER – III

CHE 901: ORGANOTRANSITION METAL CHEMISTRY

UNIT-I

Synthesis, Properties, Structure and Bonding of:

(Giving some specific examples)

(i) η^1- bonded alkyl complexes
(ii) η^1- carbene and carbyne complexes
(iii) η^2 - alkene and alkyne complexes
(iv) η^3- allyl complexes
(v) η^4 - dienyl complexes
(vi) η^5- dienyl complexes

UNIT-II

Metal nitrosyls, cyanides and isocyanides:

Synthesis, reactions, structure and bonding in metal nitrosyls: nitrosyl complexes, metal cyanides and isocyanides: cyanogens, cyanates and its analogue. Sulfur, selenium and tellurium ion. Diisocyanides, reactions of isocyanide complexes and their uses.

UNIT-III

Synthetic and Catalytic Aspects of Organotransition Metal Chemistry:

(i) Transition metal organometallics in organic synthesis
(ii) Homogenous catalysis by transition metal organometallics
(a) Hydrogenation of alkenes
(b) Hydrosilylation of alkenes
(c) Metathesis of alkenes
(d) Oligomerization and polymerization of alkenes and alkynes
(e) Hydroformylation of alkenes
(f) Acetic acid synthesis and other carbonylation reactions
(g) Oxidation of alkenes

UNIT-IV

Catalysis

(a) Heterogenous catalysis by organotransition metal compounds
(b) Fisher-Tropsch synthesis: Methanation reactions, Synthesis of methanol, gasoline production, function of ZSM-5 Zeolite in stabilization of carbine molecule, application of reaction to industry.
(c) Water gas shift reaction: Role of ZnO/Cr_2O_3 in the reaction, Acetic acid synthesis from water gas shift, Role of Co catalyst.
(d) Fluxional organometallic compounds: Rate of rearrangement, Simple examples of non rigid molecules in different coordination geometries, classification, future developments.

SUGGESTED BOOKS AND REFERENCES

1. J.P. Collman, L.S. Hegsdus, J.R. Norton and R.G. Finke, Principles and Applications of Organotransition Metal Chemistry, University Science Books, 1987.
2. R.H. Crabtree, The Organometallic Chemistry of Transition Metals, John Willey, 1989.
3. A.J. Pearson, Metalloorganic Chemistry, Wiley, 1985.
4. R. C. Mehrotra and A. Singh, Organometallic Chemistry, New Age International, 1991.
5. J.P. Candlin K. Aayler and D.T Thomson, Reaction of Transition Metal Complexes, Elsevier
6. M.L.H. Green, Organometallic Compounds, Vol. II, Methuen, 1968.

CHE 902: ORGANIC SYNTHESIS-I

UNIT - I

Enolate Chemistry

Formation of enolates, kinetic and thermodynamic control. Reactions of enolate anions with electrophiles: O vs C alkylation. Enolate condensation reactions: Synthetic applications of inter- and intramolecular Aldol condensations, Claisen, Dieckmann, Knovenagel, Stobbe condensations, Mukaiyama Aldol reaction. Boron enolates. Nozaki-Hiyama-Kishi coupling. Stereoselective enolate reactions: diastereoselection, Zimmermann-Traxler model, Evans model, Noyori open-chain model. Michael addition and related reactions. Baylis-Hillmann reaction, Robinson annulations. α-Halogenation, Reformatski reaction.

UNIT - II

Metal and non-metal mediated oxidation

Mechanism, selectivity, stereochemistry and applications of Oppenauer oxidations, aromatization, dehydrogenation, cleavage of C=C bond, ozonolysis, epoxidation using peracids, Baeyer-Villeger oxidation. Oxidations using $FeCl_3$, DDQ, NBS, lead tetraacetate, selenium dioxide, Ag, Cr and Mn reagents, periodic acid and osmium tetraoxide. DMSO-based oxidations. Oxidation of S, Se and N containing compounds.

Hydroboration: Introduction, preparation of alkyl- and alkenylboranes. Synthetic transformations: protonolysis, hydrohalogenation, coupling, isomerisation and displacement reactions. Preparation of amines and sulfides *via* hydroboration.

UNIT - III

Metal and non-metal mediated reduction

Mechanism, selectivity, stereochemistry and applications of catalytic hydrogenations (using Pd, Pt and Ni catalysts), Clemmensen reduction, Wolff-Kishner reduction, Meerwin-Ponndorf-Verley reduction, dissolving metal reductions, metal hydride reductions ($NaBH_4$, $LiAlH_4$, DIBAL). Stereoselectivity in hydride transfer reductions, Wilkinson's catalysis. Boranes in reduction. Hydrosilylation. Photoreduction.

UNIT – IV

New Synthetic Reactions

a. Metal mediated C-C and C-X coupling reactions: Suzuki, Heck, Stille, Sonogashira cross coupling, Buchwald-Hartwig amination and Negishi, Kumada coupling reactions.
b. C=C Formation Reactions: Shapiro, Bamford-Stevens, McMurrey reactions, Julia-Lythgoe olefination and Peterson's stereoselective olefination.
c. Multicomponent Reactions: Mannich, Biginelli, Hantzsch, Passerini, Ugi reaction.
d. Ring Formation Reactions: Pausan-Khand reaction, Bergman cyclisation, Nazarov cyclisation.
e. Click Chemistry: Criteria for Click reaction, Sharpless azide cycloadditions.
f. Olefin metathesis: Shrocks, Grubb's 1st and 2nd generation catalyst, Grubb-Hoveyda catalyst. Olefin cross metathesis (OCM), ring closing metathesis (RCM), ring opening metathesis (ROM) and applications.
g. Other important synthetic reactions: Eschenmoser-Tanabe fragmentation, Mitsunobu reaction, Stork-enamine reaction.

SUGGESTED BOOKS AND REFERENCES

1. Carey A and Sundberg R.J., Advanced Organic Chemistry, Part B: Reaction and Synthesis, Springer, 2008.

2. March J, Advanced organic chemistry: Reactions, mechanism and stereochemistry, John Wiley, 2013.
3. Parkanyi C., Theoretical organic chemistry, Elsevier, 1997.
4. Kurti L, Czako B, Strategic applications of named reactions in organic synthesis, Academic Press, 2005.
5. Smith M.B., Organic synthesis, McGraw Hill, 2002.
6. Nicolaou E.J., Classics in total synthesis, Chemie Verlag, 1996.
7. Corey E.J. and Cheng X.M., The logic of chemical synthesis, John Wiley & Sons, 1989.
8. Fieser and Fieser, Reagents for organic synthesis, Wiley, 1967.
9. Wipf P, Handbook of reagents for organic synthesis, John Wiley & Sons, 2005.
10. Greene T, Wuts P.G.M., Protecting group in organic synthesis, John Wiley & Sons, 1989.
11. Carruther W., Modern methods of organic synthesis, Cambridge University Press, 1971.
12. Smith W.A., Bochkor A.F., Caple, R., Organic synthesis: The science behind art, RSC, 1998.

CHE 903: BIO-PHYSICAL CHEMISTRY

UNIT I

Biological Cell and its Constituents:

Biological Cell, Structure and functions of proteins, DNA and RNA in living system, Helix Coil Transition.

Cell Membrane and transport of Ions:

Structure and functions of cell membrane, ion transport through cell membrane, irreversible thermodynamic treatment of membrane transport, Nerve conduction, Domman membrane equilibrium. Active transport mechanisms. Autoanalyzers. Biological Half life, effective half life, Stable isotopes, Radioactive tracer and dilution analysis.

UNIT II

Bioenergetics:

Standard free energy change in biological reactions, Exergonic and endergonic processes, Hydrolysis of ATP, Synthesis of ATP from ADP.

Biopolymer Interactions:

Forces involved in biopolymers interactions, Electrostatic charges and molecular expansions, hydrophobic forces, dispersion forces, Multiple Equilibria and various binding process in biological systems. Hydrogen ion titration curve.

UNIT III

Statistical Methods in Biopolymer:

Chain Configuration of macromolecules, statistical distribution end to end dimensions, calculations of average dimension of various chain structure. Polypeptide and protein structure. Introduction to protein folding problems.

Molecular weights of biopolymers:

Evaluations of size, shape and extent of hydration of biopolymers by various experiments, determination of molecular weight of biopolymers by light scattering, sedimentation, viscosity and osmotic pressure methods. Bio-degradable polymers.

UNIT IV

Biosensors

Definition, Biosensor system, Bio receptors, surface attachment of biological elements. Electro-chemical transducers, placement of biosensors.

Applications:

Glucose monitoring, food analysis, DNA biosensors, microbial biosensors, commercialized biosensors, identification of blood glucose (diabetes) and pregnancy test by colorimetric and electrochemical strip.

SUGGESTED BOOKS AND REFERENCES

1. Satake and Iqbal, Biophysical Chemistry, Discovery Press, 2003.
2. James P Allen, Biophysical Chemistry, Wiley-Blackwell Publisher, 2008.
3. Alan Cooper, Biophysical Chemistry, RSC Publication, 2004, ISBN: 978-0-85404-480-1.
4. Upadhyay, Biophysical Chemistry, Himalaya Publishing Publication House, 2014.
5. Zhang, Ju and Joseph Wang, Electrochemical Sensors, Biosensors and their Bio-medical Applications, Academic Press, Elsevier, 2008.

