

STAREX UNIVERSITY

SCHOOL OF PHYSICAL SCIENCES

M.Sc. Chemistry

Course Structure & Syllabus Outline



STAREX UNIVERSITY
GURUGRAM, HARYANA- 122413

PREAMBLE

The University Grants Commission (UGC) has initiated several measures to bring equity, efficiency and excellence in the Higher Education System of country. The important measures taken to enhance academic standards and quality in higher education include innovation and improvements in curriculum, teaching-learning process, examination and evaluation systems, besides governance and other matters. The UGC has formulated various regulations and guidelines from time to time to improve the higher education system and maintain minimum standards and quality across the Higher Educational Institutions (HEIs) in India. The academic reforms recommended by the UGC in the recent past have led to overall improvement in the higher education system. However, due to lot of diversity in the system of higher education, there are multiple approaches followed by universities towards examination, evaluation and grading system. While the HEIs must have the flexibility and freedom in designing the examination and evaluation methods that best fits the curriculum, syllabi and teaching-learning methods, there is a need to devise a sensible system for awarding the grades based on the performance of students.

Presently the performance of the students is reported using the conventional system of marks secured in the examinations or grades or both. The conversion from marks to letter grades and the letter grades used vary widely across the HEIs in the country. This creates difficulty for the academia and the employers to understand and infer the performance of the students graduating from different universities and colleges based on grades. The grading system is considered to be better than the conventional marks system and hence it has been followed in the top institutions in India and abroad. So it is desirable to introduce uniform grading system. This will facilitate student mobility across institutions within and across countries and also enable potential employers to assess the performance of students. To bring in the desired uniformity, in grading system and method for computing the cumulative grade point average (CGPA) based on the performance of students in the examinations, the UGC has formulated these guidelines.

CHOICE BASED CREDIT SYSTEM (CBCS)

The CBCS provides an opportunity for the students to choose courses from the prescribed courses comprising core, elective/minor or skill based courses. The courses can be evaluated following the grading system, which is considered to be better than the conventional marks system. Therefore, it is necessary to introduce uniform grading system in the entire higher education in India. This will benefit the students to move across institutions within India to begin with and across countries. The uniform grading system will also enable potential employers in assessing the performance of the candidates. In order to bring uniformity in evaluation system and computation of the Cumulative Grade Point Average (CGPA) based on student's performance in examinations, the UGC has formulated the guidelines to be followed.

Outline of Choice Based Credit System:

1. **Core Course:** A course, which should compulsorily be studied by a candidate as a core requirement is termed as a Core course.

2. **Elective Course:** Generally a course which can be chosen from a pool of courses and which may be very specific or specialized or advanced or supportive to the discipline/ subject of study or which provides an extended scope or which enables an exposure to some other discipline/subject/domain or nurtures the candidate's proficiency/skill is called an Elective Course.

2.1 **Discipline Specific Elective (DSE) Course:** Elective courses may be offered by the main discipline/subject of study is referred to as Discipline Specific Elective. The University/Institute may also offer discipline related Elective courses of interdisciplinary nature (to be offered by main discipline/subject of study).

2.2 **Dissertation/Project:** An elective course designed to acquire special/advanced knowledge, such as supplement study/support study to a project work, and a candidate studies such a course on his own with an advisory support by a teacher/faculty member is called dissertation/project.

2.3 **Generic Elective (GE) Course:** An elective course chosen generally from an unrelated discipline/subject, with an intention to seek exposure is called a Generic Elective. P.S.: A core course offered in a discipline/subject may be treated as an elective by other discipline/subject and vice versa and such electives may also be referred to as Generic Elective.

3. **Ability Enhancement Courses (AEC)/Competency Improvement Courses/Skill Development Courses/Foundation Course:** The Ability Enhancement (AE) Courses may be of two kinds: AE Compulsory Course (AECC) and AE Elective Course (AEEC). "AECC" courses are the courses based upon the content that leads to Knowledge enhancement. They ((i) Environmental Science, (ii) English/MIL Communication) are mandatory for all disciplines. AEEC courses are value-based and/or skill-based and are aimed at providing hands-on-training, competencies, skills, etc.

3.1 **AE Compulsory Course (AECC):** Environmental Science, English Communication/MIL Communication.

3.2 **AE Elective Course (AEEC):** These courses may be chosen from a pool of courses designed to provide value-based and/or skill-based instruction.

Project work/Dissertation is considered as a special course involving application of knowledge in solving / analyzing /exploring a real life situation / difficult problem. A Project/Dissertation work would be of 6 credits. A Project/Dissertation work may be given in lieu of a discipline specific elective paper.

M.Sc (Chemistry)

Semester I

Course	Course Code	Credits	Course Type
Inorganic Chemistry-I		4	CC
Organic Chemistry-I		4	CC
Physical Chemistry-I		4	CC
Practical Inorganic Chemistry		4	CC
Sustainable and Green Chemistry		4	DCEC
Generic paper to be opted from other departments		4	GEC
List of Generic Papers for Other Department			
Chemistry of Materials		4	GEC
Total Credits: 24			

Semester II

Course	Course Code	Credits	Course Type
Inorganic Chemistry-II		4	CC
Organic Chemistry-II		4	CC
Physical Chemistry-II		4	CC
Practical Organic Chemistry		4	CC
Organic Chemistry of Polymers		4	DCEC
Generic paper to be opted from other departments		4	GEC
List of Generic Papers for Other Department			

Environmental Chemistry		4	GEC
Total Credits: 24			

SemesterIII

Course	Course Code	Credits	Course Type
Inorganic Chemistry-III		4	CC
Organic Chemistry-III		4	CC
Physical Chemistry-III		4	CC
Practical Physical Chemistry		4	CC
To be taken from other departments		4	GEC
Any two of the following courses			
Medicinal Chemistry		2	DCEC
Advanced Computational Chemistry		2	DCEC
Seminar Presentation (Compulsory)		2	DCEC
List of Generic Papers for Other Department			
General Polymer Chemistry		4	GEC
Total Credits: 24			

SemesterIV

Course	Course Code	Credits	Course Type
Major Project/Dissertation		24	PROJECT
OR			
Minor Project		16	PROJECT
Any two of the following courses			

Organometallic Chemistry		4	DCEC
Bioinorganic Chemistry		4	DCEC
Heterocycles and Natural Products		4	DCEC
Organic Synthesis		4	DCEC
Chemical Dynamics and Catalysis		4	DCEC
Micelles and Electrochemistry		4	DCEC
List of Generic Papers for Other Department			
Basics of Medicinal Chemistry		4	GEC
			Total= 24

Course Type

- Core Course (CC)
- Generic Elective Course(GEC)
- Discipline Centric Elective Course(DCEC)

Semester	Credits			Total Credits	Total marks
	Core Courses	Elective Courses			
		DCEC	GEC		
I	16	4	4	24	600
II	16	4	4	24	600
III	16	4	4	24	600
IV	16	4	4	24	600
Total	64	16	16	96	2400

SEMESTER - I
Inorganic Chemistry-I

Paper Code:
Max. Marks: 75

Time Allowed: 3 Hours
Credits: 4

Note for Examiners and Students:

1. The question paper will consist of four sections A, B, C & D. Examiner will set nine questions in all, selecting two questions from section A, B, C, and D of 15 marks each and may contain more than one part. Question 1 will be of 15 marks and consists of short answer type questions of 2 to 3 marks each covering the entire syllabus.
2. The candidate will be required to attempt five questions in all i.e. selecting one question from each section including the compulsory question. The duration of the examination will be 3 hours.

Section:A

Symmetry, Structure and Bonding in Inorganic Compounds

Symmetry elements and symmetry operations, symmetry groups with examples from inorganic compounds, groups of very high symmetry, molecular dissymmetry and optical activity. Valence bond theory, electro neutrality principle and limitations, Crystal field theory, splitting of d-orbitals in cubic, octahedral, tetragonal, tetrahedral and square planar ligand environments. Structural consequences of splitting of d-orbitals, Jahn Teller theorem, trends in ionic radii, lattice energy and heat of ligation. Structure of spinels. MOT with σ and π bonding Brief introduction of coordination polymers-1D, 2D, 3D and interpenetration.

Section:B

Transition Elements, Lanthanides and Actinides

General Aspects Elements of first transition series and their comparison with the second and third series, general periodic trends, chemistry of the various oxidation states of first row transition metals and their comparison based on electronic configuration. The splitting off-orbitals in octahedral field, Lanthanide contraction, Lanthanide shift reagent, oxidation states complexes, magnetic and optical properties of lanthanides and actinides.

Section:C

Chemistry of Non Transition Elements

Structures and acidic behavior of boron halides, Types and nomenclature boron hydrides (boranes), Wade's polyhedral skeleton electron pair theory (PSEPT). W. N. Lipscomb's STYX rules and semi-topological structures of boranes. Preparation, and properties of boron hydrides, carboranes, metalloboranes and metallo carboranes. Preparation, structure and properties of borazines, phosphazenes, sulphur-nitrogen compounds, silicates, interhalogens, Chlorofluorocarbons, pseudohalides and noble gas compounds.

Section:D

Metal Carbonyls and Clusters

Molecular orbital of carbonyl, classification of metal carbonyls, bonding in metal carbonyl, valence electron count (EAN rules), preparation and properties of mononuclear and polynuclear carbonyl complexes, bond lengths and stretching frequencies, carbonylate ions, carbonyl hydride complexes, isolobal fragments, structure and important reactions of transition metal nitrosyl. Bonding, preparation and properties of dinuclear metal cluster (dirhenium complex $[\text{Re}_2\text{Cl}_8]^{2-}$ ions), trinuclear and hexanuclear metal clusters.

Reference Books:

1. Advanced Inorganic Chemistry, F.A.Cotton and Wilkinson, JohnWiley.
2. Inorganic Chemistry, J.E. Huheey,HarperCollins.
3. Chemistry of theElements,N.N.GreenwoodandA.Earnshaw,Pergamon.
4. Magnetochemistry, R.L. Carlin, SpringerVerlog.
5. Magnatochemistry, A.Earnshaw.
6. Inorganic chemistry, G.Wulf'sburg.
7. Introductiontoligandfields,B.N.Figgis,WileyEastern-IIed

Organic Chemistry-I

Paper Code:
Max. Marks: 75

Time Allowed: 3 Hours
Credits: 4

Note for Examiners and Students:

1. The question paper will consist of four sections A, B, C & D. Examiner will set nine questions in all, selecting two questions from section A, B, C, and D of 15 marks each and may contain more than one part. Question 1 will be of 15 marks and consists of short answer type questions of 2 to 3 marks each covering the entire syllabus.
2. The candidate will be required to attempt five questions in all i.e. selecting one question from each section including the compulsory question. The duration of the examination will be 3 hours.

