VIVEKANANDA COLLEGE

College with Potential for Excellence

Residential & Autonomous – A Gurukula Institute of Life-Training
Re-accredited with 'A' Grade (CGPA 3.59 out of 4.00) by NAAC
Affiliated to Madurai Kamaraj University
Tiruvedakam West, Madurai District– 625 234

POSTGRADUATE AND RESEARCH DEPARTMENT OF CHEMISTRY

M.Sc. Chemistry

SYLLABUS

Outcome Based Education

(For those students admitted during the Academic Year 2019-20 and after)

Vision

- ✓ To prepare the students of chemistry in such a way that they are self-reliant, highly informative and a better candidate in the demanding and ever changing world.
- ✓ To prepare the knowledgeable graduates for careers in academia, industry and government.

Mission

- ✓ To foster robust degree programme that prepare students for advanced studies in chemistry and careers in chemical industry.
- ✓ To encourage students to face CSIR-NET, GATE, SET and other competitive examinations.
- ✓ To invite scientists from National/International laboratories for lectures of global standard.
- ✓ To function as a vibrant and high quality research centre by supporting the faculty involved in such pursuits.

About the Programme

M.Sc Chemistry is a Post-Graduate Degree that is pursued by a student who has an Under Graduate Degree in the relevant field. The duration of the course is 2 years with 4 semesters included in the course. A bachelor's degree of 3 years in the relevant field from a recognized university with a minimum of 50% is eligible for this course. This course deals with Chemistry as a major subject with more concerned with physical, organic, inorganic and analytical Chemistry. This course allows you to specialize in a specific field of chemistry. MSc Chemistry has a wider range of scope in various fields such as pharmaceuticals and various research-based industries.

Programme Educational Objectives (PEOs)

PEO Number	PEO Statement
PEO1	Firm foundations in fundamentals of chemistry, effective skills to critically assess, analyse and solve problems in chemistry
PEO2	Depth knowledge to qualify CSIR–NET, SET and GATE examinations and ability in designing research methodology to pursue research
PEO3	Enormous job opportunities at all level of academic, chemical, pharmaceutical, paper, food, leather, cement and materials related industry
PEO4	Extend to continuously progress in their professional career through life long learning and respecting human values and ethics with environment concern
PEO5	Developed teamwork, leadership skills and moral values procured through life training for the welfare of their working environment and society

Programme Outcomes (POs)

PO Number	Programme Outcome	PO Statement
PO1	Disciplinary knowledge and critical thinking	Take informed actions after identifying the assumptions that frame our thinking and actions, checking out degree to which these assumptions are accurate and valid, and looking at our ideas and decisions (intellectual, organizational, and personal) from perspectives.
PO2	Effective communication and digital literacy	Speak, read, write and listen clearly in person and through electronic media in English and in one Indian language, and make meaning of the world by connecting people, ideas, books, media and technology.
PO3	Research related skills and scientific reasoning	Critically analyse the research processes, products and practices with a view of strategic use of data in their field and society.

PO4	Effective citizenship and social responsibility	Demonstrate empathetic social concern and equity centred national development, and the ability to act with an informed awareness of issues and participate in civic life through volunteering and life training.
PO5	Team work and leadership quality	Inculcating team spirit and leadership quality to carry out the mission where the student will work or serve.
PO6	Environment, ethics and values	Understand the issues of environmental contexts and recognize different value systems, the moral dimensions of their decisions, and accept responsibility for them.
PO7	Self –directed and life – long learning	Acquire the ability to engage in independent and life – long learning in the broadest context socio- technological changes.

Programme Specific Outcomes (PSOs)

PSO Number	PSO Statement
PSO1	Have a firm foundation in the fundamentals of chemistry and their recent trends.
PSO2	Understand, identify, articulate, analyze and solve the problems pertaining to the concepts of chemistry and their related issues.
PSO3	Synthesize, compare, evaluate, classify, interpret and utilize the basic laws, principle, chemical phenomena, processes, reaction mechanisms involved in the topics of chemistry, chemical experiments and scientific problems.
PSO4	Make use of modern instrumentation, online searching methods to obtain information about chemicals, chemical techniques, chemistry models or an issue relating to chemistry.
PSO5	Explicitly communicate and exchange their ideas in view of the theoretical and experimental findings, impact of chemistry on environment and society to the chemist and non-chemist.