CHE A02: BIOINORGANIC CHEMISTRY

UNIT - I

Metals in Life Processes:

Role of metal ions in biological systems; essential and non-essential elements- macro minerals and essential trace elements- synergism and antagonism among essential trace elements; active transport of Na, K, Mg and Ca ions across the biological membrane; elements of bioenergetics with special reference to elements of high energy phosphate bond.

UNIT - II

Electron Carriers and Photosynthesis:

(a) Electron transfer in biology: Structure and functions of electron transfer proteins. Cytochromes and respiratory chain, iron-sulphur proteins rubredoxin and ferridoxins. Synthetic models for Fe_4S_4 cluster only.

(b) Photosynthetic pigments: Photochemistry of chlorophyll molecules, mechanism of photosynthesis, Calvin cycle and Quantum efficiency. Function of photosystem- I and photosystem-II. Cyclic and noncyclic phototphosphorylation.

UNIT - III

Transport and Storage of Dioxygen:

Haem proteins and oxygen uptake. Structure and function of haemoglobin, mygolobin. Structural model for dioxygen binding-co-operativity, Perutz mechanism and Bohr effect; non-haem oxygen carriers in some lower animals, haemocyanin and haemerythrin. Model synthetic complexes of iron, cobalt and copper.

UNIT - IV

Nitrogen Fixation:

Nitrogen in biosphere, nitrogen cycle, role of microorganisms in nitrification, nitrogen fixation in soils. Biological nitrogen fixation and its mechanism, nitrogenase, Chemical nitrogen fixation and other nitrogenase model systems.

SUGGESTED BOOKS AND REFRENCES

1. S. J. Lippard and J. M. Berg, Principles of Bioinogranic Chemistry, University Science Books, Mill Valley, CA, 1994.
2. H.v.I. Bertini, H.B. Gray, S.J. Lippard and J.S. Valentine, Bioinorganic Chemistry, University Science Books, Mill Valley, CA (USA), 1994.
3. P. S. Kalsi and J. P. Kalsi, Bio-organic, Bio-inorganic and Supramolecular Chemistry, New Age International, 2010
4. G.L. Eichhorn (ed.), Inorganic Biochemistry vol. I and II, Elsevier Scientific Publishing Co., Amsterdam, 1973.
5. Stephen J. Lippard (ed.), Progress in Inorganic Chemistry, Vol 18 and 38, Wiley, 2009.

CHE A03: SUPRAMOLECULAR CHEMISTRY

UNIT-I

Introduction

Definition and development of supramolecular chemistry, classification of supramolecular host-guest compounds. Nature of supramolecular interactions: ion-ion interactions, ion-dipole interactions, dipole-dipole interactions. Cation binding hosts, binding of anions, binding of neutral molecules, binding of organic molecules.

UNIT-II

Molecular Recognition and Crystal Engineering

Receptors, design and synthesis of co receptors and multiple recognition. Hydrogen bonds, strong, weak and very weak H-bonds, utilization of H-bonds to create supramolecular structures, use of H-bonds in crystal engineering and molecular recognition.

UNIT-III

Supramolecular Reactivity and Catalysis

Supramolecular metallocatalysis, biomolecular and abiotic catalysis. Transport processes and carrier design, cation carriers, anion carriers, coupled transport processes.

UNIT-IV

Devices and Chemistry

Supramolecular devices, supramolecular photochemistry, molecular and supramolecular photonic devices, photosensitive molecular receptors. Supramolecular chemistry of Fullerene, Fullerene as guests, Fullerene as hosts, Fullerene as superconducting intercalation compounds.

SUGGESTED BOOKS AND REFERENCES

1. J.M. Lehn, Supramolecular Chemistry – Concept and Perspectives, VCH, 2006.
2. J.W. Steed and J.L. Atwood, Supramolecular Chemistry, John Wiley & Sons. Inc., 2009.
3. Bio-organic, Bio-inorganic and Supramolecular Chemistry, P.S. Kalsi and J.P. Kalsi, New Age International, 2010.

CHE A04: INORGANIC POLYMERS

UNIT-I

Basic Concepts

Classification by connectivity, and classification by dimensionality, metal/backbone classification of metal-containing polymers, linear inorganic polymer.

Unit-II

Synthesis and Characterization

Step-growth synthesis, chain polymerization, ring-opening polymerization, reductive coupling and other redox polymerization reactions, Inorganic polymer characterization: average molecular masses, and characterizing methods using Gel permeation chromatography and viscosity, degree of polymerization

Unit-III

Applications

Polysiloxane and polyphosphazene elastomers, inorganic medical polymers: polysiloxanes and polyphosphazene as bio polymers, Inorganic polymer conductivity: main group inorganic polymers, metal-containing polymers, Luminescent inorganic polymers: Ruthenium polymers for solar energy conversion.

Unit-IV

Polymetallocenes

Introduction, Polymetallocenes with short spacers obtained by condensation routes, ring-opening polymerization (ROP) of strained Metallocenophanes, thermal ROP of silicon-bridged [1]Ferrocenophanes, thermal ROP of other strained metallocenophanes, transition metal catalyzed ROP of strained metallocenophanes.

SUGGESTED BOOKS AND REFERENCES

1. Ronald D. Archer, Inorganic and Organometallic Polymers, Wiley-VCH
2. J.E. Huheey, Inorganic Chemistry, Harper Row.
3. M.F. Lappert and G.J. Leigh, Developments in Inorganic Polymer Chemistry, ACS Publications, 1963.
4. N.H. Ray, Inorganic Polymers, Academic Press, NY, 1979.
5. F.W. Billimeyer Jr., Textbook of Polymer Science, Wiley, NY, 1977.
6. H.R. Alcock and F.W. Lambe, Contemporary Polymer Chemistry, Prentice Hall
7. I. Manners, Synthetic Metal-Containing Polymers, Wiley-VCH, Weinheim, 2004.
8. A. S. Abd-El-Aziz, I. Manners Eds., Frontiers in Transition Metal-Containing Polymers, Wiley-Interscience, 2007.

CHE B03: HETEROCYCLIC CHEMISTRY– I

UNIT-I

Nomenclature of Heterocycles

Replacement and systematic nomenclature (Hantzsch-Widman system) for monocyclic, fused, spiro and bridged heterocycles.

Aromatic Heterocycles

General chemical behaviour of aromatic heterocycles, classification (structural type), criteria of aromaticity (bond lengths, ring current and chemical shifts in ^{1}H NMR-spectra, empirical resonance energy, delocalization energy and Dewar resonance energy, diamagnetic susceptibility exaltations). Heteroaromatic reactivity.

UNIT-II

Non-aromatic Heterocycles

Strain - bond angle and torsional strains and their consequences in small ring heterocycles. Conformation of six-membered heterocycles with reference to molecular geometry, barrier to ring inversion, pyramidal inversion and 1,3-diaxial interactions. Stereo-electronic effects; anomeric and related effects. Attractive interactions - hydrogen bonding and intermolecular nucleophilic electrophilic interactions.

UNIT - III

Small Ring Heterocycles

Three-membered and Four-membered Heterocycles: Synthesis and reactions of aziridines, oxiranes, thiiranes, oxaziridines, azetidines, oxetanes, thietanes and azetedinones.

UNIT-IV

Five-membered Heterocycles with Two Heteroatoms

Synthesis and reactions of 1,2- & 1,3-diazoles, oxazoles, thiazoles and azaphospholes.

Benzo-fused five-membered Heterocycles

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

SUGGESTED BOOKS AND REFERENCES

1. R.R. Gupta, M. Kumar and V. Gupta, Heterocyclic Chemistry Vol. 1& 2. Springer India, 1998 & 1999.
2. T Eicher and S. Hauptmann, The Chemistry of Heterocycles, Wiley-VCH, 2003.
3. J.A. Joule, K. Mills and G.F Smith, Heterocyclic Chemistry, Chapman and Hall, 1995.
4. T.L. Gilchrist, Heterocyclic Chemistry, Longman Scientific & Technical, 1992.
5. G.R. Newkome and W.W. Paudler, Contemporary Heterocyclic Chemistry, Wiley-Inter Science, 1982.
6. R.M. Acheson, An Introduction to the Heterocyclic Compounds, John Wiley, 1977.
7. A.R. Katritzky, C.W. Rees and E.F.V. Scriven (Eds.), Comprehensive Heterocyclic Chemistry II, ISBN: 9780080965185, Elsevier, 1996.

CHE B04: NATURAL PRODUCTS – I

UNIT- I

Terpenoids and Carotenoids

Introduction, occurrence, nomenclature, general methods of structure determination, isoprene rule, stereochemistry and synthesis of following representative molecules: Citral, Geraniol, α-Terpineol, Menthol, Farnesol, Zingiberene, Phytol, and Abietic acid. Biosynthesis of Terpenoids. General methods of structure determination of β-Carotene and Lycopene.

UNIT-II

Alkaloids

Introduction, occurrence, nomenclature, classification based on structure, isolation, general methods of structure elucidation of alkaloids, stereochemistry and synthesis of the following: Narcotine, Quinine, Reserpine and Morphine.

UNIT - III

Steroids

Occurrence, nomenclature, basic skeleton, Diel's hydrocarbon and stereochemistry. Isolation, structure determination and synthesis of Cholesterol, Bile acids, Androsterone, Testosterone, Estrogen and Progesterone. Biosynthesis of cholesterol.

Plant Hormones

Introduction, occurrence, isolation and physiological effects of Auxins, Gibberellins (Synthesis of GA_3), Cytokinins and Abscisic acid.

Nutraceuticals and Natural Products

Occurrence, isolation, biological function and structure elucidation (by spectroscopic methods) of Curcumin, Silymarin, 5-hydroxytryptophan, Chlorogenic acid and Vinpocetine.