Section:A

Nature of Bonding in Organic Molecules

Delocalized chemical bonding-conjugation, cross conjugation, resonance, hyperconjugation, bonding in fullerenes, tautomerism; Aromaticity in benzenoid and non-benzenoid compounds, alternant and non-alternant hydrocarbons, Huckel's rule, energy level of molecular orbitals, annulenes, anti-aromaticity, homo-aromaticity; Bonds weaker than covalent-addition compounds, crown ether complexes and cryptands, inclusion compounds, cyclodextrins, catenanes and rotaxanes.

Section: B

Stereochemistry

Conformational analysis of cycloalkanes, decalins, effect of conformation on reactivity, conformation of sugars, steric strain due to unavoidable crowding; Elements of symmetry, chirality, molecules with more than one chiral center, threo and erythro isomers, asymmetric synthesis (basic principle, auxiliary, substrate, reagent and catalyst controlled). Methods of resolution, optical purity, enantiotopic and diastereotopic atoms, groups and faces, stereospecific and stereoselective synthesis. Optical activity in the absence of chiral carbon (biphenyls, allenes and spiranes); Stereochemistry of the compounds containing nitrogen, sulphur and phosphorus.

Section:C

Reaction Mechanism: Structure and Reactivity

Types of mechanisms, types of reactions, thermodynamic and kinetic requirements, kinetic and thermodynamic control, Hammond's postulate, Curtin-Hammett principle. Potential energy diagrams, transition states and intermediates, methods of determining mechanisms. Generation, structure, stability and reactivity of carbocations, carbanions free radicals, carbenes and nitrenes; Effect of structure on reactivity—resonance and field effects, steric effect. The Hammett equation and linear free energy relationship, substituent and reaction constants.

Section: D

Aliphatic Nucleophilic Substitution Reactions

The SN₂, SN₁, mixed SN₁ and SN₂ and SET Mechanisms. The neighboring group mechanism, neighbouring group participation by π and σ bonds. Classical and non classical carbocations, phenonium ions, norbornyl system, common carbocation rearrangements. The S_Ni mechanism. Nucleophilic substitution at an allylic, aliphatic trigonal and a vinylic carbon. Reactivity effects of substrate structure, attacking nucleophile, leaving group and reaction medium, phase transfer catalysis and ultrasound, ambident nucleophile, regioselectivity.

Reference Books :

1. March's Advanced Organic Chemistry: Reactions, Mechanisms, and Structure, 7th Edition, Michael B. Smith, WILEY, 2013.
2. Advanced Organic Chemistry PART A., F. A. Carey and R. J. Sundburg, Springer 2007.
3. Organic Chemistry, J. Clayden, N. Greeves and S. Warren, Oxford University Press, 2012.
4. A Guide Book to Mechanism in Organic Chemistry, Peter Sykes, Longman, 1985.
5. Organic Chemistry, Morrison, Boyd and Bhattcharjee, 6th Edition, Pearson, 2010.
6. Reaction Mechanism in Organic Chemistry, S. M. Mukherji and S. P. Singh, Macmillan, 1984.
7. Stereochemistry of Organic Compounds, Second Ed., D. Nasipuri, New Age International, 2005.
8. Stereochemistry of Organic Compounds, E. L. Eliel and S. H. Wilen, Wiley India, 2008.

Physical Chemistry-I

Paper Code:
Max. Marks: 75

Time Allowed: 3 Hours
Credits: 4

Note for Examiners and Students:

1. The question paper will consist of four sections A, B, C & D. Examiner will set nine questions in all, selecting two questions from section A, B, C, and D of 15 marks each and may contain more than one part. Question 1 will be of 15 marks and consists of short answer type questions of 2 to 3 marks each covering the entire syllabus.
2. The candidate will be required to attempt five questions in all i.e. selecting one question from each section including the compulsory question. The duration of the examination will be 3 hours.

Section:A

Introduction to Physical Chemistry and Classical Thermodynamics

Logarithmic relations, Curve sketching and linear graphs, calculation of slopes, terms of mean and median, Precision and accuracy in chemical analysis, types of error, standard deviation, Numerical Problems. Classical Thermodynamics Laws, state and path functions and their applications. Thermodynamic description of several types of processes; Maxwell's relations; spontaneity and equilibria; temperature and pressure dependence of thermodynamic quantities; Le Chatelier principle; free energy, chemical potential, and entropies.

Section:B

Solutions & Colligative Properties

Methods of Expressing the Concentration of a Solution, Activity & Activity Coefficient, Raoult's Law, Ideal and Non-Ideal Solution, Vapour pressure of Ideal Solution, Deviation from Ideal Behaviour, Thermodynamic properties of ideal solution and Azeotropes. Colligative properties of dilute solutions, Lowering of Vapour Pressure, Elevation in Boiling Point, Depression in Freezing Point & Osmotic Pressure.

Section:C

Chemical Kinetics and Theory of Unimolecular Reactions

Methods of determining rate laws, Arrhenius equation and the activated complex; Steady-State kinetics; Steady state approximation- Dynamic of chain reactions: hydrogen-bromine reaction, pyrolysis of acetaldehyde, Decomposition of Ethane; Kinetics of One-Enzyme-One-Substrate reactions: Michaelis-Menten Mechanism, Theory of Unimolecular reactions- Lindemann Mechanism.

Section:D

Electrochemistry and structure of electrified interfaces

Electrochemistry of solutions. Nernst equation, redox systems, electrochemical cells; Debye-Huckel theory; electrolytic conductance – Kohlrausch's law and its applications; ionic equilibria Debye-Huckel–Onsager treatment and its extension, ion-solvent interactions. The structure of electrified interfaces: Guoy-Chapman, Stern & Devanathan models. Over potentials & Tafel plot.

Reference Books:

1. Atkins' Physical Chemistry, Peter Atkins and Julio Paula, Oxford University Press; 10th Ed. (2014)
2. Physical Chemistry - A molecular approach, Donald McQuarrie and John Simon, Viva, 1st Ed. (2010)
3. Physical Chemistry, Ira N Levine, Tata McGraw-Hill Education; 6 Ed. (2011)
4. Chemical Kinetics, Keith J. Laidler, Pearson Education, 3rd Ed. (1997)
5. Modern Electrochemistry Vol-I and Vol-II A/B, J.O.M. Bockris and A.K.N. Reddy, Plenum

Practical Inorganic Chemistry

Paper Code:
Max Marks: 100

TIME ALLOWED: 6 HOURS
Credits – 4

Inorganic Chemistry Experiments

I Water Analysis (AnyTwo)

1. Determination of DO, COD and BOD of a waste water sample.
2. Determination of total suspended solids and total dissolved solids.
3. Determination of turbidity of a water sample by nephelometer.

II Preparations and related complementary work and physical studies(AnySix)

1. ReineckeSalt
2. $\text{VO}(\text{acac})_2$
3. $\text{Mn}(\text{acac})_3$
4. PrussianBlue/Turnbull'sBlue
5. $\text{Hg}[\text{Co}(\text{NCS})_4]$
6. Potassium trioxalatoferate (III)Trihydrate
7. Dichlorobis (hydroxylamine)Zinc(II)
8. Pentathioureadicuprousnitrate
9. Potassium trioxaltochromate(III)
10. Cis, trans-dichlorobis(ethylenediammine)cobalt(III)chloride.

III Quantitative Estimation

Quantitative estimation (involving volumetric-redox and complexometry, gravimetric) of constituents in two and three component mixtures.

IV Spectroscopic Studies

Data plotting, analysis and characterization of coordination compounds using Infrared and UV-Visible Spectroscopy.

Reference Books:

1. Vogel's Textbook of Quantitative Analysis, revised, J. Bassett, R. C. Denney, G. H. Jeffery and J. Mendham, ELBS.
2. Vogel's Textbook of Macro and Semimicro Qualitative Inorganic Analysis, revised, G. Svehla, Longman.
3. Practical Inorganic Chemistry, Marr and Rocket.
4. Practical Chemistry, A. M. James and F. E. Prichard, Longman.

Sustainable and Green Chemistry

Paper Code:
Max. Marks: 75

Time Allowed: 3 Hours
Credits: 4

Note for Examiners and Students:

1. The question paper will consist of four sections A, B, C & D. Examiner will set nine questions in all, selecting two questions from section A, B, C, and D of 15 marks each and may contain more than one part. Question 1 will be of 15 marks and consists of short answer type questions of 2 to 3 marks each covering the entire syllabus.
2. The candidate will be required to attempt five questions in all i.e. selecting one question from each section including the compulsory question. The duration of the examination will be 3 hours.

Section A

Definitions of Sustainability. Principles of Green Chemistry. Bio refinery concepts. Biomass based industrial products obtained and practiced technologies in different countries: biomass fractionation of wheat straw, rice straw and sugarcane bagasse. Biomass industrial products : cellulose, hemicellulose, lignins, pectins, starch, chitosan. Lignocellulose industrial products: extractives, biofuels, syn gases, carbondioxide

Section B

Cellulose chemistry: structure, types, sources, and grades of cellulose; functionalization of cellulose; nano celluloses and their preparation, structure and applications. Hemicellulose chemistry, structures, commercial products obtained from hemicellulose and their potential. Lignin structure, industrial sources of lignins, sodium lignosulfonate, lignosulfonates in oil-well drilling, industrial scale lignin derivatives, diverse applications of lignin, potential of lignin, nanolignins and their potential.

Section C

Cellulose, hemicellulose, lignin, glucose, lactic acid, succinic acid based biorefinery. Biochars – preparation, properties, impact on global warming.. Role of catalysis development in biomass conversion. Global impact on economics and environment. Concepts of carbon footprints, carbon trading, Life Cycle Analysis (LCA). Biodegradable polymers: definition, natural polymers cellulose, starch, lignin and chitosan, and their derivatives in the form of bioplastics, components of plastics, components of textile fibres. Semi-synthetic biodegradable polymers (natural molecules like sugars anchored chemically onto non-degradable synthetic hydrocarbon polymers, or synthetic molecules anchored onto natural polymers like cellulose via chemical grafting). Currently important synthetic polymers like Polyvinylalcohol and Polylacticacid. Biodegradability determination. BOD, COD. Biocomposites and bio nano composites. Geotextiles. Life cycle analysis of Biodegradable Polymers.

Section D

Bio catalyzed reactions with examples of cellulose and lipase catalyzed reactions, microbial oxidation and reductions. Microwave reactions with examples of reactions in water, organic solvents, and in solid state, with representative examples. Photo-induced reactions with representative examples. Ultrasound assisted reactions with representative some examples. Phase transfer catalyzed reactions with representative examples. Reactions in solid state with representative examples. Reactions in Ionic liquids with representative examples. Reactions in Supercritical fluids with special reference to supercritical carbon dioxide.