Assessment *(Pattern- CIA and ESE)*

Post Graduate Programmes - Question Paper Pattern for Both CIA & End Semester Examinations

CIA Test Question Paper Pattern (PG) – 2 Hours

Section - A: MCQs	5 X 1 = 5 Marks	PG:	Section A – Remembering (K1)
Section - B: VSA (5 out of 7)	5 X 2 = 10 Marks	**OBE**	Section B – Understanding (K2)
Section - C: SA (3 out of 5)	3 X 5 = 15 Marks	**Syllabus**	Section C – Applying (K3)
Section - D: LA (2 out of 3)	2 X 10= 20 Marks		Section D – Analysing (K4)

Total	**50 Marks**		

End Semester Examinations Question Paper Pattern (PG) – 3 Hours

Section - A: MCQs	5 X 1 = 5 Marks **(From Question Bank given by Course Teacher)**
Section - B: VSA ((5 out of 7)	5 X 2 = 10 Marks
Section - C: SA (Either-or)	5 X 6 = 30 Marks
Section - D: LA (3 out of 5)	3 X 10 = 30 Marks

Total	**75 Marks**

For competitive exam questions Pattern (OMR with 4 options will be used) 75X1=75 (**2 hours**)

PG AND RESEARCH DEPARTMENT OF CHEMISTRY

Programme: M.Sc. Chemistry (Under CBCS and OBE)

(For those students who admitted during the Academic Year 2019 -2020 and after)

2019-2021-Batch

SCHEME OF EXAMINATION

FIRST SEMESTER

Part	Study Component	Course Code	Title of the Paper	Hours	Credit	CIA Marks	END SEME. Marks	Total
III	Core	33CT11	Organic Chemistry – I	5	4	25	75	100
	Core	33CT12	Inorganic Chemistry – I	5	4	25	75	100
	Core	33CT13	Physical Chemistry – I	5	4	25	75	100
	Core	33CP14	**Practical –I**: Organic Analysis	5	3	40	60	100
	Core	33CP15	**Practical –II**: Inorganic Qualitative Analysis	5	3	40	60	100
	Elective	33EP1A 33EP1B	Computer Applications in Chemistry / Environmental Science	5	5	25	75	100
			TOTAL	**30**	**23**			**600**

SECOND SEMESTER

Part	Study Component	Course Code	Course Title	Hours	Credit	CIA Marks	END SEME. Marks	Total
III	Core	33CT21	Organic Chemistry – II	5	4	25	75	100
	Core	33CT22	Inorganic Chemistry – II	5	4	25	75	100
	Core	33CT23	Physical Chemistry – II	5	4	25	75	100
	Core	33CP24	**Practical –III**: Organic Preparation and Quantitative Estimation	5	3	40	60	100
	Core	33CP25	**Practical –IV**: Experiments in Physical Chemistry	5	3	40	60	100
	Elective	33EP2A 33EP2B	Medicinal and Pharmaceutical Chemistry / Biochemistry	5	5	25	75	100
			TOTAL	**30**	**23**			**600**

THIRD SEMESTER

Part	Study Component	Course Code	Course Title	Hours	Credit	CIA Marks	END SEME. Marks	Total
III	Core	33CT31	Organic Chemistry – III	5	4	25	75	100
	Core	33CT32	Inorganic Chemistry –III	5	4	25	75	100
	Core	33CT33	Physical Chemistry – III	5	4	25	75	100
	Core	33CP34	**Practical –V**: Inorganic Quantitative Estimation	5	3	40	60	100
	Core	33PV41	Project and Viva -Voce	5	-	-	-	
	Non Major	33NE31	Forensic Chemistry	5	5	25	75	100
			TOTAL	**30**	**20**			**500**