UNIT-IV

Natural Pigments

Occurrence, nomenclature and general methods of structure determination. Isolation, structure determination and synthesis of Luteolin, Quercetin, Luteolin, Diadzein, Genistein, and Cyanidin chloride.

Porphyrins: Structure, reactions and synthesis of haemoglobin, chlorophyll, chlorins, bacteriochlorins and purpurin anhydride. Photosensitizers in Photodynamic Therapy.

SUGGESTED BOOKS AND REFERENCES

1. J. Mann, R.S. Davidson, J.B. Hobbs, D.V. Banthrope and J.B. Harborne, Natural Products, Chemistry and Biological Significance, Prentice Hall, 1994.
2. I. L. Finar, Organic Chemistry: Vol. 2, ELBS, Longman, 1996.
3. M. Norgradi, Stereoselective Synthesis; A Practical Approach, Wiley-VCH, 1994.
4. S.V. Bhat, B.A. Nagasampagi and M. Sivakumar, Chemistry of Natural Products, Narosa Publishing House, 2015.
5. Ed. Kurt Hostettmann, M.P. Gupta and A. Marston, Chemistry, Biological and Pharmacological Properties of Medicinal Plants from the Americas, Harwood Academic Publishers, 1999.
6. B.A. Bohm, Introduction to Flavonoids, Harwood Academic Publishers, 1998.
7. Ata-ur-Rahman and M.I. Choudhary, New Trends in Natural Products Chemistry, Harwood Academic Publishers, 1998.

CHE B05: MEDICINAL CHEMISTRY - I

UNIT-I

Drug Design

Development of new drugs, procedures followed in drug design, concepts of prodrugs and soft drugs, structure-activity relationship (SAR and QSAR). Factors affecting bioactivity – resonance, inductive effect, isosterism, bio-isosterism, spatial consideration. Theories of drug activity. Elementary treatment of drug receptor interactions.

UNIT-II

Pharmacodynamics : Definition, Receptors and specificity, agonists and antagonists, Site(s) of drug action, Mechanism of Drug action: therapeutic and side effects, elementary treatment of enzyme stimulation, enzyme inhibition, membrane active drugs, Drug metabolism, xenobiotics, biotransformation significance of drug metabolism in medicinal chemistry.

Pharmacokinetics : Introduction to drug absorption, disposition and elimination using pharmacokinetics, Clinical Pharmacokinetics: bioavailabilty, volume of distribution, clearance, elimination, Design and optimization of dosage regimen, Therapeutic drug monitoring, importance of pharmacokinetics and pharmacodynamics in drug development process.

UNIT-III

Posology : Definition, dose-response relationship, potency and effective dose 50 (ED 50), minimal effective concentration, efficacy: time-response graph, onset, duration and termination of action.

Drug Toxicity and Poisoning : Types of therapeutic drug toxicity, Mechanism of Toxicity, Dose response complexities, Therapeutic Index, Lethal Dose 50 (LD 50), Adverse drug effects, Principles of treatment of poisoning, Mechanism of Detoxification and testing.

UNIT-IV

Bio-statistics : Introduction its role and use, Collection, Organization: Graphics and pictorial representation of data, Sampling: Random and non random sampling methods, standard deviation and coefficient of variation, Probability, student t-test, F-Test, chi square test, correlation and regression.

SUGGESTED BOOKS AND REFERENCES

1. J. Stringer, Basic Concepts in Pharmacology, 3rd edn., McGraw-Hill Professional, 2005.
2. B. Katzung, Basic and clinical pharmacology, 11th edn., McGraw-Hill medical, 2009.
3. Goodman & Gilman, Pharmacological basis of Therapeutics, McGraw-Hill, 2005.
4. A. Burger & M.E. Wolff (Ed.), Medicinal Chemistry and Drug Discovery, Vol-1, John Wiley, 1994.
5. S.S. Pandeya & J.R Dimmock, Introduction to drug design, New Age International, 2000.
6. D. Lednicer, Strategies for organic drug Synthesis and Design, John Wiley, 1998.
7. Graham & Patrick, Introduction to medicinal Chemistry, 3rdedn., OUP, 2005.
8. Bernand Rosner, Fundamental of Biostatistics, 8th edn, CENGAGE Learning Custom Publisher, 2016.
9. Skoog & West, Fundamentals of analytical chemistry, CENGAGE, 2013.
10. J. Susan Milton, Statistical methods in biological and health sciences, Tata McGraw-Hill Int. Edition, 1984.
11. J. Susan Milton, Introduction to statistics, Tata McGraw-Hill Int. Edition, 1996.
12. B.K. Mahajan, Methods in Biostatistics, JayPee Brothers, New Delhi, 2002.

CHE C02: ADVANCED ELECTROCHEMISTRY- I

UNIT-I

Fuel Cells

Electrochemical Generators (Fuel Cells): Hydrogen oxygen cells. Hydrogen Air Cell, Hydrocarbon air cell, alkaline fuel cell, Phosphoric acid fuel cell, Direct NaOH fuel cells, applications of fuel cells.

Electro-chemical Energy Storage

Properties of Electrochemical energy storages: measure of battery performance, Charging and discharging of batteries, Storage density, Energy density.

Classical Batteries: (i) Lead Acid (ii) Nickel-Cadmium (iii) Zinc – Manganese dioxide. Modern Batteries: (i) Zinc- Air (ii) Nickel- Metal hydride (iii) Lithium Battery. Future electricity stores: Storage in (i) Hydrogen (ii) alkali metals (iii) Non-aqueous solutions

UNIT-II

Corrosion and Passivity

Electrochemical mechanism of corrosion of metals, thermodynamics and stability of metals, potential - pH (or Pourbaix) Diaphragms, uses and abuses, corrosion current and corrosion potential - Evans diagrams.

Measurement of corrosion rate: weight loss method and Electrochemical method. Inhibition of Corrosion (i) by addition of substrates to the electrolyte environment (ii) By charging corroding method from external source, anodic protection, organic inhibitors. The Fuller theory, Green inhibitors.

Passivation : Structure of passivation films, mechanism of passivation, spontaneous passivation, nature's method for stabilizing surfaces.

UNIT-III

Bio-electrochemistry and Bioelectrocatalysis

Membrane potential, simplistic and modern theory, Electrical conductance in biological organisms, electrochemical mechanism of nervous systems, enzymes as electrodes, Biosensors, Bio-electrocatalysis. Enzymes as biological catalysts, immobilization, methods of immobilization.

UNIT-IV

Kinetics of Electrode Process

Essentials of electrode reaction, significance of current density and overpotential in electrode processes, Standard rate constant (k^0) and Electron Transfer coefficient (α) and its significance, exchange current density. Criteria of irreversibility information from irreversible wave. Koutecky's method, Meits Israel and Gelling's method for determining kinetic parameters for quasireversible and irreversible waves.

SUGGESTED BOOKS AND REFERENCES

1. John O'M. Bockris and Amulya K.N. Reddy, Modern Electrochemistry, Volume 2A & 2B, Springer, 2000.
2. Brett CMA and Brett AMO, Electrochemistry: Principle and Applications, Oxford Press, 2005.
3. Joseph Wang, Analytical Electrochemistry, Wiley-VCH Publication, 1985.
4. Zhang, Ju and Joseph Wang, Electrochemical Sensors, Biosensors and their Bio-medical Applications, Academic Press, Elsevier, 2008.
5. A. J. Fry and W. E. Britton, Topics in Organic Electrochemistry, Plenum publishing press, New York, 1980.
6. M. M. Baizer and H. Lund, Organic Electrochemistry, Marcel Dekker, New York, 1985.

CHE C03: ADVANCED CHEMICAL KINETICS-I

UNIT I

Kinetics of Atmospheric Reactions

Physical structure of atmosphere. Chemical composition of atmosphere, Kinetics and mechanism of NO_x, ClO_x cycles and $H_2 + O_2$ reaction. Mechanism of general methane oxidation. Kinetics and mechanism of low temperature oxidation of methane.

UNIT - II

Radiation Chemistry

Radiation chemistry and Photochemistry. Radiation chemistry of water and aqueous solutions. Hydrogen atom and hydroxyl radical-oxidizing and reducing conditions. Kinetics and mechanism of photochemical and photosensitized reactions (one example in each case). Stern-Volmer equation and its application. Hole-concept in the presence of semi-conductor photo-catalysts. Kinetics of exchange reactions (mathematical analysis).

UNIT - III

Dynamics of Gas-Surface Reactions

Adsorption/desorption, kinetics and transition state theory, Dissociative adsorption and precursor state. Mechanism of Langmuir's adsorption of the oxidation of carbon monoxide to carbon dioxide. True and apparent activation energies. Industrial importance of heterogeneous catalysis.

Transition State:

A brief aspect of statistical mechanics and transition state theory, application in calculation of the second order rate constant for reactions with collision for (i) atom + atom (2) atom + molecule (3) molecule (for both linear and non-linear molecules) + molecule reactions. Static solvent effects and thermodynamic formulations. Adiabatic electron transfer reactions, energy surfaces.

UNIT - IV

Enzymes and Inhibitors

Enzyme catalyzed models of 1:2 type enzyme-substrate systems. Kinetics of one enzyme-Two substrate systems and their experimental characteristics. Enzyme inhibitors and their experimental characteristics. Kinetics of enzyme inhibited reactions.

Micelles Catalysis and Inhibition

(a) Micelles and their classification, Kinetics and mechanism of micelle catalyzed reactions (first and second order). Various type of micelle catalyzed reactions. Micelle inhibited reactions.