Reference Books:

1. Green Chemistry—A Textbook, V.K. Ahluwalia, Narosa (New Delhi) (2013)
2. Biomass for Renewable Energy, Fuels, and Chemicals, Donald L. Klass, Elsevier (2006)
3. Cellulose Science and Technology, 1st Ed., J. L. Wertz, J. P. Mercier, O. Beque, EPFL Press, Distributed by CRC Press, Taylor and Francis Group, (2010)
4. Experiments in Green and Sustainable Chemistry, H. Rosky, D. Kenepml, J. M. Lehn, Wiley-VCH (2009)
5. Biodegradable Polymers for Industrial Applications, Ray Smith, Ed., CRC Press (New York), Woodhead Publishing Ltd. (Cambridge, England) (2005)
6. Biorefineries-Industrial Processes and Products: Status Quo and Future Directions, Birgit Kamm (Editor), Patrick R. Gruber (Editor), Michael Kamm (Editor), Wiley (2010)
7. Lignin and Lignans as Renewable Raw Materials: Chemistry, Technology and Applications, Francisco G. Calvo-Flores, Jose A. Dobado, Joaquín Isac-García, Francisco J. Martín-Martínez, Wiley (2015)

Chemistry of Materials

Paper Code:
Max. Marks: 75

Time Allowed: 3 Hours
Credits: 4

Note for Examiners and Students:

1. The question paper will consist of four sections A, B, C & D. Examiner will set nine questions in all, selecting two questions from section A, B, C, and D of 15 marks each and may contain more than one part. Question 1 will be of 15 marks and consists of short answer type questions of 2 to 3 marks each covering the entire syllabus.
2. The candidate will be required to attempt five questions in all i.e. selecting one question from each section including the compulsory question. The duration of the examination will be 3 hours.

Section :A

Structures and properties of solids

- 1) Introduction, crystalline and amorphous solids, Unit cell, Bravais lattices, structure of NaCl and KCl, point defects – Frenkel, Schottky defects and non-stoichiometric defects.
- 2) Conductors, variation of conductivity with temperature, semiconductors, p and n types, photovoltaic cell. Piezoelectric and pyro-electrics. Photoluminescence.
- 3) Diamagnetic, paramagnetic, anti-ferromagnetic, ferro- and ferrimagnetic materials. Magnetic susceptibility, variation with temperature – Curie-Weiss law, Curie temperature and Neel temperature. Permanent and temporary magnets.

Section: B

Hazardous and nonhazardous materials, treatment and disposal to these types of wastes

- 1) Identify the physical hazards of chemicals, and categorize chemicals according to their hazards and physical characteristics.
- 2) Define toxicity as it relates to humans and hazardous chemicals and list the elements of risk assessment.
- 3) Explain the pathways for transport of hazardous materials in various environments.

Section :C

Nano Materials and Composites

- 1) Nano scale Regime, gas phase clusters, condensed phase, Nano particles. Classification of nano materials.
- 2) Methods of preparation. Top to down and Bottom up approach, Reduction of metal ions, Zeolite and inverse micelles and co-precipitation methods.
- 3) Composite materials: Introduction, types of fillers and matrix, classification of composite materials based on distribution and nature of fillers.
- 4) Particulate and fibrous metal/non-metal composites, polymer nanocomposites and their applications

Section :D

Analytical Methods in Chemistry

- 1) Qualitative and quantitative aspects of analysis: Sampling, evaluation of analytical data, errors, accuracy and precision, methods of their expression.
- 2) Analysis of soil, Composition of soil, Concept of pH and pH measurement, Analysis of water, Definition of pure water, sources responsible for contaminating water, water purification methods.
- 3) Food Analysis, food adulteration.

Reference Books:

1. A.R. West, Solid State Chemistry and its Applications, 2nded. (2014) John Wiley and Sons, Singapore.
2. W. D. Callister, D. G. Rethwisch, Material Science and Engineering, An Introduction, 9thed. (2014) Callister, Wiley.
3. L.V. Azaroff, Introduction to Solids, (1977) Tata McGraw-Hill, New Delhi.
4. D. A. Skoog and D.M. West, Fundamental of Analytical Chemistry, International Edition, 7th Edition (1996), Saunders College Publishing, Philadelphia, Holt, London.

Generic Elective
Pharmaceutical Analytical Techniques

Paper Code:
Max. Marks: 75

Time Allowed: 3 Hours
Credits: 4

Note for Examiners and Students:

1. The question paper will consist of four sections A, B, C & D. Examiner will set nine questions in all, selecting two questions from section A, B, C, and D of 15 marks each and may contain more than one part. Question 1 will be of 15 marks and consists of short answer type questions of 2 to 3 marks each covering the entire syllabus.
2. The candidate will be required to attempt five questions in all i.e. selecting one question from each section including the compulsory question. The duration of the examination will be 3 hours.

SECTION A

UV-Visible spectroscopy: Introduction, Theory, Laws, Instrumentation associated with UV-Visible spectroscopy,

IR spectroscopy: Theory, Modes of Molecular vibrations, Sample handling, Factors affecting vibrational frequencies and Applications of IR spectroscopy

SECTION B

NMR spectroscopy: Quantum numbers and their role in NMR, Principle, Instrumentation, Solvent requirement in NMR, Relaxation process, NMR signals in various compounds, Chemical shift, Factors influencing chemical shift, Spin-Spin coupling, Coupling constant. Applications of NMR spectroscopy.

SECTION C

Mass Spectroscopy: Principle, Theory, Instrumentation of Mass Spectroscopy, Different types of ionization like electron impact, chemical, Mass fragmentation and its rules, Applications of Mass spectroscopy

Spectrofluorimetry: Theory of Fluorescence, Factors affecting fluorescence, Applications of fluorescence spectrophotometer.

SECTION D

Chromatography: Principle, apparatus, instrumentation, chromatographic parameters, factors affecting resolution and applications of the following:

a) Paper chromatography b) Thin Layer chromatography c) Gas chromatography d) High Performance Liquid chromatography

REFERENCES

1. Spectrometric Identification of Organic compounds - Robert M Silverstein, Sixth edition, John Wiley & Sons, 2004.
2. Principles of Instrumental Analysis - Douglas A Skoog, F. James Holler, Timothy A. Nieman, 5th edition, Eastern press, Bangalore, 1998.
3. Instrumental methods of analysis – Willards, 7th edition, CBS publishers.
4. Practical Pharmaceutical Chemistry – Beckett and Stenlake, Vol II, 4th edition, CBS Publishers, New Delhi, 1997.
5. Organic Spectroscopy - William Kemp, 3rd edition, ELBS, 1991.
6. Quantitative Analysis of Drugs in Pharmaceutical formulation - P D Sethi, 3rd Edition, CBS Publishers, New Delhi, 1997.
7. Pharmaceutical Analysis- Modern methods – Part B - J W Munson, Volume 11, Marcel Dekker Series

SEMESTER - II
Inorganic Chemistry –II

Paper Code:
Max. Marks: 75

Time Allowed: 3 Hours
Credits: 4

Note for Examiners and Students:

1. The question paper will consist of four sections A, B, C & D. Examiner will set nine questions in all, selecting two questions from section A, B, C, and D of 15 marks each and may contain more than one part. Question 1 will be of 15 marks and consists of short answer type questions of 2 to 3 marks each covering the entire syllabus.
2. The candidate will be required to attempt five questions in all i.e. selecting one question from each section including the compulsory question. The duration of the examination will be 3 hours.

Section:A

Electronic Spectra and Magnetic Properties of Transition Metal Complexes

Spectroscopic ground states and the evaluation of energies of various J states of free ions, splitting of S, P, D and F terms under octahedral and tetrahedral electrostatic potential, correlation, Orgel and Tanabe-Sugano diagrams for transition metal complexes (d1-d9 states), calculations of Dq , B and β parameters, charge transfer spectra of complexes (both metal to ligand and ligand to metal), spectroscopy method of assignment of absolute configuration in optically active metal chelates and their stereochemical information, anomalous magnetic moments, magnetic exchange coupling and spin crossover.

Section: B

Metal-Ligand Equilibria in Solution

Stepwise and overall formation constants and their interaction, trends in stepwise constants, factors influencing stability of metal complexes dependent on size and charge, metal class, ligand preference, nature of transition metal ions, basic strength, chelate effect, ring size, steric strain, macrocyclic effect, thermodynamic and kinetic stability, determination of formation constants by pH-metry and spectrophotometry.

Section:C

Reaction Mechanism of Transition Metal Complexes

Energy profile of a reaction, reactivity of metal complexes, inert and labile complexes, kinetic application of valence bond and crystal field theories, kinetics of octahedral substitution, acid hydrolysis, factors affecting acid hydrolysis, base hydrolysis, conjugate base mechanism, direct and indirect evidences in favour of conjugate mechanism, anation reactions, reactions without metal ligand bond cleavage. Substitution reaction in square planar complexes, trans effect, mechanism of the substitution reactions. Redox reactions, electron transfer reactions, mechanism of one electron transfer reactions, outer sphere type reactions, cross reactions and Marcus-Hush theory, inner sphere type reactions.

Section:D

Crystal engineering and supramolecular chemistry

Introduction to crystal engineering-synthon principle. Origin of supramolecular chemistry- "Chemistry beyond the molecules". Concepts and terminology of supramolecular chemistry.

Nature and types of supramolecular interactions (Hydrogen bonding, van der Waal interactions, π stacking, C-H π interactions etc.). Molecular recognition- Information and complementarity.

Different types of receptors with special reference of Crown ethers, cryptates and Calix [4] arene.

Anion recognition and anion coordination chemistry. Molecular self-assembly formation and examples. Supramolecular chemistry of life, application of supramolecular chemistry in drug design. Application in material science- molecular machines.

Reference Books:

1. J. E. Huheey, E. A. Keiter, R. L. Keiter, O. K. Medhi; Inorganic Chemistry: Principles of Structure and Reactivity, 4thed. Pearson Education, 2006.
2. F. A. Cotton, G. Wilkinson, C. A. Murillo and M. Bochmann; Advanced Inorganic Chemistry, 6thed. John Wiley, 1999.
3. N. N. Greenwood and E. A. Earnshaw; Chemistry of elements, 2nded. Butterworth-Heinemann, 1997.
4. B. E. Douglas, D. H. McDaniel, J. J. Alexander; Concepts and Models of Inorganic Chemistry, 3rded. John Wiley, 1993.
5. G. R. Desiraju, J. J. Vittal, A. Ramanan; Crystal Engineering, A Textbook, World Scientific, 2011.
6. J.W. Steed and J.L. Atwood; Supramolecular Chemistry, John Wiley, 2ndEd., 2009.
7. J. M. Lehn; Supramolecular Chemistry, VCH, Weinheim, 1995.
8. J. P. Sauvage; Transition metals in supramolecular chemistry: John Wiley & sons: UK, 1stEd., 1999.