FOURTH SEMESTER

Part	Study Component	Course Code	Course Title	Hours	Credit	CIA Marks	END SEME. Marks	Total
III	Core	33CT41	Organic Chemistry – IV	5	4	25	75	100
	Core	33CT42	Inorganic Chemistry – IV	5	4	25	75	100
	Core	33CT43	Physical Chemistry – IV	5	4	25	75	100
	Core	33PV41	Project and Viva - Voce	10	7	40	60	100
	Elective	33DE4A	Introduction to Nano Science	5	5	25	75	100
		33DE4B	Chemistry for National Eligibility Test					
			TOTAL	**30**	**24**			**500**
All End semester practical Examinations = 6 Hrs								
			Total Hours	**120**				
			Total Credits		**90**			
			Total Marks					**2200**

Core:

DEPARTMENT OF CHEMISTRY

Programme: M.Sc. Chemistry, (CBCS and Outcome Based Education (OBE)

(For those students admitted during the Academic Year 2019-20 and after)

PART – III **: Core Theory**		SEMESTER **- I**
Course Title: **Organic Chemistry - I**		
Course Code: 33CT11	Hours per week: 5	Credits: 4
CIA Marks: 25	ESE Marks: 75	Total Marks: 100

Preamble

Students are enabled to

- ✓ Develop an understanding of reactivity of organic compounds, reaction mechanisms and to know the chemistry of organic molecules based on stereochemistry.
- ✓ Understand the symmetry operations and identify the stereocenters and assign the configuration of the molecule
- ✓ Know and understand the chemistry of carbohydrates, selected terpenes and alkaloids.

Course Outcomes (CO)

On the successful completion of the course, students will be able to

No.	Course Outcome	Knowledge Level (according to Bloom's Taxonomy)
CO 1	Understand and examine the electron displacement effects and its significance	K1&K4
CO 2	Classify and infer the stability of reaction intermediates and determination of reaction mechanism	K2, K4
CO3	Define and identify aromaticity	K2&K4
CO 4	Assign R/S and E/Z nomenclature and understand the asymmetric synthesis and topical relationship in organic molecules	K4
CO 5	Describe the chemistry of disaccharides, trisaccharides and elucidate the structures of selected terpenes and natural alkaloids.	K2

K1-Knowledge K2-Understand K3-Apply K4-Analyze K5-Evaluate

Mapping of CO with PO

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7
CO 1	9	1	3	1	1	1	3
CO 2	9	1	3	1	1	1	3
CO 3	9	1	3	1	1	1	3
CO 4	9	1	3	1	1	1	3
CO 5	9	1	3	1	1	1	3
Weightage of the	45	5	15	5	5	5	15

course							

9-Strong; 3-Medium; 1-Low

Mapping of CO with PSO

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO 1	9	9	3	1	1
CO 2	9	9	3	1	1
CO 3	9	9	3	1	1
CO 4	9	9	3	1	1
CO 5	9	9	3	1	1
Weightage of the course	45	45	15	5	5

9-Strong; 3-Medium; 1-Low

Syllabus

UNIT-I: ELECTRON DISPLACEMENT EFFECT

Inductive effect and field effect – bond distances – bond energy – delocalized bonds – cross conjugation – rules of resonance – resonance energy – resonance effect – steric inhibition of resonance – hyper conjugation – hydrogen bonding–addition compounds – EDA complexes – Crown ether complexes – inclusion compounds –effects of structure on the association constants of acids and bases – concept of hard and soft acids and bases.

UNIT-II: INTRODUCTION TO REACTION MECHANISM

Reaction intermediates – free radicals, carbenes, nitrenes, carbanions, carbocations formation and stability of reaction intermediates – methods of determination of reaction mechanism – kinetic and thermodynamic control of chemical reactions – kinetic and non-kinetic methods for determining organic reaction mechanism – principle of microscopic reversibility – energy profile diagram – Hammond postulate.