(b) Kinetics and Mechanism of Substitution Reaction: Classification of ligand substitution mechanism, anation and base catalysed Kinetics of anation reactions. Aquation and acid catalyzed Kinetics of aquation reactions (octahedral complexes).

SUGGESTED BOOKS AND REFERENCES

1. Henry Taube, S Lippard (Ed.), Progress in Inorganic Chemistry, Vol 30, John Wiley & Sons, NY, 1983.
2. R. Lumry and R.W. Raymond, Electron transfer reaction, Inter-Science Publication, 1997.
3. N. L. Bender, Mechanism of homogeneous Catalysis from protein to protein, Wiley, 1971.
4. A. G. Sykes, Kinetics of Inorganic reactions, Pergamon Press, 1966.
5. S. W. Benson, Jacob Kleinberg, R. Kent Murmana, R. T. M. Fraser, John Bauman, Mechanism of Inorganic Reactions, Academic Press, 1965.
6. H.Taube, Electron transfer reactions in solution, Academic Press, London, 1970.

CHE C04: CHEMICAL ANALYSIS

UNIT-I

Water Analysis

Sources of water pollution domestic, industrial, agricultural soil and radioactive wastes as sources of pollution. Objectives of analysis-parameter for analysis color, turbidity, total solids, conductivity, acidity, alkalinity, hardness, chloride, sulphate, fluoride, silica, phosphates and different forms of nitrogen. Heavy metal pollution-public health significance of cadmium, chromium, copper, lead, zinc, manganese, mercury and arsenic. General survey of instrumental technique for the analysis of heavy metals in aqueous systems. (Measurement of DO, BOD and COD). Pesticides as water pollutants and analysis. Water pollution laws and standards.

UNIT-II

Food Analysis

Moisture, ash, crude protein, fat, crude fiber, carbohydrates, calcium, potassium, sodium and phosphate. Food adulteration-common adulterants in food, contamination of food stuffs. Microscopic examination of foods for adulterants. Pesticide analysis in food products. Extraction and purification of sample: HPLC, Gas chromatography for organophosphates. Thin-layer chromatography for identification of chlorinated pesticides in food products.

UNIT-III

Soil and Fuel Analysis

(a) Analysis of soil, moisture, pH, total nitrogen, phosphorus, silica, lime, magnesia, manganese, sulphur and alkali salts.

(b) Fuel analysis: liquid and gas. Ultimate and proximate analysis, heating values-grading of coal. Liquid fuels flash point, aniline point, octane number and carbon residue. Gaseous fuels-producer gas and water gas-calorific value.

UNIT-IV

Body Fluids and Drug Analysis

Composition of blood collection and preservation of samples. Serum electrolytes, blood glucose, blood urea nitrogen, uric acid albumin, globulins acid and alkaline phosphatases, Immunoassay: Principle of radio immunoassay (RIA) and applications. The blood gas analysis trace elements in the body.

Narcotics and dangerous drugs classification of drugs. Screening by gas and thin layer chromatography and spectrophotometric measurements.

SUGGESTED BOOKS AND REFERENCES

1. G.D. Christian, P.K. Dasgupta, K.A. Schug, Analytical Chemistry, Wiley, 7th edn., 2013.
2. D.A. Skoog, D.M. West and F.J. Hooler, S.R. Crouch, Fundamentals of Analytical Chemistry, 9th edn., 2014.
3. J.H. Kennedy, Analytical Chemistry – Principles, Saunders College Publishing, New York, 2nd edn., 1990.
4. L.G. Hargis, Analytical Chemistry - Principles and Techniques, Prentice Hall, 1988.
5. R.A. Day, Jr. and A.L. Underwood, Quantitative Analysis, 6th edn., Prentice Hall, 1991.
6. S.M. Khopkar, Environmental Solution, Wiley Eastern.
7. S.M. Khopkar, Basic Concepts of analysis Chemistry, New Age International, 1998.
8. Alka L. Gupta, Analytical Chemistry, Pragati Publication, 2014.
9. D C Das, Analytical Chemistry, Prentice Hall India Learning Private Limited, 2010.

CHE 911: CHEMISTRY CORE LAB – 3

A. Quantitative analysis:

1. Spectrophotometric determination of Iron-phenanthroline complex: Job's method of continuous variations.
2. Analyse the given sample of Copper Ferrite ($CuFe_2O_4$) & determine the amount and percentage of Copper and Iron Volumetrically.
3. Determination of ferrous (Fe^{2+}) and ferric (Fe^{3+}) ions in the given solution.
4. Determination of Ca^{2+} and Mg^{2+} ions in a given solution and estimation of total hardness of water.
5. Estimation of Zinc involving Potassium ferrocyanide.
6. Estimation of Sulphate as Barium sulphate.

B. Qualitative Organic mixture analysis: Separation and identification of three component organic mixture of pure organic acidic, basic and neutral components. Preparation of their derivatives.

C. Chemical Analysis

1. Determine the dissolved oxygen (DO) of the given water sample.
2. Determine the biological oxygen demand (BOD) of the given water sample.
3. Determine the Chemical Oxygen Demand (COD) of the given water sample
4. Determine the Nitrate (NO_3^-) in drinking water sample.
5. Determine the phenolic substance in the waste water sample.
6. Determine the amount of free Chlorine in given water sample.
7. Determine the amount of Fluoride in given water sample.
8. Determine the dissolved CO_2 in the given water sample.

CHE A11: CHEMISTRY ELECTIVE LAB-3

A. Chromatographic separation and identification by paper chromatography and determination of Rf values:
   1. Cadmium and Copper.
   2. Zinc and Manganese.
   3. Arsenic, Antimony and Tin.
   4. Lithium, Sodium and Potassium.
   5. Fe^{3+}, Al^{3+} and Cr^{3+}
   6. Ca^{2+}, Sr^{2+} and Ba^{2+}
   7. Ni^{2+}, Co^{2+}, Mn^{2+} and Zn^{2+}
   8. Cu^{2+}, Fe^{3+}, Ni^{2+} and Ti^{4+}

B. Standardization of ceric sulphate solution using ferrous ammonium sulphate as intermediate solution.

C. Estimation of H_2O_2 by iodometric method.

CHE B11: CHEMISTRY ELECTIVE LAB-3

Multi-step Organic Synthesis based on Name Reactions

The exercise should illustrate the use of organic reagents and purification of products by chromatographic techniques.

i. Photochemical reaction :
   (Benzophenone → Benzpinacol → Benzpinacolone)

ii. Beckman Rearrangement : Benzanilide from benzene
(Benzene → Benzophenone → Benzophenone oxime → Benzanilide)
iii. Benzilic acid rearrangement : Benzilic acid from benzoin
(Benzoin → Benzil → Benzilic acid).
iv. Synthesis of heterocyclic compounds
a. Skraup synthesis: Preparation of quinoline from aniline
b. Fisher Indole synthesis: Preparation of 2-phenylindole from phenylhydrazine.
v. Diazocoupling: Phthalic anhydride → Phthalamide → anthranilic acid → methyl red.

CHE C11: CHEMISTRY ELECTIVE LAB-3

1. Determining the energy of activation and entropy of activation in $KMnO_4$-benzyl alcohol reaction measuring the rate constant at least at three temperatures.
2. Determining the Formation Constant for the $[Ce^{+4}$-$H_3PO_2]$ intermediate complex and also the rate constant of its decomposition.
3. Determine the rate constant in bleaching of malachite green in the basic medium.
4. Determination of Solubility of various salts like NaCl, KCl, KNO_3 and $NaNO_3$ at different temperature and draw the solubility Curve.
5. Study the variation of viscosity of pure liquid with temperature and determination of temperature coefficient of viscosity of the liquid.
6. Determination of Glass transition temperature of a given slat (e.g., $CaCl_2$) conductometrically.
7. Determination of molecular weight of non-volatile and non-electrolyte/electrolyte by cryscopic method and to determine the activity coefficient of an electrolyte.

EoSE of CHEMISTRY CORE LABORATORY COURSE

DURATION: 6 Hrs MAX. MARKS: 100

Practical Exercises	75 Marks (three each of 25 marks)
Practical Record	10 Marks
Viva	15 Marks

SEMESTER –IV

CHE X01: SOLID STATES AND NANOMATERIALS

UNIT-I

Solid State Chemistry

Introduction to the solid state, defects of solids, classification of imperfections, Electronic defects, atomic defects, Lattice imperfections, thermodynamics of Schottky defect and Frenkel defect. Electrical, optical, magnetic and thermal properties of inorganic materials.

Solid State Reactions: general principles, types; sintering; nucleation; Factors influencing the reactivity of solids; co-precipitation as a precursor to solid state reactions, kinetics of solid state reactions.

UNIT-II

Superconductors

Superconductors, with special emphasis on the synthesis and structure of high temperature superconductors; solid state LASERS (Ruby, YAG and tunable lasers): Inorganic phosphor materials; synthesis and advantages of optical fibers over conducting fibres, diffusion in solids, catalysis and zone refining of metals.

UNIT-III

Diffraction Methods

A. X-ray Diffraction

Bragg condition, Miller indices, Laue Method, Bragg method, Debye Scherrer method of X-ray structural analysis of crystals, index reflections, identification of unit cells from systematic absences in diffraction pattern, Structure of simple lattices and X-ray intensities, structure factor and its relation to intensity and electron density, phase problem; description of the procedure for an X-ray structure analysis, absolute configuration of molecules.