Organic Chemistry-II

Paper Code:
Max. Marks: 75

Time Allowed: 3 Hours
Credits: 4

Note for Examiners and Students:

1. The question paper will consist of four sections A, B, C & D. Examiner will set nine questions in all, selecting two questions from section A, B, C, and D of 15 marks each and may contain more than one part. Question 1 will be of 15 marks and consists of short answer type questions of 2 to 3 marks each covering the entire syllabus.
2. The candidate will be required to attempt five questions in all i.e. selecting one question from each section including the compulsory question. The duration of the examination will be 3 hours.

Section: A

Aromatic Substitution and Elimination Reactions

Aromatic Electrophilic Substitution

The arenium ion mechanism, orientation and reactivity. The ortho/para ratio, ipso attack, orientation in other ring systems. Diazonium coupling, Vilsmeier reaction, Gattermann-Koch reaction.

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 Richter, Sommelet-Hauser, and Smiles rearrangements.

Elimination Reactions

The E2, E1 and E1cB mechanisms. Orientation of the double bond. Reactivity – effects of substrate structures, attacking base, the leaving group and the medium.

Section: B

Chemistry of carbon-carbon and carbon-heteroatom multiple bonds

Addition to Carbon-Carbon Multiple Bonds

Mechanistic and stereochemical aspects of addition reactions involving electrophiles, nucleophiles and free radicals. Hydrogenation of double and triple bonds, hydrogenation of aromatic rings. Hydroboration. Michael reaction. Sharpless asymmetric epoxidation.

Addition to Carbon-Hetero Multiple Bonds

Mechanism of metal hydride reduction of carbonyl compounds, acids and esters. Addition of Grignard reagents, organozinc and organolithium reagents to carbonyl compounds. Wittig reaction. Mechanism of condensation reactions involving enolates; Aldol, Knoevenagel, Claisen, Mannich, Benzoin, Perkin and Stobbe reactions. Hydrolysis of esters and amides.

Section: C

Free Radical Reactions and Photochemistry

Free radicals: Types of free radical reactions, free radical substitution mechanism, mechanism at an aromatic substrate, neighbouring group assistance. Reactivity in the attacking radicals. The effect of solvents on reactivity. Allylic halogenation (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.

Organic Photochemistry: Fundamentals of photochemistry, photochemical reactions of alkenes, aromatic compounds, carbonyl compounds and other systems, synthetic applications of photochemical reactions, modern methods in organic photochemistry.

Section: D

Pericyclic Reactions

Molecular orbital symmetry, Frontier orbitals of ethylene, 1,3-butadiene, 1,3,5-hexatriene and allyl system. Classification of pericyclic reactions. FMO approach. Electrocyclic reactions – conrotatory and disrotatory motions, $4n$, $4n + 2$ and allyl systems. Cycloadditions – antarafacial and suprafacial additions, $4n$ and $4n+2$ systems, $2+2$ addition of ketenes. Sigmatropic rearrangements – suprafacial and antarafacial shifts of H, sigmatropic shifts involving carbon moieties, 3,3- and 5,5-sigmatropic rearrangements. Claisen, Cope and aza-Cope rearrangements. Ene reaction.

Reference Books:

1. March's Advanced Organic Chemistry: Reactions, Mechanisms, and Structure, 7th Edition, Michael B. Smith, WILEY, 2013.
2. Advanced Organic Chemistry PART A and PART B., F. A. Carey and R. J. Sundburg, Springer 2007.
3. Organic Chemistry, J. Clayden, N. Greeves and S. Warren, Oxford University Press, 2012.
4. Organic Chemistry, Morrison, Boyd and Bhattcharjee, 6th Edition, Pearson, 2010.
5. A Guide Book to Mechanism in Organic Chemistry, Peter Sykes, Longman, 1985.
6. Pericyclic Reactions, S. M. Mukherji, Macmillan, India, 1980.
7. Reaction Mechanism in Organic Chemistry, S. M. Mukherji and S. P. Singh, Macmillan, 1984.
8. Advanced Organic Chemistry: Reaction Mechanism, R Bruckner, Harcourt (India) Pvt. Ltd., 2001.

Physical Chemistry-II

Paper Code:
Max. Marks: 75

Time Allowed: 3 Hours
Credits: 4

Note for Examiners and Students:

1. The question paper will consist of four sections A, B, C & D. Examiner will set nine questions in all, selecting two questions from section A, B, C, and D of 15 marks each and may contain more than one part. Question 1 will be of 15 marks and consists of short answer type questions of 2 to 3 marks each covering the entire syllabus.
2. The candidate will be required to attempt five questions in all i.e. selecting one question from each section including the compulsory question. The duration of the examination will be 3 hours.

Section: A

Partial molar properties; partial molar free energy, partial molar volume and partial molar heat content and their significance. The concept of fugacity and determination of fugacity. Thermodynamics of ideal and non-ideal gases, and solutions. Non-ideal systems: Excess functions for non-ideal solutions. Activity, activity coefficient, Debye-Huckel theory for activity coefficient of electrolytic solutions; determination of activity and activity coefficients; ionic strength.

Section: B

Statistical Thermodynamics

The concept of distribution, ensemble averaging, postulates of ensemble averaging. Canonical, grand canonical and micro canonical 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, applications of partition functions. Heat capacity, Fermi-Dirac statistics, distribution law and Bose – Einstein statistics - distribution law and applications.

Section: C

Molecular Spectroscopy- Rotational Spectroscopy

The Born-Oppenheimer Principle, Rotational Spectroscopy-Rigid Rotator, Selection rule for rotational/microwave spectrum, determination of bond-length, intensity of spectral lines, effects of isotopes on rotational spectra, Non-rigid rotator, Stark effect, Nuclear spin interactions, application of microwave spectroscopy.

Section: D

Molecular Spectroscopy- Vibrational Spectroscopy

Infrared/Vibrational Spectroscopy-Vibration in Diatomic molecules, Harmonic Oscillator Model, Zero-point Energy, Selection Rule, An-harmonic Oscillator, Population of Vibrational Energy level, Diatomic Vibrating Rotator, P-Q-R Branches of Spectra, Break down of Born- openheimer approximation, Fundamental Vibration and Symmetry, Overtone and combination frequency.

Reference Books:

1. Atkins' Physical Chemistry, Peter Atkins and Julio Paula, Oxford University Press; 10th Ed. (2014)
2. Statistical Mechanics, R K Pathria & Paul D Beal, Elsevier III Ed. (2016)
3. An Introduction to Statistical Thermodynamics, Terrell L. Hill, Dover Publication, (2008)
4. Physical Chemistry - A molecular approach, Donald McQuarrie and John Simon, Viva, 1st Ed. (2010)
5. Physical Chemistry, Ira N Levine, Tata McGraw-Hill Education; 6 Ed. (2011) Fundamentals of Molecular & Spectroscopy, CN Banwe II, Tata McGraw-Hill Education IV Ed. (2013)
6. Rita Kakkar, Atomic and Molecule Spectroscopy: Basic Concepts and Applications, Cambridge University Press, 2015.
7. Molecular Spectroscopy, J L McHale, Pearson Education India (2008)

Practical Organic Chemistry

Paper Code:
Max Marks: 100

TIME ALLOWED: 6 HOURS
Credits – 4

Section: A

Qualitative Analysis

Qualitative analysis of common organic compounds having (aromatic rings, unsaturation, alcohols, phenols, carboxylic acids, carbonyl compounds, nitro, amine, amide and sugars)

Section: B

Separation and Purification Techniques

Recrystallisation, vacuum distillation and sublimation.

Thin Layer Chromatography: Separation of a mixture of organic compounds by TLC.

Measurement of R_f values.

Column chromatography, separation of coloured and colourless mixtures.

Section: C

Solvent Extraction Technique

Separation of an organic mixture containing two solid components using solvent extraction

Extraction of caffeine from tea leaves

Section: D

Organic Synthesis and Characterization Techniques

1) Preparation of an organic compounds involving one step.

2) Preparation of an organic compound involving two steps.

3) Characterization of compounds with the help of chemical analysis and confirmation of their structures with the help of IR/NMR/UV-Vis spectral data (IR, NMR spectra to be provided).

Reference Books:

1. Vogel's Textbook of Practical Organic Chemistry, Ed. 5, Longman, 1989.
2. Experiments and Techniques in Organic Chemistry, Pasto, Johnson and Miller, Prentice Hall, 1992.
3. Macroscale and Microscale Organic Experiments, K. L. Williamson, D. C. Heath, 7th Ed., 2011.
4. Systematic Qualitative Organic Analysis, H. Middleton, Edward Arnold.
5. Handbook of Organic Analysis- Qualitative and Quantitative, H. Clark, Edward Arnold.

Organic Chemistry of Polymers

Paper Code:
Max. Marks: 75

Time Allowed: 3 Hours
Credits: 4

Note for Examiners and Students:

1. The question paper will consist of four sections A, B, C & D. Examiner will set nine questions in all, selecting two questions from section A, B, C, and D of 15 marks each and may contain more than one part. Question 1 will be of 15 marks and consists of short answer type questions of 2 to 3 marks each covering the entire syllabus.
2. The candidate will be required to attempt five questions in all i.e. selecting one question from each section including the compulsory question. The duration of the examination will be 3 hours.

Section: A

Classification of polymers by properties (morphological, elastomeric, thermoplastic, thermoset, emulsion polymers, suspension polymers), and structures (aliphatic hydrocarbons, aromatic hydrocarbons, polysaccharides, polyesters, polyamides, polyurethanes, polyphosphazenes, silicones, glasses, phenol-formaldehyde resins)

Section: B

Applications of polymers (elastomeric, adhesives, membranes, agricultural mulch films. Introduction to polymer structures. Synthesis of different classes of polymers (condensation polymers, free radical polymers, coordination polymers). Mechanisms of polymerizations by anionic, cationic, free radical and coordination catalysis.

Section: C

Synthesis of polymers by radical, emulsion, suspension, and ionic mechanisms, Copolymers, Functionalization of synthetic (hydrocarbons) and natural polymers (cellulose, lignin) by use of chemical reactions, Cross linking of polymers, Stereochemistry of polymers, cis trans rubbers, poly (methylmethacrylate) polymers.

Section: D

Natural Polymers (cellulose, starch, lignin, galactomannans, xanthan gum, alginic acid). Biodegradable Polymers, with special reference to Polyvinyl alcohol, polylactic acid, and cellulose esters. Applications of biodegradable polymers.

Reference Books:

1. Principles of Polymerization, George Odian, 4th. Edition, Wiley-Interscience(2004).
2. Textbook of Polymer Science, Fred W. Billmeyer, 3rd. Ed., John Wiley and Sons (Asia) (2013).
3. A Textbook of Polymer Chemistry, M.S. Bhatnagar, S. Chand & Co., (New Delhi) (2014 reprint).
4. Biodegradable Polymers for Industrial Applications, Ray Smith, Ed., CRC Press (New York, Woodhead Publishing Co., (Cambridge) (2005).