UNIT- III: AROMATIC CHARACTER

Aromatic character in benzene – six-member rings, five, seven and eight member rings – other systems with aromatic sextets – Huckel's rule – Craigs rule concept of homoaromatic and antiaromatic – systems with 2,4,8 and 10 electromagnetic systems with more than 10 electron – alternant and nonalternant hydrocarbons –chemical of cyclopentadienyl anion – Fulvene, Azulene, Tropolones, Syndnones and Annulenes.

Novel ring systems: Nomenclature of bicycle and tricyclic systems –adamantane, diamantane, cubane and catenanes.

UNIT - IV: STEREOCHEMISTRY

symmetry elements – optical activity – chirality – asymmetry and dissymmetry – enantiomers and diastereomers – Fischer's projections – absolute configurations – Cahn-Ingold-Prelog rules – E-Z nomenclature asymmetric synthesis – asymmetric catalyst – chiral auxiliaries – optical purity and enantiomeric excess – enantiotopic and diastereostopic atoms.

Stereoselectivity and stereospecificity – enantioselective and diastereoselective representative reactions – role of enzymes – optical activity and stereochemistry of biphenyl, allenes and spiranscompounds – molecular overcrowding – optical acitivity of compounds containing Nitrogen and Sulphur – use of

spectroscopic methods in determining configurations of geometrical isomers – stereoisomerism of cyclic compounds – three, four and five membered ring systems.

UNIT - V: NATURAL PRODUCTS

Carbohydrates: Configuration and conformation of aldohexopyranoses – structure and synthesis of disaccharides – maltose, lactose, sucrose – polysaccharides – starch and cellulose – Chemistry of amino sugars – methods of determining the size of the sugar rings –cyclodextrins.

Terpenes: Structural elucidation of α-santonine and zingiberene.

Alkaloids: General methods of determining structure – structural elucidation and stereo chemistry of quinine and morphine.

Reference Books

1. March, J. *Advanced organic Chemistry – Reactions, Mechanism and structure*,4th Ed., John Wiley and sons, 2007.
2. Clayden, J., Greeves, N. andWarren, S.*Organic Chemistry*, 2nd Ed.,OXFORD University Press, 2014.
3. Norman, R.O.C. and Coxan, J.M. *Principles of Organic Synthesis*, 3rd Ed., Nelson Thomes, 2001.
4. Carey, F.A. and Sunberg, R.J. *Advanced Organic Chemistry*, Part A and Part B, Kluwer Academic/Plenum Publishers, 2004.
5. Sykes, P. *A Guide book to Mechanism in Organic Chemistry*, 6th Ed., Orient Longman Ltd., 1997.
6. Mukherjee, S.M. and Singh, S.P. *Reaction Mechanism in Organic Chemistry*, 1st Ed., Macmillan India Ltd., 1990.
7. Kalsi, P.S. *Stereochemistry,conformation and mechanism*, 4th Ed.,Wiley Eastern Ltd., 2006.
8. Eliel, E.L. *Stereochemistry of Carbon Compounds*, Tata-McGraw Hill, 2000.
9. Nasipuri, D. *Stereochemistry of organic compounds*, *Principles and application*,2nd Ed., Wiley Eastern Ltd.,2006.
10. Agarwal, O.P. *Chemistry of Organic Natural products*, Vol I - 37th& II 34thEd., GOEL publishing House, Meerut, 2008.
11. Finar, I.L.*Organic Chemistry*, Vol – II, 5th Ed., ELBS Longman, 1975

Core:

DEPARTMENT OF CHEMISTRY

Programme: M.Sc. Chemistry, (CBCS and Outcome Based Education (OBE)

(For those students admitted during the Academic Year 2019-20 and after)

PART – III **: Core Theory**		SEMESTER **- I**
Course Title: **Inorganic Chemistry - I**		
Course Code: 33CT12	Hours per week: 5	Credits: 4
CIA Marks: 25	ESE Marks: 75	Total Marks: 100