B. Electron Diffraction

Scattering intensity vs. scattering angle, Wierl equation, measurement technique, elucidation of structure of simple gas phase molecules, low energy electron difffraction and structure of surfaces.

UNIT-IV

Nanomaterials

Various preparative approaches and techniques; characteristic differences of nanomaterials over bulk materials; dynamic light scattering, atomic force microscopy and characterization of nanomaterials; imaging techniques: electron microscopy (Scanning Electron Microscopy, Transmittance Electron Microscopy). Applications of nanomaterials.

SUGGESTED BOOKS AND REFERENCES

4. H.V. Keer, Principles of the Solid State; Wiley Eastern Ltd.: New Delhi, 1993.
5. A.R. West, Solid State Chemistry and its Applications; 2nd Edn, John Wiley and Sons, 2014.
6. N. B. Hannay, Treatise on Solid State Chemistry; Plenum, 1976.
7. A. K. Cheetham and P. Day, Eds. Solid State Chemistry Techniques; Clarendon Press, Oxford, 1987.
8. John Wulff, The structure and properties of materials, John Wiley & Sons; Trans edition, 1966.
9. L. V. Azaroff, J. J. Brophy, Electronic processes in materials, Mc Craw Hill, 1967.
10. D. K. Chakrabarty, Solid State Chemistry, New Wiley Eastern, 2009.
11. M.C. Day, J. Selbin, Theoretical Inorganic Chemistry, Reinhold Publishing, NewYork, 1962.
12. A.W. Adamson and A.P. Gast, Physical Chemistry of Surfaces, Wiley-Interscience; 6th Ed 1997.
13. G. Timp, Ed. Nanotechnology; Springer-Verlag: N. Y., 1999
14. B. D. Fahlman, Materials Chemistry, Springer, 2007.

CHE X02: ORGANIC SYNTHESIS – II

UNIT-I

Reterosynthetic Analysis

An introduction to synthons and synthetic equivalents. Disconnection approach, good disconnections, functional group inter-conversions, importance of the order of events in organic synthesis. One group C-X disconnections. Chemoselectivity. Two group C-X disconnections.

Reversal of polarity (Umpolung), generation of acyl anion equivalent-1,3-dithiane from carbonyl compounds, use of methylthio-methylsulfoxide via cyanide ion and cyanohydrin ethers, nitro compounds and metallated vinyl ethers.

Protecting Groups: Principle of protection of carbonyl, hydroxyl, amino and carboxyl groups.

Enamines: Preparation and synthetic applications

UNIT –II

One Group C-C Disconnections

One group C-C disconnection involving alcohols and carbonyl compounds, regioselectivity. Alkene synthesis, use of acetylenes, aliphatic nitro compounds in organic synthesis.

Two group C-C Disconnections

Diels-Alder reaction. 1,3-Difunctionalised compounds; α,β-unsaturated carbonyl compounds; control in carbonyl condensation; 1,5-difunctionalised compounds, Michael addition and Robinson annulation.

1,2-Difunctionalised compounds. Radical reactions in synthesis. 1,4-Difunctionalised compounds. Reconnections. 1,6-Difunctionalised compounds.

UNIT III

Ring Synthesis

Introduction to ring synthesis of saturated heterocycles. General strategy and stereoselectivity. 3-Membered rings from cyclisations and insertion reactions. Rerarrangements in synthesis. 4-Membered rings from photocycloadditions and use of ketenes.

Five-membered rings from 1,4- and 1,6-dicarbonyl compounds. Pericyclic rearrangements and special methods. 6-Membered rings from carbonyl condensations, Diels-Alder reactions and reduction of aromatic compounds. Synthesis of aromatic Heterocycles.

UNIT IV

Asymmetric Synthesis

Concepts of prochirality, enantioselectivity and diastereoselectivity. Methods for determination of enantiomer purity. Stereogenic skeletal bond forming reactions, synthesis of a racemate and resolution. Asymmetric synthesis, enantiomeric excess, chiral pool, chiral auxiliaries, chiral reagents and chiral catalysts.

Organic Transformations by C-H functionalization

Introduction to C-H Activation and C-H functionalization, Transition metal catalyzed C-C bond and C-X bond formation *via* C-H functionalization. Metal free organic transformations via C-H functionalization.

SUGGESTED BOOKS AND REFERENCES

1. Smith M.B., Organic synthesis, McGraw Hill, 2002.

2. Warren S. & Wyatt P., Organic synthesis: The disconnection approach 2nd edn., John Wiley & Sons, 2008.
3. Warren S, Wyatt P, Workbook for Organic Synthesis: The Disconnection Approach, 2nd edn., John Wiley & Sons, 2009. ISBN: 978-0-470-71227-6
4. Warren S., Designing organic synthesis: The synthon approach, Wiley, 1978 (Reprinted 2002).
5. Jonathan Clayden, Nick Greeves, Stuart Warren and Peter Wothers, Organic Chemistry, Oxford University Press, 2001.
6. Fuhrhop J and Li G, Organic Synthesis – Concepts, Methods and Starting Materials, Wiley-VCH, 2003.
7. Kalsi P S, Organic synthesis through disconnection approach, Scientific International, 2014
8. Carruther W., Modern Methods of Organic Synthesis, Cambridge University Press, 2004.
9. House H.O., Modern Synthetic Reactions: Organic chemistry monograph series, W.A. Benjamin, 1972.
10. Xiao-Feng Wu, Transition Metal-Catalyzed Heterocycle Synthesis via C-H Activation, Wiley, 2015. ISBN: 978-3-527-33888-7.

2. Warren S. & Wyatt P., Organic synthesis: The disconnection approach 2nd edn., John Wiley & Sons, 2008.
3. Warren S, Wyatt P, Workbook for Organic Synthesis: The Disconnection Approach, 2nd edn., John Wiley & Sons, 2009. ISBN: 978-0-470-71227-6
4. Warren S., Designing organic synthesis: The synthon approach, Wiley, 1978 (Reprinted 2002).
5. Jonathan Clayden, Nick Greeves, Stuart Warren and Peter Wothers, Organic Chemistry, Oxford University Press, 2001.
6. Fuhrhop J and Li G, Organic Synthesis – Concepts, Methods and Starting Materials, Wiley-VCH, 2003.
7. Kalsi P S, Organic synthesis through disconnection approach, Scientific International, 2014
8. Carruther W., Modern Methods of Organic Synthesis, Cambridge University Press, 2004.
9. House H.O., Modern Synthetic Reactions: Organic chemistry monograph series, W.A. Benjamin, 1972.
10. Xiao-Feng Wu, Transition Metal-Catalyzed Heterocycle Synthesis via C-H Activation, Wiley, 2015. ISBN: 978-3-527-33888-7.

CHE X03: ADVANCED PHYSICAL CHEMISTRY

UNIT-I

Quantum Mechanical aspects of Chemical bonding:

Molecular orbital (MO) theory: LCAO concept, orbital interaction diagram, MO energy levels, orbital symmetry, MO of simple organic molecules like ethelene, allylic compounds, cyclobutadiene, butadiene and benzene. Application of MO Theory to Hydrogen Molecule Ion (H_2^+). Born Oppenheimer's Approximation. Valence Bond (VB) Theory and its application to H_2 molecule. Extended HMO Theory, Advanced techniques in PMO and FMO theory. Introduction to Molecular mechanics, semiempirical, *ab* initio Hartree-Fock, DFT methods.

UNIT-II

Non Equilibrium Thermodynamics and Magnetochemistry:

Thermodynamic criteria of non-equilibirium state, Entropy production and entropy flow, Entropy balanced equations for different irreversible states (e.g. Heat flow, chemical reaction etc), transformations of generalized fluxes and forces, non-equilibirium stationary state, phenomenological equation, Microscopic reversibility and Onsager's reciprocity relations, electro-kinetics phenomenon and electrical conduction.

Magnetochemistry: Introduction, Magnetic Susceptibility and its determination, theories of paramagmetism and ferromagnetism, effect of temperature on magnetic behavior of substances.

UNIT-III

Macromolecules – I

Basic Concepts: Monomers, repeat units, degree of polymerization, linear, branched and network polymers. Classification: condensation, addition, radical, ATRP, RAFT, polymerization. Polymerization conditions and polymer reactions. Polymerization in homogeneous systems. Measurement of molecular weights by viscosity, light scattering, osmotic pressure and ultracentrifugation methods.

UNIT-IV

Macromolecules – II

Chemical Analysis of polymers by spectroscopic methods. X-ray diffraction study of polymers. Morphology and order in crystalline polymers-configurations of polymer chains. Crystal structures of polymers. The glass transition temperature, effects of molecular weight, chemical structure, branching and cross linking. Polyethylene, polyvinylchloride, polyamides, polyesters, phenolic resins and epoxy resins polymers. Functional polymers – fire retarding polymers and electrically conducting polymers. Biomedical applications of polymers – contact lens, dental polymers, artificial heart, kidney, skin and blood cells.

SUGGESTED BOOKS AND REFERENCES

1. P. Bahadur, Principles of polymer Science, Narosa Publication, 2002.
2. V. R. Gowariker, N.V. Vishwanathan and Jayadev Sreedhar, Introduction to Polymer Science, New Age international, 1986.
3. R. P. Rastogi and R. R. Mishra, Introduction to Chemical Thermodynamics, Vikash Publication House, 2000.
4. Gurdeep Raj, Advanced Physical Chemistry, KrishnaPrakashan, 2003.
5. A K Chandra, Quantum Chemistry, Tata McGraw Hill, 2011.