Environmental Chemistry

Paper Code:
Max. Marks: 75

Time Allowed: 3 Hours
Credits: 4

Note for Examiners and Students:

1. The question paper will consist of four sections A, B, C & D. Examiner will set nine questions in all, selecting two questions from section A, B, C, and D of 15 marks each and may contain more than one part. Question 1 will be of 15 marks and consists of short answer type questions of 2 to 3 marks each covering the entire syllabus.
2. The candidate will be required to attempt five questions in all i.e. selecting one question from each section including the compulsory question. The duration of the examination will be 3 hours.

Section: A

General aspects of environment

Environmental segments: Atmosphere, Hydrosphere, Lithosphere and Biosphere. Vertical structure of the atmosphere. Greenhouse effect, global temperature and acid rain. Ozone depletion: ozone layer formation, reactions, role and ozone depletion processes. Consequences of ozone depletion.

Section: B

Environmental pollution and toxicology

Types and classification of pollutions. Pollution control techniques. Contaminants and their natural pathways into atmosphere. Toxicology of inorganic and organic compounds. Reactions and fate of Hazardous waste. Chemical methods of treatment for hazardous waste.

Section: C

Green Chemistry and Industrial Ecology

Principle of green chemistry. Waste prevention. Renewable feedstocks. Industrial ecology: Major components of industrial ecosystem, Environmental impact in industrial ecology, Industrial waste reduction and minimization methods.

Section: D

Climate change

Consequences, predications and adapting to climate change. International response to climate change: Montreal protocol, Rio de Janeiro summit, Kyoto protocol, ONG Earth summit, Copenhagen summit and Paris climate accord.

Reference Books

1. Environmental Chemistry, Manahan S.E., 3rd edition, CRC Press, 2009.
2. Environmental Science, Technology, and Chemistry, Manahan S.E., CRC Press, 2000.
3. Fundamentals of Environmental Chemistry, Manahan S.E., CRC Press, 2001.
4. Understanding Our Environment An Introduction to Environmental Chemistry and Pollution, Harrison, R. M., 3rd edition, RSC, 1999.
5. Environmental Chemistry, De A.K.; Fourth Edition; New Age International Pvt. Ltd., New Delhi, 2003.

SEMESTER - III
Inorganic Chemistry-III
Spectroscopy and Photoinorganic Chemistry

Paper Code:
Max. Marks: 75

Time Allowed: 3 Hours
Credits: 4

Note for Examiners and Students:

1. The question paper will consist of four sections A, B, C & D. Examiner will set nine questions in all, selecting two questions from section A, B, C, and D of 15 marks each and may contain more than one part. Question 1 will be of 15 marks and consists of short answer type questions of 2 to 3 marks each covering the entire syllabus.
2. The candidate will be required to attempt five questions in all i.e. selecting one question from each section including the compulsory question. The duration of the examination will be 3 hours.

Section: A

Infrared and Raman Spectroscopy

Molecular vibrations, force constants, molecular vibrations and absorption of Infrared radiations. Raman spectroscopy, polarized Raman lines. Use of symmetry considerations to determine the number of lines in IR and Raman Spectra. Structural studies involving IR and Raman Spectroscopy of coordination compounds containing the following molecules/ions and ligands: NH_3 , H_2O , OH , SO_4^{2-} , ClO_4^- , COO^- , NO_2 , CN^- , SCN^- , NO , O_2 , PR_3 , Halides, DMSO, azopyridine, oxime, quinine, acetylacetone, amino acids. Hydrogen bonding and infrared spectra, metal ligand and related vibrations. Application of resonance Raman spectroscopy to structural elucidation of the active sites of heme and non-heme oxygen carriers.

Section: B

Electron Spin Resonance Spectroscopy

Basic principle, selection rules, presentation of spectra, origin and interpretation of Lande's factor (g), factor affecting 'g-value', isotropic and anisotropic hyperfine coupling, super hyperfine coupling, spin-orbit coupling, line shape, zero field splitting, Kramer's degeneracy, quadrupolar interactions, ESR analysis of organic compounds, transition metal complexes of vanadium, chromium, manganese, iron, copper, cobalt and iron.

Application of ESR spectroscopy: structure determination, interpretation of ESR spectra of simple organic radicals like benzene, naphthalene, toluene and xylene radical ions, study of unstable paramagnetic species.

Section: C

Mössbauer and Nuclear Quadrupole Resonance Spectroscopy

Mössbauer Spectroscopy: Introduction to Mössbauer effect - Basic principles, recoilless emission & absorption of γ -rays. Mössbauer experiment - Instrumentation, scheme of Mössbauer spectrometer, Mössbauer spectrum. Isomer shift, quadrupole splitting and hyper fine interactions, application of Mössbauer effect to the investigations of compounds of iron and tin.

Nuclear Quadrupole Resonance Spectroscopy: Principle, nuclear quadrupole resonance experiment, structural information from NQR spectra, Interpretation of nuclear quadrupole coupling constants.

Section: D

Photochemistry

Interaction of electromagnetic radiation with matter, electronic transition, Frank-Condon principle, selection rules, Grotthus-Draper law, Stark-Einstein law of photochemical equivalence and Lambert-Beer's law, quantum yield, photodissociation, predissociation, photochemical reactions: photoreduction, photooxidation, photodimerization, photochemical substitution, photoisomerization. Photo physical phenomena: Electronic structure of molecules, molecular orbital, electronically excited singlet states, life time of electronically excited state, construction of Jablonski diagram, electronic transitions and intensity of absorption bands, photophysical pathways of excited molecular system (radiative and non-radiative), chemiluminescence, phosphorescence and fluorescence.

Reference Books:

1. K. Nakamoto; Infrared and Raman Spectra of Inorganic and Coordination Compounds, Part A and B, 6thed. Wiley, 2008.
2. C. N. Banwell and E. M. McCash; Fundamentals of Molecular Spectroscopy, 4thed. Tata McGraw Hill, 1994.
3. D. L. Pavia, G.M. Lampman, G.S. Kriz and J. R. Vyvyan; Introduction to Spectroscopy, 5thed. Cengage India, 2015.
4. K. K. Rohatgi and K. K. Mukherjee; Fundamentals of Photochemistry, 3rded. New Age International (P) Ltd., 2014.
5. J. R. Lakowicz, Principles of Fluorescence Spectroscopy, 3rded. Springer, New York, 2006.
6. N. J. Turro, V. Ramamurthy and J. C. Scaiano, Modern Molecular Photochemistry of Organic Molecules, 1sted. University Science, Books, CA, 2010.
7. I. Ninomiya, T. Naito, Photochemical Synthesis, 1sted. Academic Press, New York, 1989.

Organic Chemistry-III (Spectroscopy)

Paper Code:
Max. Marks: 75

Time Allowed: 3 Hours
Credits: 4

Note for Examiners and Students:

1. The question paper will consist of four sections A, B, C & D. Examiner will set nine questions in all, selecting two questions from section A, B, C, and D of 15 marks each and may contain more than one part. Question 1 will be of 15 marks and consists of short answer type questions of 2 to 3 marks each covering the entire syllabus.
2. The candidate will be required to attempt five questions in all i.e. selecting one question from each section including the compulsory question. The duration of the examination will be 3 hours.

Section:A

Ultraviolet and Visible Spectroscopy

Various electronic transitions, Beer-Lambert law, visible spectrum & colour, effect of solvent on electronic transitions, ultraviolet bands for carbonyl compounds, unsaturated carbonyl compounds, dienes, conjugated polyenes. Fieser-Woodward rules for conjugated dienes and carbonyl compounds, ultraviolet spectra of aromatic and heterocyclic compounds.

Section: B

Infrared Spectroscopy

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

Section: C

Nuclear Magnetic Resonance Spectroscopy

General introduction and definition, chemical shift, spin-spin interaction, shielding and deshielding mechanism, 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 & mercapto), chemical exchange, effect of deuteration, complex spin-spin interaction between two, three, four and five nuclei (first order spectra), virtual coupling. Stereochemistry, hindred rotation, Karplus curve-variation of coupling constant with dihedral angle. Simplification of complex spectra, nuclear magnetic double resonance, contact shift reagents. Fourier transform technique, nuclear Overhauser effect (nOe). Resonance of other nuclei-F, P. Carbon-13 NMR Spectroscopy: General considerations, chemical shift (aliphatic, olefinic, alkyne, aromatic, heteroarmatic and carbonyl carbon), coupling constants and DEPT ¹³C NMR spectra. General introduction to two-dimensional NMR spectroscopy-COSY, HETCOR, INADEQUATE and NOESY.

Section: D

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. Nitrogen rule. High resolution mass spectrometry (HRMS). Combined problems: Combined problems relating to structure elucidation by UV, IR, NMR Spectroscopy and Mass Spectrometry.

Reference Books

1. Spectrometric Identification of Organic Compounds, Silverstein, Bassler and TMorrill, JohnWiley.
2. Introduction to NMR Spectroscopy, R. J. Abraham, J. Fisher and P. Loftus, Wiley.
3. Application of Spectroscopy of Organic Compounds, J.R. Dyer, Prentice Hall.
4. Spectroscopic Methods in Organic Chemistry, D.H. Williams, I. Fleming, Tata McGraw-Hill.
5. Organic Chemistry, William Kemp, John Wiley.
6. Organic Spectroscopy, Jag Mohan, Narosa Publishers, New Delhi
7. Rita Kakkar, Atomic and Molecule Spectroscopy: Basic Concepts and Applications, Cambridge University Press, 2015.

Physical Chemistry-III

Paper Code:
Max. Marks: 75

Time Allowed: 3 Hours
Credits: 4

Note for Examiners and Students:

1. The question paper will consist of four sections A, B, C & D. Examiner will set nine questions in all, selecting two questions from section A, B, C, and D of 15 marks each and may contain more than one part. Question 1 will be of 15 marks and consists of short answer type questions of 2 to 3 marks each covering the entire syllabus.
2. The candidate will be required to attempt five questions in all i.e. selecting one question from each section including the compulsory question. The duration of the examination will be 3 hours.

Section: A

Principles of Quantum Mechanics

Introduction to Quantum Mechanical Approach, Quantum Mechanical operators, Eigen values of Quantum Mechanical operators, Hermitian operator, commutation relations, postulates of quantum mechanics and Uncertainty Principle.

Schrodinger equation for finding wave function of a particle, Energy of a particle in One- Dimension box, Extension to Schrodinger equation for finding wave function in a three- dimensional box, Energy of a particle in Three-Dimension box, Energy levels, Eigen value, degeneracy and selection rules.

Section: B

Approximation Methods: Quantum approach

Harmonic oscillator: Application to diatomic molecules and Energy levels; Rigid rotator: Model for a rotating di atomic molecule and Energy level; The Hydrogen atom: Schrodinger equation for hydrogen atom and shapes of atomic orbitals.

Approximate Methods: The linear variation principle, Perturbation theory (first order and non-degenerate).