Preamble

Students are enabled to

- ✓ Understand the structure and bonding in molecules and gain knowledge about main group elements.
- ✓ Learn the various concepts of acids and bases and know the importance of non-aqueous solvents
- ✓ Understand the basics of nuclear chemistry

Course Outcomes (CO)

On the successful completion of the course, students will be able to

No.	Course Outcome	Knowledge Level (according to Bloom's Taxonomy)
CO 1	Predict the chemistry and theories involved in ionic compounds	K6

CO2	Make use of VSEPR theory to predict the shapes of molecules and compare the bonding theories	K2, K3& K6
CO 3	Compare and contrast the various concepts of acid and bases and classify the hard and soft acids and bases	K2 & K4
CO 4	Summarize and classify the types and uses of boranes, silicates and carbides.	K3
CO 5	Describe the basic concepts of nuclear chemistry and types of nuclear reaction.	K1 & K2

K1-knowledge K2-Understand K3-Apply K4-Analyze

Mapping of CO with PO

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**
CO 1	9	3	1	3	1	1	3
CO 2	9	3	1	3	1	1	3
CO 3	9	3	1	3	1	1	3
CO 4	9	3	1	3	1	1	3
CO 5	9	3	1	3	1	1	3
Weightage of the course	45	15	5	15	5	5	15

9-Strong; 3-Medium; 1-Low

Mapping of CO with PSO

	PSO 1	**PSO 2**	**PSO 3**	**PSO 4**	**PSO 5**
CO 1	9	9	3	1	3
CO 2	9	9	3	1	3
CO 3	9	9	3	1	1
CO 4	9	9	3	1	1
CO 5	9	9	3	1	3
Weightage of the course	45	45	5	5	11

9-Strong; 3-Medium; 1-Low

Syllabus

UNIT-I: THE IONIC BOND

Chemical bond, types of bonds, ionic bond, properties of ionic compounds, factors favouring theformation of ionic compounds, ionization potential, electron affinity and electronegativity,packing of ions in crystals and crystal structures, ccp, hcp, bcc, fcc, radius ratio and structure ofionic lattices, geometrical method of computing radius ratios, relation between radius ratio andcoordination number, stoichiometry and crystal structures.

Lattice energy: definition, Born-Lande equation, factors affecting lattice energy, Born-Habercycle, enthalpy of formation of ionic compounds and stability, calculation of ionic radius,Pauling's method and Linde's method, effective nuclear charge, Slater's rule, covalent characterin ionic compounds, polarization and Fajan's rules, effects of polarization, solubility, meltingpoints and thermal stability of typical ionic compounds.

UNIT- II: THE COVALENT BOND AND WEAK CHEMICAL FORCES

Lewis structures, valence bond theory and its limitation, hybridization and geometry, VSEPR theory, regular and irregular geometry (shapes of $BeCl_2$, BH_3, SiF_4, PF_5, SF_6, IF_7, $SnCl_2$, NH_3, H_2O, SF_4, ClF_3, XeF_2, XeF_4, IF_5, CO_3^{2-}, SO_4^{2-} and I_3^-,), Bent's rule, molecular orbitaltheory, linear combination of atomic orbitals, bonding, antibonding and non-bonding molecularorbitals, MOs of homonuclear diatomic molecules (H_2, O_2 and N_2), bond strength bond order of and bheteronuclear diatomicmolecules (CO, NO and HF), Comparison of VBT and MOT.

Hydrogen bonding, nature and its types, consequences and importance of hydrogen bonding.

Intermolecular forces, dipole-dipole, induced dipole-induced dipole interactions.

UNIT-III: ACIDS AND BASES & NON-AQUEOUS SOLVENTS

Acid-base concept: Bronsted-Lowry definition, Lux-Flood definition, solvent system definition, Lewis definition and Usanovich definition.

Hard and soft acids and bases: classification of acids and bases as hard or soft, symbiosis, theoretical basis of hardness and softness, HSAB principle and its applications.

Non-aqueous solvents: classification of solvents, study of following non-aqueous solvents such as liquid NH_3, SO_2, N_2O_4, HF and acetic acid.