CHE A05: ADVANCED BIOINORGANIC CHEMISTRY

UNIT-I

Metalloenzymes:

Structure and functions of the following enzymes: carbonicanhydrase, carboxypeptidase, alchoholdehydrogenase, catalalse and peroxidase, cytochrome P-450, super oxide dismutase and xanthin oxidase, coenzyme, vitamin B12.

UNIT-II

Metal Storage and Transport:

Iron storage and transport for mammalia systems, transferrin, ferritin, Transport of iron in microorganism, siderophores, types of siderophores - The catecholate siderophores (eg: enterobactin) and hydroxamate siderophores (eg: ferrichrome), Mechanism involved in binding of Iron(III) siderophores complexes to receptors and the release of Iron into the Cytoplasm. Other storage & transport systems: ceruloplasmin and serum albumin for copper, metalothioneins and phytochepatins.

UNIT-III

Metal/Nucleic Acid Interactions

Metal complexes of polynucleotide, nucleosides and nucleic acids (DNA and RNA), Fundamental interactions with nucleic acids, Fundamental reactions of transition metal complexes with nucleic acids, Applications of different Metal Complexes that bind nucleic acids.

UNIT-IV

Metal Deficiency and Diseases:

Iron, zinc and copper deficiency, metal ion toxicity, copper over load and Wilson's disease, iron toxicity, toxicity of arsenic, cadmium, mercury and lead, metal complexes in medicine – chelation therapy – BAL, penicillamine, polyamino carboxyclic acids and desferrioxamine – gold compounds and rheumatoid arthritis – platinum complexes as anticancer, drugs – metal complexes in radio diagnosis and magnetic resonance imaging.

SUGGESTED BOOKS AND REFRENCES

1. S. J Lippard & J. M. Berg, Principles of Bioinorganic Chemistry, University Science Books.
2. S. J. Lippard, Progress in Inorganic Chemistry, Vols. 18 and 38, Wiley-Interscience.
3. I Bertini, H.B. Gray. S.J. Lippard and J. S. Valentine, Bioinorganic Chemistry, University Science Books.
4. G.L. Eichhorn (Ed.), Inorganic Biochemistry Vols I and II Elsevier.

CHE A06 – MATERIALS AND INDUSTRIAL CHEMISTRY

UNIT – I

Industrial Chemistry : Ferrous and non-ferrous metal industries - quality control methods, general principles applied in studying an industry; manufacture of iron, steel and alloy steels; introduction to metallurgy; metallurgy of iron, aluminium, copper, gold and silver; contaminants; waste management; recycling and pollution control; deformation in metals; modes of failure analysis; an overview of corrosion & its protection; industrial shaping of metals.

UNIT –II

Cement : Classification of cement, manufacture of portland cement, setting and hardening of cement, chemical constitution of portland cement and their characteristics, special cements and their uses, Cement Industries in India.

Ceramics : Classification of ceramics, basic raw materials, manufacture and applications, components imparting colours, comparison of pottery porcelain and china ware. Glass-raw materials, manufacture and applications: special glass, optical, borosilicate, flint and coloured glasses.

UNIT III

Chemistry of Selective Materials

Solid electrolytes: AgI, $RhAg_4I_5$, β-Alumina – NASICON – Principles and Applications of solid electrolytes.

Ferroelectric, piezoelectric and pyroelectric materials – principle, properties and applications.

LED – principle – types – advantages and disadvantages of LED displays

Liquid crystal display LCD – properties – twisted nematic field display – Advantages and disadvantages of LCD – comparison of LCD & LED.

Shape Memory alloys (SMA) – classification – working principles. Non-linear optical materials – second harmonic generators

UNIT IV

Chemistry of Inorganic Materials : Refractories – characterization properties and applications. Microscopic composites; dispersion strengthened and particle – reinforced, fibre- reinforced composites, macroscopic composites. Nanocrystalline phase, preparation procedures, special properties and applications.

SUGGESTED BOOKS AND REFERENCES

1. Harold H. Trimm, William Hunter III, Harold Henry Trimm, Industrial Chemistry: New Applications, Processes and Systems, Apple Academic Press, Inc., 2011
2. Fontana and Greene, Corrosion Engineering; McGraw Hill Publication, 1986.
3. E. Stocchi, Industrial Chemistry, Vol-I, Ellis Horwood Ltd. UK, 1990.
4. R.M. Felder, R.W. Rousseau, Elementary Principles of Chemical Processes, Wiley, New Delhi.
5. George Austin, Shreve's Chemical Process Industries, McGraw-Hill Book Company, 1985.
6. R. M. E. Diamant, Applied Chemistry for Engineer, Pitman Publishing, 3rd Edition, 1972.
7. Alan Heaton, An Introduction to Industrial Chemistry, Springer, 1996.
8. R.N. Sherve, "Chemical process industries", McGraw-Hill, Kugakuisha Ltd., Tokyo, 1984.
9. Riegels Hand Book of Industrial Chemistry, 9th edition, J.A. Kent (Ed), New York, 1992
10. J. A. Kent, Riegel's Handbook of Industrial Chemistry, CBS Publishers, New Delhi.
11. Mark Anthony Benvenuto, Industrial Chemistry, de Gruyter GmbH, 2013.
12. S. S. Dara, S. S. Umare, A Textbook of Engineering Chemistry, S. Chand & Company Ltd. New Delhi, 2013.
13. Study Material in vocational subject, Industrial Chemistry (UGC Sponsored).

CHE A07: PHOTOINORGANIC CHEMISTRY

UNIT-I

Basic Concept

Introduction, Photochemical laws and photochemical kinetics. Physical properties of the electronically excited molecules; Photophysical processes in electronically excited molecules

UNIT-II

Photophysical Properties

Photophysical kinetics of Biomolecular processes; kinetics of collisonal quenching: Stern-Volmer Equation, Concentration dependence of quenching and excimer formation, charge transfer mechanism and energy transfer mechanism.

UNIT-III

Photochemical Reactions

Photoelectochemistry of excited state redox reactions. Photosensitization. Types of Photochemical reactions; substitution, decomposition and fragmentation, rearrangement, and redox reactions, photochemistry of metallocenes.

UNIT-IV

Redox Reactions by Excited Metal Complexes

Redox reactions of metal complexes in excited states, excited electron transfer, examples using $[Ru(bpy)_3]^{2+}$ complex and $[Fe(bpy)_3]^{3+}$ complex. Role of spin-orbit coupling, life-times of excited states in these complexes.

Metal Complex Sensitizers: Electron relay, semiconductor supported metal oxide systems, water-photolysis, nitrogen fixation and carbon dioxide reduction.

SUGGESTED BOOKS AND REFERENCES:

1. K.K.Rohatagi-Mukherjee, Fundamentals of Photochemistry, WileyEastern, 1986
2. A.W. Adamson and P.D. Fleischauer, Concepts of Inorganic Photochemistry, Wiley, NY, 1975.
3. G.L.Geoffrey and M.S. Wrighton, Organometallic Photochemistry, Academic Press, 1979.
4. Inorganic Photochemistry, J. Chem. Educ. vol. 60 No. 10, 1983.
5. Coordination Chem. Revs., vol. 39, 121, 1231, 1981; 14, 321,1975; 97, 313, 1990.
6. V. Balzari and V. Carassiti, Photochemistry of Coordination Compounds, Academic Press, 1970.
7. G.J. Ferraudi, Elements in Inorganic Photochemistry, Wiley, NY, 1988.
8. S.J. Lippard, ed., Progress in Inorganic Chemistry, Vol. 30. Wiley, 2009.

CHE B06: HETEROCYCLIC CHEMISTRY – II

UNIT – I

Five-membered Heterocycles with more than two Heteroatoms: Synthesis and reactions of triazoles, tetrazoles, oxadiazoles, thiadiazoles and diazaphospholes.

Meso-ionic Heterocycles: General classification, chemistry of some important meso-ionic heterocycles of type A and B and their applications.

UNIT –II

Six-Membered Heterocycles with one Heteroatom: Synthesis and reactions of pyrylium salts, pyrones, coumarins, chromones and phosphorine (phosphabenzene).

Six-Membered Heterocycles with two or more Heteroatoms: Synthesis and reactions of diazines, triazines, tetrazines and azaphosphorine.

UNIT –III

Oxazines, Benzoxazines; synthesis and reactions.

Thiazines, 1,4-benzothiazines and phenothiazines; synthesis and reactions.

Diazepines, 1,4- or 1,5-benzodiazepines; synthesis and reactions.

Thiazepines, 1,4- or 1,5-benzothiazepines; synthesis and reactions.

UNIT-IV

Large membered heterocycles

Eight-membered : 1-Azocine, Diazocine, synthesis and reactions.

Nine-membered : 1-Azonine, 2-Oxonine, synthesis and reactions.

Ten or large membered rings, synthesis and reactions.

SUGGESTED BOOKS AND REFERENCES

1. R.R. Gupta, M. Kumar and V. Gupta, Heterocyclic Chemistry Vol 1-3, Springer Verlag, 1998, 1999 & 2006.
2. T Eicher and S. Hauptmann, The Chemistry of Heterocycles. Wiley-VCH, 2003.
3. J.A. Joule, K. Mills and G.F Smith, Heterocyclic Chemistry, Chapman and Hall, 1995.
4. T.L. Gilchrist, Heterocyclic Chemistry, Longman Scientific & Technical, 1992.
5. G.R. Newkome and W. W. Paudler, Contemporary Heterocyclic Chemistry. Wiley-Inter Science, 1982.
6. A.R. Katrizky & C W Rees (eds), Comprehensive Heterocyclic Chemistry, Pergamon Press, 1984.