Section: C

Surface Chemistry

The extent of adsorption: Physisorption and Chemisorptions, Adsorption isotherms, Rates of surface processes (adsorption, desorption and mobility on surfaces). BET equation.

Heterogeneous catalysis: Mechanism of heterogeneous catalysis; Langmuir–Hinshelwood mechanism.

Section: D

Principles of Symmetry and Group Theory

Symmetry elements and symmetry operations; Definitions of groups, subgroups, and classes; Improper Axes and Improper Rotations, General relations among symmetry elements and operations; Symmetrical Point Groups; Linear Molecules, Symmetry elements in Allene, H₂O₂, Benzene and Ferrocene; Determination of point groups of small molecules and Schon flies Symbols; Representations

of groups by matrices; The Great Orthogonality theorem and its consequences. Character table for point group $C_n, C_{nh}, C_{nv}, D_n, D_{nh}$ ($n=2,3$ and 4), T_d and O_h .

Reference Books:

1. Atkins' Physical Chemistry, Peter Atkins and Julio Paula, Oxford University Press; 10th Ed. (2014)
2. Quantum Chemistry, Ira N Levine, Pearson Education, 7th Ed. (2013)
3. Introductory Quantum Chemistry, A.K. Chandra, Tata McGraw-Hill (1998)
4. Quantum Chemistry, R.K. Prasad, New Age International (2001)
5. Statistical Mechanics, R.K. Pathria & Paul D. Beal, Elsevier III Ed. (2016)
6. An Introduction to Statistical Thermodynamics, Terrell L. Hill, Dover Publication, (2008)
7. Chemical Applications of Group Theory, F. A. Cotton, John Wiley & Sons, 3rd Ed. (2008)
8. Physical Chemistry - A molecular approach, Donald McQuarrie and John Simon, Viva, 1st Ed. (2010)

Practical Physical Chemistry

Paper Code:
Max. Marks: 75

Time Allowed: 6 Hours
Credits: 4

Physical Chemistry Experiments:

1. Determine the Energy of Activation for a reaction.
2. Study the nature of salt effect on the $(S_2O_8)^{2-}$ I^- reaction and calculate overall order of there action and w.r.t. each reactant species.
3. Study the kinetics of saponification conductometrically and determine the rate constant.
4. Verify Beer's law for the solution of potassium permanganate.
5. Determine the Half wave potential for the cation like Cd^{2+} , Pb^{2+} and Cu^{2+} .
6. Phase diagram of three component system: water-acetic acid-chloroform.
7. Determination of the equivalent conductance of strong electrolytes such as HCl, KCl, KNO_3 , $AgNO_3$, and NaCl at different concentration and the validity of Onsager equation.
8. Study conductometric/pH titration of (1) HCl/NaOH (2) CH_3COOH /NaOH and comment on nature of graph.
9. Study conductometric/ pH titration of (1) HCl/ NH_4OH (2) CH_3COOH / NH_4OH and commentonnatureofgraph.
10. Determine the equivalent conductance, degree of dissociation and dissociation constant of aceticacid.
11. Determination of relative viscosities of acids/solvents and polymers.
12. To determine the strength of acids including polybasic acids by titrating against base pH meter and potentiometrically.

Reference Books:

1. Experimental Physical Chemistry: A Laboratory Textbook, A. Halpern & G. McBane III Ed. W. H. Freeman(2006)
2. Vogel's Textbook of Quantitative Analysis, revised, J. Bassett, R. C. Denney, G. H. Jeffery and J. Mendham, ELBS.
3. Vogel's Textbook of Macro and Semimicro Qualitative Inorganic Analysis, revised, G. Svehla, Longman.
4. Practical Chemistry, A. M. James and F. E. Prichard, Longman.
5. Practical Physical Chemistry, B.P. Levitt and Zindley's, Longman.
6. Practical Physical Chemistry, S. R. Palit and S. K. De, Science Book Agency.
7. Experimental Physical Chemistry, R.C. Das and B. Behra, McGraw Hill.
8. Experiments in Physical Chemistry, Shoemaker and Gailand McGraw Hill.

Seminar

Paper Code:

Max. Marks: 50

Credits: 2

Each student must present at least one seminar (45 minutes) which will be followed by discussion session (15 minutes) with participation from other students and the concerned faculty members present. The student must also submit the slides/write-up of the presentation content to the faculty-in-charge. The seminar, participation in discussions, the submitted slides and overall attendance (as per ordinance) will form the basis of the evaluation. There will be no separate final exam for this course.

Medicinal Chemistry

Paper Code:
Max. Marks: 50

Time Allowed: 3 Hours
Credits: 2

Note for Examiners and Students:

1. The question paper will consist of four sections A, B, C & D. Examiner will set nine questions in all, selecting two questions from section A, B, C, and D of 15 marks each and may contain more than one part. Question 1 will be of 15 marks and consists of short answer type questions of 2 to 3 marks each covering the entire syllabus.
2. The candidate will be required to attempt five questions in all i.e. selecting one question from each section including the compulsory question. The duration of the examination will be 3 hours.

Section: A

Drug Design

Development of new drugs, concept of lead compounds and lead modifications, structure- activity relationship (SAR), factors affecting bioactivity, resonance, inductive effect, isosterism, bio-isosterism. Theories of drug activity, Quantitative structure activity relationship, Concepts of drugs receptor, Elementary treatment of drug receptor interactions, Physico-chemical parameters: lipophilicity, partition coefficient, electronic ionization constants, steric factors.

Section: B

Antineoplastic Agents

Introduction, cancer chemotherapy, targets of cancer chemotherapy, role of alkylating agents and antimetabolites in treatment of cancer. Synthesis of any three representative anticancer drugs, Recent development in cancer chemotherapy.

Section: C

Antibiotics and Cardiovascular Drugs

Cell wall biosynthesis, inhibitors, β -lactam rings, antibiotics inhibiting protein synthesis, Synthesis of penicillin G, amoxicillin, cephalosporin, ciprofloxacin. Introductory idea of tetracycline and streptomycin. Introduction and general mode of action. Synthesis of diltiazem, verapamil, methyldopa and atenolol.

Section: D

Local Antiinfective Drugs and Psychoactive Drugs

Introduction and general mode of action. Synthesis of furazolidone, naldixic acid, dapson, isoniazid, ethambutol, gluconazole, chloroquin and primaquin. Introduction, neurotransmitters, CNS depressants, general anaesthetics, mode of action of hypnotics, sedatives, anti-anxiety drugs, benzodiazepines, buspirone. Antipsychotic drugs – the neuroleptics, antidepressants, butyrophenones. Synthesis of diazepam, alprazolam, phenytoin and glutethimide.

Reference Books:

1. An Introduction to Medicinal Chemistry, 5th Edition, G. L. Patrick, Oxford University Press, 2013.
2. Wilson and Gisvold's Text Book of Organic Medicinal and Pharmaceutical Chemistry, Ed Robert F Dorge, 12th Edition, 2010.
3. An Introduction to Drug Design, 1st Edition, S. S. Pandeya and J. R. Dmmock, New Age International, 1999.
4. Burger's Medicinal Chemistry and Drug Discovery, Vol. 1, 7th Edition, Ed. M E Wolff, John Wiley, 2010.
5. The Organic Chemistry of Drug Design and Drug Action, 3rd Edition, R. B. Silverman, Academic Press, 2014.

Advanced Computational Chemistry

Paper Code:
Max. Marks: 75

Time Allowed: 3 Hours
Credits: 4

Note for Examiners and Students:

1. The question paper will consist of four sections A, B, C & D. Examiner will set nine questions in all, selecting two questions from section A, B, C, and D of 15 marks each and may contain more than one part. Question 1 will be of 15 marks and consists of short answer type questions of 2 to 3 marks each covering the entire syllabus.
2. The candidate will be required to attempt five questions in all i.e. selecting one question from each section including the compulsory question. The duration of the examination will be 3 hours.

Section: A

Fundamentals of Molecular Dynamics (MD) simulations

Topics: Introduction to Computer Simulation–Visual Representation of Molecular Systems, Lennard-Jones potentials -- Potentials and Force-Fields, Phase Space, Periodic Boundary Conditions, Minimum Image convention. Propagation of Newton's Equation, Time Step and Energy Minimization

Section: B

Applications to Macroscopic properties

A) Topics: Treatment of Statistical Mechanical Ensembles–Averages–Fluctuations–Time Correlation Function–Radial Distribution Function, Mean Square Displacement-Diffusion coefficient

B) Molecular Dynamics simulations–Hands on exercise Simulations of water
Topics: Introduction and Use of GROMACS MD Program, Visualization using Visual Molecular Dynamics (VMD)

Section: C

Introduction to Quantum Computational Chemistry

Topics: Scope of Computational Chemistry, Restricted and Unrestricted Hartree-Fock, Density Functional Theory: Exchange-Correlation Functional, Local Density Approximation, Generalized Gradient Approximation, Hybrid Density Functional Methods and Basis Sets: Slater and Gaussian Type Orbitals, Polarization and Diffuse Functions, Split-valence Sets, Core-valence Sets

Section: D

A) Basic concepts of potential energy surfaces

Topics: Stationary Points, Geometry Optimization, Local and Global Minima, and Transition State Theory (TST)

B) Hands on exercise (2hrs instructions+12hrs lab)

Topics: Computations of Single Point Energy, Optimizations and Transition States of Polyatomic Molecules, Intrinsic Reaction Coordinate Analysis.

Reference Books:

1. Computer Simulations of Liquids, M. P. Allen and D. J. Tildesley.
2. Molecular Modeling: Principles and Applications, Andrew R. Leach, Addison Wesley Publishing Company (March 1997).
3. Introduction to Computational Chemistry, Frank Jensen, John Wiley & Sons, 2007
4. Electronic Structure: Basic Theory & Practical Methods, by Richard M. Martin, Cambridge University Press
5. A Practical Guide for Applying Techniques to Real-World Problems by David C. Young, Cytoclonal Pharmaceuticals Inc. 2001
6. Introduction to the Theory and Applications of Molecular and Quantum Mechanics, by Errol Lewars, Kluwer Academic Publishers, New York, Boston, Dordrecht, London, Moscow, 2004
7. Essentials of Computational Chemistry: Theories and Models, 2nd Edition, Christopher J. Cramer, John Wiley & Sons Ltd, 2002.
8. Essentials of Computational Chemistry: Theories and Models, 2nd Edition, Christopher J. Cramer, John Wiley & Sons Ltd, 2004.
9. Exploring Chemistry with Electronic Structure Methods, 2nd Edition, James B. Foresman and Aileen Frisch, Gaussian Inc

General Polymer Chemistry

Paper Code:
Max. Marks: 75

Time Allowed: 3 Hours
Credits: 4

Note for Examiners and Students:

1. The question paper will consist of four sections A, B, C & D. Examiner will set nine questions in all, selecting two questions from section A, B, C, and D of 15 marks each and may contain more than one part. Question 1 will be of 15 marks and consists of short answer type questions of 2 to 3 marks each covering the entire syllabus.
2. The candidate will be required to attempt five questions in all i.e. selecting one question from each section including the compulsory question. The duration of the examination will be 3 hours.