UNIT-IV: MAIN GROUP ELEMNTS

Boranes: Preparation, properties, structure and bonding of diborane, bonding in boranes, *styx* number, Wade's rule, carboranes, preparation and structure of borazine.

Carbides: classification, salt-like carbides, covalent carbides and interstitial carbides, uses of carbides.

Silicates: different types of silicates, silicates, ortho, pyro,cyclic, chain, sheet, three dimensional silicates,

Synthesis, structure and bonding in polyanions and isopolyanions of phosphorous, vanadium, chromium, molybdenum and tungsten, hetero poly anions of molybdenum and tungsten.

Chemistry of S-N compounds, synthesis and reactivity of S_4N_4 and S_2N_2.

UNIT-V: NUCLEAR CHEMISTRY

Composition of nucleus, nuclear size, nuclear forces, packing fraction, nuclear density, massdefect, binding energy of the nucleus, nuclear models, concept of nuclear spin.Radioactivity, radioactive disintegration, radioactive decay and half-life, radioactive equilibrium, steady state, transmutation of elements, group displacement rule, nuclearstability, radioactive series, isotopes, isobars, isotones, separation of isotopes, determination ofatomic masses, artificial radioactivity, induced radioactivity, transuranic elements, nuclearcoulombic energy barrier, q values of nuclear reactions, nuclear fission, nuclear fusion.Detectors: scintillation counter, gas ionisation chamber, proportional counter, Cerenkov counter,accelerators, cyclotron, synchrocyclotron, betatron, applications of radioactivity, activationanalysis, isotopic dilution technique, radiometric titration.

References:

1. Huheey, J.E., Keiter, E.A. and Keiter, R.L., *Inorganic chemistry: Principles of structure and reactivity*, 4th Ed., Pearson Education Pte. Ltd., Delhi, 2004.
2. Shriver, D.F. and Atkins, P.W., Inorganic chemistry, 3rdEd., OxfordUniversity Press, London, 2001.
3. Purcell K.F. and Kotz J.C., Inorganic chemistry, Cengage Learning India Private Limited, Delhi, 2017.
4. Meissler, G.L. and Tarr, D.A., Inorganic chemistry, 3rd Ed., Pearson India Education Services Pvt Ltd., 2015.
5. Weller, M., Overton, T., Rourke, J. and Armstrong, F., Inorganic chemistry, 6th Ed., OxfordUniversity Press, Delhi, 2015.
6. Lee, J.D, *Concise Inorganic chemistry*, 5th Ed, Blackwell Science Ltd., 1996.
7. Puri, B.R., Sharma, L.R. and Kalia, K.C., *Principles of inorganic chemistry*, Vishal Publishing, 2017.
8. Arnikar, H.J., *Essentials of Nuclear Chemistry*, 4thEd., New Age International, New Delhi, 1995.

Core:

DEPARTMENT OF CHEMISTRY

Programme: M.Sc. Chemistry, (CBCS and Outcome Based Education (OBE)

(For those students admitted during the Academic Year 2019-20 and after)

PART – III **: Core Theory**		SEMESTER **- I**
Course Title: **Physical Chemistry - I**		
Course Code: 33CT13	Hours per week: 5	Credits: 4
CIA Marks: 25	ESE Marks: 75	Total Marks: 100

Preamble

Students are enabled to

- ✓ have a good foundation in quantum mechanics.
- ✓ understand the basic concepts of classical thermodynamics, chemical kinetics, gaseous state and liquid state.