CHE B07: NATURAL PRODUCTS – II

UNIT-I

Biosynthesis of natural products

Biosynthesis of secondary metabolites: Introduction, Difference between Laboratory synthesis and biosynthesis. Methods for determination of biosynthetic mechanism. Isolation and identification of Biosynthetic precursors, Feeding experiments – use of radioisotopes Measurement of incorporation – absolute incorporation, specific incorporation. Identification of the position of labels in labeled natural products by chemical degradation and spectral methods.

Major biosynthetic pathways: 1) Acetate-Malonate pathway: Biosynthesis of aromatic compounds, 2) Shikimic acid pathway; Biosynthesis of essential amino acids – phenylalanine, tyrosine and tryptophan, carboxylic acid derivatives, flavonoids and morphine alkaloids. 3) Mevalonic acid pathway: Biosynthesis of terpenes – mono, sesqui, di, tri (β-amyrin) and carotenoids, steroids – cholesterol.

UNIT-II

Synthesis of Some Natural Products

Approaches to prostaglandin synthesis; Woodward synthesis of PGF2a, Corey's synthesis of prostaglandins E and F. Synthesis Tetrahydroisoquinoline alkaloids. Synthesis of Taxol. Asymmetric Synthesis of α-Amino Acid.

UNIT-III

Design and synthesis of analogues of natural products

Introduction, diverted total synthesis (DTS), function-oriented synthesis (FOS), biology-oriented synthesis (BIOS), complexity to diversity (CtD), hybrid molecules, and biosynthesis inspired synthesis. The latter includes mutasynthesis, the synthesis of natural products encoded by silent genes, and propionate scanning

UNIT-IV

Chemistry of Natural Products: such as carbohydrates, proteins and peptides, fatty acids, nucleic acids and Lipids.

SUGGESTED BOOKS AND REFERENCES

1. J. Mann, Secondary Metabolism, 2nd Edition, Oxford University Press, 1987.
2. J. Mann, Chemical aspects of Biosynthesis, Oxford University Press, 1995.
3. I. L. Finar, Organic Chemistry: Vol. 1 & 2. ELBS, Longman, 1996.
4. R. O. C. Norman and J. M. Coxon, Principles of organic synthesis, Chapman and Hall, 1993.
5. Fieser and Fieser, Steroids, Literary Licensing, LLC, 1959.
6. P. Yates, W.A. Benjamin, Structure Determination, Inc., New York, 1967.
7. P. Manitto, Biosynthesis of Natural Products. John Wiley & sons, 1981.
8. K. C. Nicolaou & E. J. Sorensen, Classics in Total Synthesis, Wiley VCH, 1996.
9. Jonathan Clayden, Nick Greeves, Stuart Warren and Peter Wothers, Organic Chemistry, Oxford University Press, 2000.
10. P. S. Kalsi, Chemistry of Natural Products, Kalyani Publishers/Lyall Bk Depot, 2001.
11. Monroe E. Wall, M. C. Wani, C. E. Cook, Keith H. Palmer, A. T. McPhail, G. A. Sim, Plant Antitumor Agents. I. The Isolation and Structure of Camptothecin, a Novel Alkaloidal Leukemia and Tumor Inhibitor from Camptotheca acuminate, J. Am Chem. Soc. 88, 3888-3890, 1966.
12. M. C. Wani and M. E. Wall, Plant antitumour agents. The structure of two new alkaloids from Camptotheca acuminate, J. Org. Chem. 34, 1364, 1969.

13. R. Misra, R. C. Pandey, Sukh Dev, The chemistry of the oleo resin from hardwickia pinnata: a series of new diterpenoids, Tetrahedron Letters, 3751,1964; (ii) R. Carrington, G. Shaw, D.V. Wilson, Use of 5-phospho-β-D-ribosyl azide in a new direct synthesis of nucleotides, Tetrahedron Letters, 2861, 1968.
14. J.C.S. Perkin Transactions II, 288-292, 1973; (ii) J. Am. Chem. Soc. Vol.77.432-437, 1955.
15. Martin E. Maier, Design and synthesis of analogues of natural products, Org. Biomol. Chem., 13, 5302, 2015.
16. Robert M. Williams, Natural Products Synthesis: Enabling Tools To Penetrate Nature's Secrets of Biogenesis and Biomechanism, J. Org. Chem., 76, 4221–4259, 2011.
17. Mirna Leonor Sua´rez-Quiroz *et al.*, Isolation of green coffee chlorogenic acids using activated carbon, Journal of Food Composition and Analysis 33, 55–58, 2014.

CHE B08: MEDICINAL CHEMISTRY – II

UNIT-I

Antineoplastic agents : Introduction to cancer chemotherapy, Classification of antineoplastic agents, role of alkylating agents and antimetabolites in treatment of cancer. Carcinolytic antibiotics and mitotic inhibitors. Synthesis of Cyclophosphamide, Melphalan, Fluorouracil. Recent development in cancer chemotherapy.

Local Antiinfective drugs : Introduction. Synthesis and general mode of action of Furazolidone, Ciprofloxacin, Dapsone, Isoniazid, Fluconazole. Antimalarials: Synthesis and general mode of action of Chloroquin.

UNIT-II

Cardiovascular Drugs : Introduction, Classification and general mode of action, Cardiovascular disease, drug inhibitors of peripheral sympathetic function. Synthesis of Sorbitrate, Diltiazem, Verapamil, Methyldopa, Atinolol.

Diuretics : Introduction, Classification and general mode of action, Synthesis of Acetazolamide, Chlorothiazide, Frusemide, Spironolactone, Triamterene.

Hypoglycaemic Agents : Introduction, General mode of action, Insulin and insulin preparations, Oral hypoglycemic agents: Classification, Synthesis of Tolbutamide.

UNIT-III

Psychoactive drugs : Introduction, Neurotransmitters, CNS depressants, general anaesthetics, mode of action of hypnotics, sedatives, antianxiety drugs.

Anticonvulsant Drugs : Introduction, Classification and general mode of action, synthesis of Phenytoin sodium, Troxidone, Ethosuximide, Primidone.

Antiviral Drugs : Introduction, Classification and general mode of action, synthesis of Amantadine Hydrochloride, Idoxuridine, Methisazone.

UNIT-IV

Antibiotics : Antibiotics inhibiting protein synthesis, β-lactam rings. Synthesis of Penicillin-G, Ampicillin, Amoxycillin, Chloramphenicol, Cephalosporin, Tetracyclin and Streptomycin.

Antihistamines : Introduction, Classification and general mode of action, Synthesis of Pheniramine, Promethazine, Ranitidine, Sodium Cromoglycate.

Analgesics and Antipyretics : Classification, Nonnarcotic analgesic. Synthesis of Mefenamic acid, Diclofenac.

SUGGESTED BOOKS AND REFERENCES

1. J. Stringer, Basic Concepts in Pharmacology (3rd edn.), McGraw-Hill Professional, 2005.
2. B. Katzung, Basic and clinical pharmacology (11th edn.), McGraw-Hill medical, 2009.
3. A. Burger, M.E. Wolff, Medicinal Chemistry and Drug Discovery, Vol-I, John Wiley, 1994.
4. Goodman & Gilman, Pharmacological basis of Therapeutics, McGraw-Hill, 2005.
5. S.S. Pandeya & J.R Dimmock, Introduction to drug design, New Age International, 2000.
6. A. Kar, Medicinal Chemistry, New Age International, 2007.
7. H. Singh & V. K. Kapoor, Medicinal and Pharmaceutical Chemistry, Vallabh Prakashan, New Delhi, 2001.
8. D. Lednicer, Strategies for organic drug Synthesis and Design, John Wiley, 1998.
9. A. Gringauz, Introduction to Medicinal Chemistry: How drugs act and Why? John Wiley and Sons, 1997.
10. Graham and Patrick, Introduction to medicinal Chemistry (3rd edn.), OUP, 2005.

CHE C05: ADVANCED CHEMICAL KINETICS - II

UNIT - I

Induced Phenomena:

Induced reactions, kinetics of Induced reactions and their characteristics. Induction factor and its mechanistic significance. Mechanism of –

(i) Fe (II) induced oxidation of iodide by Cr (VI).

(ii) As (III) induced oxidation of Mn (II) by chromate in acid solutions.

(iii) Kinetics and mechanism of induced reactions in metal complexes (octahedral complexes of cobalt (III) only).

UNIT II

Metal-ion Catalysis: Kinetics and Mechanism of following Reactions

(i) When reaction rate is independent of one of the reactants in presence of metal ion catalyst.

(ii) When reaction rate is retarded by one of the products in presence of metal ion catalyst.

(iii) When metal ion catalysis indicates an intermediate species.

(iv) Cyclodextrines are acting as catalyst mode of catalysis. Analysis of one full case study of B-cyclodextrine, catalysed reaction, Hydroformylation reaction

UNIT – III

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

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

UNIT – IV

Electron Transfer Reactions in Metal Complexes:

Inner-sphere and outer-sphere reactions, Mechanism of inner sphere and outer sphere mode of electron transfer reactions. Henry Taube's classical reaction, its kinetics and mechanism, experimental analysis by chromatographic and spectroscopic techniques. Pattern of reaction via adjacent and remote attacks, linkage isomerism.

Marcus – Cross-relation in outer-sphere reactions, (no mathematical derivation) in following reactions -

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

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

Bridged outer-sphere electron transfer mechanism.