Section: A

Introduction to polymers

Nomenclature of polymers: names based on source, structure (IUPAC and Non-IUPAC) and trade names. Exposure to important terminologies and definitions used in polymer chemistry such as molecular weight, size, glass transition temperature and morphology.

Section: B

Types of polymerization

Step polymerization, Chain transfer for polymerization, Anionic & Cationic polymerization, Coordination polymerization, Solution & Template polymerization, Bulk & Block polymerization, Radical polymerization, Ring opening polymerization.

Section: C

Application of synthetic polymers

- (i) In medicinal field as artificial heart, artificial skin, contact lenses and dental resins.
- (ii) Electrical properties: Conducting polymers (polyacetylenes), polymer electronics (polymer based LED, solarcells, transistors, and sensors).

Section: D

Natural and Biodegradable polymers

Naturally occurring Polymers (polysaccharides, cellulose, starch, proteins, nucleic acid, lignin, melanins). Biodegradable Polymers, with special reference to polyvinyl alcohol, polylactic acid, and cellulose esters. Application of biodegradable polymers.

Reference Books:

1. Introduction to Polymer Chemistry, Charles E. Carraher, Jr., 3rd. Edition, CRC press (2013).
2. Introduction to Polymers, Robert J. Young and Peter A. Lovell, 3rd. Edition, CRC press (2011).
3. A Textbook of Polymer Chemistry, M.S. Bhatnagar, S. Chand & Co., (New Delhi) (2014)

reprint).

4. Biodegradable Polymers for Industrial Applications, Ray Smith, Ed., CRC Press (new York, Woodhead Publishing Co., (Cambridge)(2005).

Organometallic Chemistry

Paper Code:
Max. Marks: 75

Time Allowed: 3 Hours
Credits: 4

Note for Examiners and Students:

1. The question paper will consist of four sections A, B, C & D. Examiner will set nine questions in all, selecting two questions from section A, B, C, and D of 15 marks each and may contain more than one part. Question 1 will be of 15 marks and consists of short answer type questions of 2 to 3 marks each covering the entire syllabus.
2. The candidate will be required to attempt five questions in all i.e. selecting one question from each section including the compulsory question. The duration of the examination will be 3 hours.

Section: A

Alkyls, Aryls, Carbenes and Carbynes of Transition Metals

Synthesis, structure and bonding considerations of Zeise's salt; synthesis, stability and decomposition pathways of organocopper in organic synthesis; synthesis and reactivity of alkyl lithium; synthesis and reactivity of organozinc compounds.

Metal carbenes: preparation, reactivity, structure and bonding considerations of Fischer and Schrock carbene complexes, Tebbe's reagent, Grubb's reagent, Petasis reagent, Metal carbynes: synthesis, reactivity, structure and bonding considerations of Fischer and Schrock carbyne complexes.

Section: B

Transition Metal π -Cyclic Complexes

Half and bent sandwich compounds, molecular orbitals of metallocenes, structures of cyclopentadienyl compounds, covalent versus ionic bonding, 18 electron rule, synthesis, structure, aromatic behaviour of Ferrocene, reactions such as metallation, Friedal Craft, Mannich reaction, sulphonation, nitrations, halogenations reactions, Synthesis, structure and reactions of other metallocenes (with Cr, Ni and Zr metals).

Section: C

Fluxional Organometallic Compounds and Coupling Reactions

Rates of rearrangement and techniques of study, NMR study of Fluxional behavior, Classification of fluxional organometallic Compounds, Mechanism of fluxionality in compounds of η^1 -Cyclopentadienyls and η^3 -allyls. Stereochemical non rigidity in case of coordination numbers- 4 & 5 (cis-trans, atomic inversion, Berry Pseudorotation).

Tsuji-Trost, Mizoroki-Heck, Miyaura-Suzuki, Stille, Negishi, Sonogashira, Kumada, Hiyama, Buchwald-Hartwig amination or coupling reactions

Section: D

Catalytic Processes involving Transition Metal Organometallic Compounds:

Oxidative addition, reductive elimination, insertion-migration reactions, C-H bond activation catalytic mechanism of hydrogenation, hydroformylation, oxidation and isomerization of alkenes, Monsanto

acetic acid synthesis, olefin metathesis, Fischer-Tropsch synthesis and Ziegler-Natta polymerization of alkenes, water gas shift reaction, asymmetric and supported organometallic catalysis.

Reference Books:

1. Principles and Application of Organotransition Metal Chemistry, J. P. Collman, L.S. Hegsdus, J. R. Norton and R. G. Finke, University ScienceBooks.
2. The Organometallic Chemistry of the Transition Metals, Crabtree, R.H. John Wiley.
3. Organometallic Chemistry, Mehrotra R.C. and Singh, A. New Age International.
4. Organometallics, Salzer, A. Ch. Elschenbrioch. VCH Publications.
5. Reaction Mechanism of Inorganic and Organometallic systems; 2nd edn.; Robert .b. Jordan.
6. Inorganic Chemistry, 3rd edn.,; Miessler ,G. L., Donald, A.T.
7. Inorganic Chemistry ; 4th edn.; Huheey, J. E.; Keiter, E. A.; Keiter, R. L.; Medhi, O. K.; Pearson Education, Inc.

Bioinorganic Chemistry

Paper Code:
Max. Marks: 75

Time Allowed: 3 Hours
Credits: 4

Note for Examiners and Students:

1. The question paper will consist of four sections A, B, C & D. Examiner will set nine questions in all, selecting two questions from section A, B, C, and D of 15 marks each and may contain more than one part. Question 1 will be of 15 marks and consists of short answer type questions of 2 to 3 marks each covering the entire syllabus.
2. The candidate will be required to attempt five questions in all i.e. selecting one question from each section including the compulsory question. The duration of the examination will be 3 hours.

Section: A

Metal ions in Biological Systems and Bioenergetics

Essential and trace metals. Role of metals ions in biological processes. Calcium in biology: Calcium in living cells, transport and regulation, molecular aspects of intramolecular processes. Na^+/K^+ Pump DNA polymerisation, glucose storage, metal complexes in transmission of energy.

Section: B

Nitrogenase and Photosynthesis

Biological nitrogen fixation, molybdenum nitrogenase, spectroscopic and other evidence, other nitrogenases model systems. Chlorophylls, photosystem I and photosystem II in cleavage of water. Model systems.

Section: C

Electron Transfer, Transport and Storage of Dioxygen

Structure and function of metalloproteins in electron transport processes— cytochromes and iron-sulphur proteins, synthetic models. Heme proteins and oxygen uptake, structure and function of hemoglobin, myoglobin, hemocyanins and hemerythrin, model synthetic complexes of iron, cobalt and copper.

Section: D

Metalloenzymes, Metal storage Transport and Biomineralization

Zinc enzymes- carboxypeptidase and carbonic anhydrase. Iron enzymes- catalase, peroxidase and cytochrome P-450. Copper enzymes- superoxide dismutase. Molybdenum oxotransferase enzymes- xanthine oxidase. Coenzyme vitamin B_{12} , Ferritin, transferrin and siderophores.

Reference Books:

1. Principles of Bioinorganic Chemistry, S. J. Lippard and J. M. Berg, University Science Books.
2. Bioinorganic Chemistry, I. Bertini, H. B. Gray, S. J. Lippard and J. S. Valentine, University Science Books.
3. J. E. Huheey, E. A. Keiter, R. L. Keiter, O. K. Medhi; Inorganic Chemistry: Principles of

Structure and Reactivity, 4thed. Pearson Education,2006.

Heterocycles and Natural Products

Paper Code:
Max. Marks: 75

Time Allowed: 3 Hours
Credits: 4

Note for Examiners and Students:

1. The question paper will consist of four sections A, B, C & D. Examiner will set nine questions in all, selecting two questions from section A, B, C, and D of 15 marks each and may contain more than one part. Question 1 will be of 15 marks and consists of short answer type questions of 2 to 3 marks each covering the entire syllabus.
2. The candidate will be required to attempt five questions in all i.e. selecting one question from each section including the compulsory question. The duration of the examination will be 3 hours.

Section: A

Aromatic and Non-aromatic Heterocycles

- 1) General chemical behaviour of aromatic heterocycles, criteria of aromaticity (bond length, ring current and chemical shifts in ^1H NMR spectra, empirical resonance energy, delocalization energy and Dewar resonance energy). Heteroaromatic reactivity and tautomerism in aromatic heterocycles.
- 2) Strain-bond angle and torsional strain and their consequences in small ring heterocycles. Conformation of six-membered heterocycles with reference to molecular geometry, barrier to ring inversion, pyramidal inversion and 1,3-diaxial interaction.

Section: B

Heterocyclic synthesis and reactions

- 1) Synthesis and reactions of three and four membered heterocycles (aziridines, oxiranes, thiiranes, azetidines, oxetanes and thietanes).
- 2) Synthesis and reactions of benzopyrroles, benzofurans and benzothiophenes.
- 3) Synthesis and reactions of pyrylium salts and pyrones and their comparison with pyridinium & thio pyrylium salts and pyridones.
- 4) Synthesis and reactions of quinolinium and benzopyrylium salts.

Section: C

Chemistry of Natural Products (Terpenoids and Steroids)

Terpenoids and Carotenoids: Classification, nomenclature, occurrence, isolation, general methods of structure determination, isoprene rule. Stereochemistry, synthesis and biosynthesis of the following representative molecules: Citral α Terpineol, Farnesol, Santonin, Phytol and β -carotene.

Steroids: Occurrence, nomenclature, basic skeleton, Diel's hydrocarbon and stereochemistry. Isolation and synthesis of Cholesterol, Testosterone, Progesterone, Oestrone.

Section: D

Natural Products Chemistry (Alkaloids)

Definition, nomenclature, occurrence, isolation, general methods of structure elucidation, degradation, classification based on nitrogen Heterocyclic ring. Stereochemistry, synthesis and biosynthesis of the following: Ephedrine, Nicotine, Atropine and Quinine.

Reference Books

1. The chemistry of Heterocycles, T. Eicher and S. Hauptmann, Thieme.
2. Heterocyclic Chemistry, J. A. Joule, ELBS.
3. Heterocyclic Chemistry, T. L. Gilchrist, Longman Scientific Technical.
4. Contemporary Heterocyclic Chemistry, G. R. Newkome and W. W. Paudler, Wiley-Interscience.
5. An Introduction to Heterocyclic Chemistry, R. M. Acheson, John Wiley.
6. Comprehensive Heterocyclic Chemistry, A. R. Katritzky and C. W. Rees, eds. Pergamon Press.
7. Natural products: Chemistry and Biological Significance, Mann, Davidson, Hobbs, Bantrop and Harborne, Longman, Essex.
8. Organic Chemistry, Vol. 2, I. L. Finar, ELBS.
9. Rodd's Chemistry of Carbon Compounds, Ed. S. Coffey, Elsevier.
10. Introduction of Flavonoids, B. A. Bohm, Harwood Academic Publishers.
11. Chemistry, Atta-ur-Rahman and Choudhary, Harwood Academic Publishers.