Course Outcomes (CO)

On the successful completion of the course, students will be able to

No.	Course Outcome	Knowledge Level (according to Bloom's Taxonomy)
CO1	Understand the basic concepts of quantum mechanics	K1
CO2	Summarize the applications of quantum mechanics	K2
CO3	Interpret the principles of chemical thermodynamics	K2 & K4
CO4	Understand and explain the theories of chemical kinetics	K2
CO5	Define and explore the phenomena involved in gaseous and liquid state	K1

K1-Knowledge K2-Understand K3-Apply K4 – Analyze

Mapping of CO with PO

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**
CO 1	9	1	3	1	3	1	3
CO 2	9	1	3	1	3	1	3
CO 3	9	1	3	1	3	1	3
CO 4	9	1	3	1	3	1	3
CO 5	9	1	3	1	3	1	3
Weightage of the course	45	5	15	5	15	5	15

9-Strong; 3-Medium; 1-Low

Mapping of CO with PSO

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO 1	9	9	3	1	3
CO 2	9	9	3	1	3
CO 3	9	9	3	1	3
CO 4	9	9	3	1	3
CO 5	9	9	3	1	3
Weightage of the course	45	45	15	5	15

9-Strong; 3-Medium; 1-Low

Syllabus

UNIT-I:QUANTUM MECHANICS– I

Black body radiation, de-Broglie's wave particle duality Experimental verification of matter waves Photo electric effect-Compton effect -Heisenberg's uncertainty principle, postulates of quantum mechanics, operators, linear and non -linear operators, Hermitian operators, momentum, kinetic energy, total energy, angular momentum, proving operators are Hermitian commutator algebra, Evaluation of commutators, introducing Dirac notation, Eigen function, Eigen value and degeneracy, setting up of Schrodinger wave equation, interpretation of wave function, Orthogonal function ,expansion theorem, Schmidt orthogonalisation

UNIT-II:QUANTUM MECHANICS – II

Application of SWE to free particle moving in one dimension, particle moving in a one-dimension box with zero potential energy inside and infinite potential outside. Particle moving in 3D cubical and rectangular box. quantum mechanical Tunnelling and transmission coefficient, particle in a ring – Simple harmonic oscillator 3D uncoupled Isotropic harmonic oscillator,rigid rotator, hydrogen atom, radial distribution functions ,spherical harmonics, shapes of various orbitals (1s, 2s, 2p) ,angular momentum, spin momentum.

UNIT- III:CHEMICAL THEROMODYNAMICS

Thermodynamic equation of state, derivation and their application to non-ideal gases ,calculation of $(\Delta H/\partial P)_T$, $(\Delta E/\partial V)_T$ and $\mu_{JT.}$ Thermodynamics of system of variable composition -partial molal quantities ,chemical potential ,relationship between partial molal quantities ,determination of partial molal quantities , Gibbs Duhem equation ,thermodynamic properties of real gases Fugacity concept, determination of fugacity of real gases activity concepts of condensed states, choice of standard states. determination of activity and activity coefficients. Basic concepts of non-equilibrium thermodynamics. Onsager reciprocal relationships, microscopic reversibility (concept only derivation not necessary).

UNIT- IV:CHEMICAL KINETICS

Simple collision theory, potential energy surfaces, absolute reaction rate theory, thermodynamic treatment, comparison of ARRT and collision theories. Application of ARRT to simple bimolecular process, steady state approximation. Theory of unimolecular reactions, Lindemann, Hinshelwood, RRKM and Slater treatments. Reactions in solutions, factors influencing reaction rate in solution, significance of activation, salt effect, and kinetic isotope effect.

UNIT- V:GASEOUS AND LIQUID STATE

Maxwell distribution of molecular velocities, derivation and experimental verification, types of velocities, energy distribution Maxwell – Boltzmann distribution Law - equipartition principle and heat capacity, mean free path, molecular collisions, transport properties, thermal conductivity, viscosity and diffusion. Structure of liquids,X-ray method, internal pressure,- liquid crystals, theory and applications