SUGGESTED BOOKS AND REFEREN

1. Henry Taube, S Lippard (Ed.), Progress in Inorganic Chemistry, Vol 30, John Wiley & Sons, NY, 1983.
2. R. Lumry and R.W. Raymond, Electron transfer reaction, Inter-Science Publication, 1997.
3. N. L. Bender, Mechanism of homogeneous Catalysis from protein to protein, Wiley, 1971.
4. A. G. Sykes, Kinetics of Inorganic reactions, Pergamon Press, 1966.
5. S. W. Benson, Jacob Kleinberg, R. Kent Murmana, R. T. M. Fraser, John Bauman, Mechanism of Inorganic Reactions, Academic Press, 1965.
6. H Taube, Electron transfer reactions in solution, Academic Press, London, 1970.

CHE C06: ADVANCED ELECTROCHEMISTRY – II

UNIT-I

Electrochemical analysis

Introduction to electrochemical methods, electrochemical cells, diffusion controlled limiting current, voltage scanning polarography, shape and interpretation of polarographic wave, current –voltage relationship during electrolysis. General Principle and applications of Linear Sweep Voltammetry (LSV), Cyclic Voltammetry (CV), Square Wave Voltammetry (SWV), and Differential pulse Voltammetry (DPV). Stripping voltammetry: Principle, classification and Applications.

UNIT-II

Electro-catalysis

Chemical catalysis and Electro-catalysis, cathodic and anodic electro catalysis; electrocatalysis of mixed oxides of titanium dopped with rare earth oxides (Ebonex); Electrolysis in simple redox reactions. Electrocatalysis of bimettalic nanostructured materials. Photoelectrochemistry: introduction, Principle of photoelectrochemistry, types of photoassisted redox reaction, organic photo-electrochemical reactions. Examples of some abnormal electro-organic synthesis.

UNIT-III

Electro-organic Synthesis

Types of electro organic reactions, constant current and constant potential electrolysis, cell design, effect of variable, nature of medium, nature of electrode materials, over-voltage, effect of redox couple, application to sewage waste water treatment, electro-chemical incineration of human waste in combined space. Electro-organic synthesis of novel drugs.

UNIT-IV

Electrochemical Sensors

Electrochemical Sensors for Nitric Oxide (NO), pesticides, glucose and superoxide species, Electrochemical sensors based on carbon nano tubes and their applications.

Energy Options: Hydrogen Economy, Introduction, Hydrogen Production, Hydrogen Transmission, storage and distribution, Hydrogen fueled equipments, local electricity production from hydrogen, Hazards and safety aspects of hydrogen.

SUGGESTED BOOKS AND REFERENCES

1. Joseph Wang, Analytical Electrochemistry, Wiley-VCH Publication,1998.
2. Zhang, Ju and Joseph Wang, Electrochemical Sensors, Biosensors and their Bio-medical Applications, Academic Press, Elsevier, 2008.
3. A. J. Fry and W. E. Britton, Topics in Organic Electrochemistry, Plenum publishing press, New York, 1981.
4. Baizer Organic Electrochemistry, Marcel Dekker Press, 1980.
5. D K Sharma, Electrochemical Incineration of human waste in confined Spaces, Lambert Publication, Germany, 2012.
6. Bockris and Reddy, Modern Electrochemistry, Volume 2A & 2B, Springer.
7. Brett and Brett, Electrochemistry: Principle and Applications, Oxford Press, 2005.

CHE C07: ADVANCED NANOSCIENCE AND NANOTECHNOLOGY

UNIT-I

Nanoscience and Nanotechnology

Basic concepts of Nano science and technology, Quantum wire, Quantum well, Quantum dot, Properties and technological advantages of Nano materials, Material processing by Sol, Gel method, Chemical Vapour deposition and Physical Vapour deposition methods

UNIT II

Synthesis

Top-down (Nanolithography, CVD), Bottom-up (Sol-get processing, chemical synthesis). Wet Deposition techniques, Self-assembly (Supramolecular approach), Characterization TEM, SEM and SPM technique, Fluorescence Microscopy and Imaging.

Use of bacteria, fungi, Actinomycetes for nanoparticle synthesis, Magnetotactic bacteria for natural synthesis of magnetic nanoparticles; Viruses as components for the formation of nanostructured materials; Synthesis process and application, Role of plants in nanoparticle synthesis.

UNIT III

Nanoscale Carbon

Introduction –Carbon molecules-nature of the carbon bond-new carbon structures-discovery of C60- structure of C60 and its crystal- From a Graphene Sheet to a Nanotube, Single wall and Multi walled Nanotubes, Zigzag and Armchair Nanotubes, Euler's Theorem in Cylindrical and Defective Nanotubes.

History Molecular and Super molecular Structure-Intrinsic properties of individual carbon nano tubes-Synthesis -Arcing in the present and absent of catalyze-laser method-Chemical Vapour Deposition -ball milling.

UNIT IV

Applications

Solar energy conversion and catalysis, Polymers with a special architecture, Liquid crystalline systems, Applications in displays and other devices, Advanced organic materials for data storage, Photonics, Plasmonics, Chemical, electrochemical and biosensors, Nanomedicine, Nanofoods, Nano-cosmetics and Nanobiotechnology.

SUGGESTED BOOKS AND REFERENCES

1. B. Vishwanathan, Nano materials, Narosa Publication, 2009.
2. Foster Lynn E, Nanotechnology, Pearson education, 2005.
3. T. Varghese and K M Balakrishna, Nanotechnology, Thomas Atlantic Publication, 2005.
4. J J Ramsden, Nanotechnology: An Introduction, Elesevier Publication, 2004.
5. B. K. Parathasarathy, An Introduction to Nanotechnology, Isha publication, 2007.
6. K K Chattopadhyay, Introduction to Nanoscience and Nanotechnology, PHI Publication, 2009.
7. Frank Owens, Introduction to Nanotechnology, Wiley, 2007.

CHE A12: ELECTIVE LAB - 4

Practical Laboratory: 9 hours per week (6 Credit)
Examination: Duration: 6 Hours; Max. Marks: 100

A. Quantitative analysis: separation and determination of two metal ions involving Volumetric and Gravimetric methods:
   b. Copper – Nickel
   c. Copper – Zinc

B. Analyse the given sample of iron ore & determine Silica Gravimetrically, Iron Volumetrically and find out their percentages in the given sample.

C. Analysis of German silver for copper and nickel.

D. Estimation of copper (iodometrically) and zinc (complexometrically by EDTA) in Brass.

E. Estimation of Iron in Portland cement.

CHE B12: ELECTIVE LAB-4

Practical Laboratory: 9 hours per week (6 Credit)
Examination: Duration: 6 Hours; Max. Marks: 100

A. Separation & Purification Techniques:
   i. Purification of organic solvents by distillation method (s)
   ii. Extraction of organic compound using separating funnel, Soxhlet extraction method
   iii. Purification of organic compounds using Chromatographic methods

B. Quantitative estimations of number Functional groups (phenol, amino, methoxy groups)

C. Isolation of caffeine, casein, chlorophyll.

D. Estimation of amino acids and sugar in given samples.

E. Estimation of citric acid / vitamin C in citrus juice.

CHE C12: ELECTIVE LAB-4

A. Electrochemistry

1. Identification and Estimation of metal ions such as Cu^{+2} , Cd^{+2}, Ni^{+2} Voltammetrically.
2. To plot a cyclic voltammogram of a reversible system and calculate the number of electron in the redox process.
3. To plot a voltammogram of a organic compound (such as nitroaniline, picric acid, m-dinitrobenzene) and verification of Randel Sevcik equation (current vs scan rate and current vs concentration)
4. Determination of the strength of strong and weak acids in a given mixture using a potentiometer/pH meter.
5. Determination of the formation constant of silver-ammonia complex and stoichiometry of the complex potentiometrically.

B. Chemical Kinetics

1. Determine the order with respect to Ag (I) in the oxidation of Mn (II) by $S_2O_8^{-2}$ and the rate constant for the unanalyzed reaction.

2. Investigate the autocatalysed reaction between $KMnO_4$ and Oxalic Acid.
3. Kinetics of enzyme catalyzed reactions.
4. Flowing clock reaction (Ref: Experiments in physical Chemistry by Snowmaker).
5. Oscillatory reaction.

CHE D13: ELECTIVE LAB-5

Practical Laboratory: 9 hours per week (6 Credit)
Examination: Duration: 6 Hours; Max. Marks: 100

A. Preparation and evaluation of -
   1. Emulsion, simple syrup
   2. Aqueous iodine solution, strong iodine solution
   3. Calamine lotion, boroglycerine
   4. Pipermint water, rose water, camphor water,
   5. Formulation of magnesium hydroxide mixture (milk of magnesium)

B. Chemical Analysis and Nanomaterials
   1. Estimation of Iron in lime stone samples (Marbles).
   2. Synthesis of ZnO and TiO_2 nanoparticles and their characterization.
   3. Synthesis of copper conductive paint / ink.
   4. Synthesis of graphene, graphene oxide (GO) and reduced graphene oxide (rGO)
   5. Study of capping agent of hydrophilic and hydrophobic metal nanoparticles by FTIR.
   6. Synthesis of different size metal nanoparticles and characterized by UV measurement.

CHE D21: PROJECT WORK

Project Work: 12 Credits (180 hrs)
EoSE: Max. Marks: 100

Project report will be submitted at the end of Project work duly signed by the project guide. The EoSE assessment of the Project Work shall be as per University guidelines.