Organic Synthesis

Paper Code:
Max. Marks: 75

Time Allowed: 3 Hours
Credits: 4

Note for Examiners and Students:

1. The question paper will consist of four sections A, B, C & D. Examiner will set nine questions in all, selecting two questions from section A, B, C, and D of 15 marks each and may contain more than one part. Question 1 will be of 15 marks and consists of short answer type questions of 2 to 3 marks each covering the entire syllabus.
2. The candidate will be required to attempt five questions in all i.e. selecting one question from each section including the compulsory question. The duration of the examination will be 3 hours.

Section: A

Reagents and methods in Organic Synthesis

Modern alkali metal reagents (LDA, LiHMDS, KHMDS); Enamines and modern aldol chemistry; Olefination reactions and reagents (Wittig, Wadsworth, Peterson, Julia and McMurry); Amide coupling reagents (DCC, DIC, EDC, HOBt); Common reducing agents (Dissolving metal reductions, various hydrides, catalytic/transfer hydrogenations, diimide); Common oxidising agents, oxidations of alcohols, alkenes, aldehydes, and saturated carbons; Woodward and Prevost dihydroxylations, hypervalent iodine reagents, DDQ; Organic chemistry of boron, silicon and tin; Organocatalysis

Section: B

Rearrangement Reactions

A detailed study of the following rearrangements: Wagner-Meerwein, Pinacol, Tiffeneau-Demjanov, Wolff, Beckmann, Baeyer-Villiger, Curtius, Lossen, Schmidt, Favorskii, Baker-Venkataraman and Neber and variants of Pericyclic (Cope, Claisen) rearrangements.

Section: C

Synthetic planning and retrosynthesis

An introduction to synthons and synthetic equivalents, disconnection approach, functional group inter-conversions; chemoselectivity, reversal of polarity (Umpolung exemplified by 1,3-dithianes, benzoin condensations and N-heterocyclic carbenes); the importance of the order of events in organic synthesis. Use of carbonyl compounds, acetylenes and nitro compounds. Basics of asymmetric synthesis

Section: D

Protecting groups and total synthesis

Protecting Groups in total synthesis for alcohol, amine, carbonyl and carboxyl groups; Total synthesis, semi synthesis and formal total synthesis; Classical and modern total syntheses any two of the following natural products; Prostaglandin, Reserpine, Strychnine and Quinine

Reference Books:

1. Modern Synthetic Reactions, H. O. House, W. A. Benjamin, 1972.
2. Some Modern Methods of Organic Synthesis, W. Carruthers, Cambridge University Press, 2004.
3. Principles of Organic Synthesis, R. O. C. Norman and J. M. Coxon, Blackie Academic & Professional, 1993.
4. Organic Synthesis: The Disconnection Approach- 2nd Edition, Stuart Warren and Paul Wyatt, WILEY, 2008.
5. New Horizons in Organic Synthesis, V. Nair & S. Kumar, New Age International, 1996.
6. March's Advanced Organic Chemistry: Reactions, Mechanisms, and Structure, 7th Edition, Michael B. Smith, WILEY, 2013.
7. Advanced Organic Chemistry PART A and PART B., F. A. Carey and R. J. Sundburg, Springer 2007.
8. Organic Chemistry, J. Clayden, N. Greeves and S. Warren, Oxford University Press, 2012.
Organic Chemistry, Morrison, Boyd and Bhattacharjee, 8th Edition, Pearson, 2010

Chemical Dynamics and Catalysis

Paper Code:
Max. Marks: 75

Time Allowed: 3 Hours
Credits: 4

Note for Examiners and Students:

1. The question paper will consist of four sections A, B, C & D. Examiner will set nine questions in all, selecting two questions from section A, B, C, and D of 15 marks each and may contain more than one part. Question 1 will be of 15 marks and consists of short answer type questions of 2 to 3 marks each covering the entire syllabus.
2. The candidate will be required to attempt five questions in all i.e. selecting one question from each section including the compulsory question. The duration of the examination will be 3 hours.

Section: A

Kinetics of polymerization & Enzyme Inhibitions

Introduction, kinetics to step growth polymerization, free radical addition polymerization, calculation of radius of gyration. Enzymes and Inhibitions. Enzyme catalysed 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.

Section: B

Transition State Theory

A brief aspect of statistical mechanics and transition state theory, application on calculation of second order rate constant for reactions with collision for (atom + atom), (atom + molecule), and (molecule + molecule) reactions, static solvent effect and thermodynamic formulation, adiabatic electron transfer reaction and energy surfaces.

Section: C

Kinetics of Substitution reactions

Substitution reactions, classification of ligand substitution mechanism, inner and outer sphere electron transfer reactions and mechanism, adjacent and remote attack linkage isomerism.

Section: D

Metal ion catalysis and induced Phenomena

Metal ion catalysed reactions and reaction mechanism, induced reactions and their characteristics, applications, kinetics and mechanism of induced reaction in metal complexes, kinetics of hydroformylation reactions.

Reference Books:

1. H. Taube, Electron Transfer Reactions, Oxford Press.
2. Basolo and Pearson, Inorganic Reaction Mechanism, Wiley.
3. N. L. Bender, Mechanism of Homogenous catalysis, Wiley.
4. A. G. Sykes, Kinetics in Inorganic reactions, Academic Press.

Micelles and Electrochemistry

Paper Code:
Max. Marks: 75

Time Allowed: 3 Hours
Credits: 4

Note for Examiners and Students:

1. The question paper will consist of four sections A, B, C & D. Examiner will set nine questions in all, selecting two questions from section A, B, C, and D of 15 marks each and may contain more than one part. Question 1 will be of 15 marks and consists of short answer type questions of 2 to 3 marks each covering the entire syllabus.
2. The candidate will be required to attempt five questions in all i.e. selecting one question from each section including the compulsory question. The duration of the examination will be 3 hours.

Section: A

Molecular Orbital Theory

Molecular Orbital theory, effective Hamiltonian, Huckel theory of conjugated system, application to ethylene, butadiene, cyclopropenyl radical, cyclobutadiene, benzene etc. introduction to Extended Huckel theory.

Section: B

Micelles

Surface active agents, classification, micellization, hydrophobic interactions, critical micellar concentration (CMC), factors affecting CMC of surfactants, phase separation, micro emulsion and reverse micelles.

Section: C

Fuel Cells and Batteries

Electrochemical storage, theoretical consideration of fuel cells, maximum intrinsic efficiency, Hydrogen–Oxygen cell, alkaline fuel cell, phosphoric acid fuel cell, direct methanol fuel cell, Hydrocarbon–Air cells, Natural gas.

Battery characteristics specification, components, battery systems, Lead storage battery, Drycell, Silver-Zinc cell, Sodium–Sulphur cell and Ni-Cd battery.

Section: D

Advance Electroanalytical Methods

Potential Sweep Method: Linear Sweep voltammetry, cyclic voltammetry, controlled current techniques- chronopotentiometry: theory and applications, Polarography: theory and applications.

Reference Books:

1. Quantum Chemistry, I. M. Levine, PrenticeHall.
2. Micelles, Theoretical and applied aspects, V. Moroi, Plenum
3. Physical Chemistry, P. W. Atkins, ELBS.
4. Fuel cells from fundamental to applications, S. Srinivasan, Springer, New York, 2006.

SEMESTER-IV Project Work

For students who opt for dissertation projects in Starex University

The aim of the dissertation project work is to familiarize the students with advanced research. This course applies to students who opt to carry out their dissertation work in Starex University . The topic for the project work is to be decided by the supervisor/guide concerned. The project report is to be evaluated by a committee constituted by the Head ,Department of Chemistry/School of Physical Sciences having at least one external member.

Project Work

For students who opt for out-station dissertation projects

The aim of the dissertation project work is to familiarize the students with advanced research. This course applies to students who opt to go to other institutes for their dissertation work. The topic for the project work is to be decided by the supervisor/guide concerned. The project report is to be evaluated by a committee constituted by the Head, Department of Chemistry/School of Physical Sciences having at least one external member.

Basics of Medicinal Chemistry

Paper Code:
Max. Marks: 50

Time Allowed: 3 Hours
Credits: 2

Note for Examiners and Students:

1. The question paper will consist of four sections A, B, C & D. Examiner will set nine questions in all, selecting two questions from section A, B, C, and D of 15 marks each and may contain more than one part. Question 1 will be of 15 marks and consists of short answer type questions of 2 to 3 marks each covering the entire syllabus.
2. The candidate will be required to attempt five questions in all i.e. selecting one question from each section including the compulsory question. The duration of the examination will be 3 hours.

Section: A

Fundamentals

Historical development of systems of medicine, Basic chemical and biochemical principles, Key definitions, drug, target, receptors, enzymes, common drugs and their classification, anti-inflammatory drugs, antihistamines, antacids, antibiotics, narcotics, antivirals, and antineoplastics.

Section: B

Drug Action

Chemistry of drug-target interactions, bioavailability, drug absorption, distribution, metabolism, excretion (ADME), pharmacokinetics and pharmacodynamics, toxicity, side effects, lipophilicity and hydrophilicity, blood-brain barrier and its significance, routes of drug administration

Section:C

Drug Design and Synthesis

Development of new drugs, concept of lead compounds and lead modifications, structure- activity relationship (SAR), isosterism, bio-isosterism, important chemical principles behind design of drugs, natural products and their uses, chemical synthesis of drugs, drug formulation, drug delivery, photodynamic therapy.

Section: D

Drugs and Society

Regulatory processes for drug approval, regulatory agencies ,intellectual property, patents, drug misuse, drug abuse, abuse of antibiotics, fraud practices in treatment, historically important drugs and vaccines

Reference Books:

1. An Introduction to Medicinal Chemistry, 5th Edition, G. L. Patrick, Oxford University Press, 2013.
2. Wilson and Gisvold's Text Book of Organic Medicinal and Pharmaceutical

Chemistry, Ed Robert F Dorge, 12th Edition, 2010.

3. An Introduction to Drug Design, 1st Edition, S. S. Pandeya and J. R. Dmmock, New Age International, 1999.
4. Burger's Medicinal Chemistry and Drug Discovery, Vol. 1, 7th Edition, Ed. M E Wolff, John Wiley, 2010.
5. The Organic Chemistry of Drug Design and Drug Action, 3rd Edition, R. B. Silverman, Academic Press, 2014.