Reference Books

1. Puri, B. R. Sharma L.R and Pathania, M.S. *Principles of Physical Chemistry*, 46th Ed., Vishal Publishing Co., 2014.
2. Prasad R.K., *Quantum chemistry*, 4th Ed., New Age International (P) Ltd., Publishers, 2010.
3. McQuarrie D. A. *Quantum Chemistry*, 2nd Ed., University Science Books, California, 2008.
4. Atkins P.W. and Friedman.R.,*Molecular Quantum Mechanics,* 5th Ed., Oxford university Press, 2011.
5. Klotz I.M and. Rosenberg R.M, *Chemical thermodynamics*, 6th Ed., W.A. Benjamin Publishers, California, 1972.
6. McQuarrie D.A. and Simon, J.D. *Physical Chemistry, A Molecular Approach,* Viva Books Pvt. Ltd., New Delhi, 1999.
7. Rastogi R.P. and Misra, R.R *Classical Thermodynamic*s, Vikas Publishing, Pvt. Ltd., New Delhi, 1990.
8. Maron S.H. and Lando, J.B. *Fundamentals of Physical chemistry,* MacMillan Publishers, New York, 1974.

Lab:

DEPARTMENT OF CHEMISTRY

Programme: M.Sc. Chemistry, (CBCS and Outcome Based Education (OBE)

(For those students admitted during the Academic Year 2019-20 and after)

PART – III **: Core Lab**		SEMESTER **-I**
Course Title **:** Organic analysis		
Course Code: 33CP14	Hours per week: 5	Credits:4
CIA Marks: 40	ESE Marks: 60	Total Marks: 100

Preamble

Students are enabled to

- ✓ Separate the organic mixture and identify its composition
- ✓ apply the skill in preparation, purification and recrystallisation of organic compounds

Course Outcomes (CO)

At the end of the practical course, the students will be able to

CO Number	CO Statement	Knowledge Level
CO1	understand pilot separation technique	K1& K3
CO2	apply the skills in the separation of organic mixtures	K3 & K4
CO3	examine the confirmatory test for various functional groups	K4
CO4	expertise the various methods of preparation	K3 & K4
CO5	analysis of organic substances	K3

Syllabus

UNIT I

Separation of two component and characterization.

1. Acid substance and neutral substance
2. Basic substance and neutral substance
3. Phenolic substance and neutral substance
4. Acid substance and phenolic substance
5. Phenolic substance and basic substance

UNIT II

1. Acid substance and phenolic substance
2. Phenolic substance and basic substance
3. Phenolic substance and neutral substance

UNIT III

Single stage preparations and purification by recrystallization technique

1. Acetylation(Acetanilide from Aniline)
2. Hydrolysis(Salicylic acid from methylsalicylate)
3. Bromination(Tribromoaniline from Aniline)

UNIT IV

1. Benzoylation (Benzanilide from aniline)
2. Diazotisation (Methyl orange from sulphanilic acid)
3. Nitration (Picric Acid from Phenol)

UNIT V

1. Benzophenone oxime from benzophenone
2. Anthranilic acid from Pthalimide

Note: a) A minimum of six organic mixtures & six preparations should be done by each student.
b) Each student is expected to submit both crude and recrystallized samples of the preparation during their regular practical for evaluation at the time of practical examinations.

Reference Books:

1. Gnanapragasam, N.S and Ramamuthy. G., *Organic Chemistry – lab manual*, S.Viswanatahan Co. Pvt, Ltd, 1998.
2. Vishnoi.N. K., A*dvanced practical organic chemistry*, Vikas Publishing House Pvt.Ltd.1982.
3. Vogel. A. I.*Vogel's Textbook of Practical Organic Chemistry*, 4th Ed., Longmann group, 2008.
4. LAB MANUAL - Prepared by Faculty, Department of Chemistry, Vivekananda College.

Lab:

DEPARTMENT OF CHEMISTRY

Programme: M.Sc. Chemistry, (CBCS and Outcome Based Education (OBE)

(For those students admitted during the Academic Year 2019-20 and after)

PART – III **: Core Lab**	SEMESTER **-I**

Course Title **:** In**o**rganic Qualitative analysis		
Course Code: 33CP15	Hours per week: 5	Credits:4
CIA Marks: 40	ESE Marks: 60	Total Marks: 100

Preamble

Students are enabled to

- ✓ develop skills in identification of elements by inorganic qualitative analysis.

Course Outcomes (CO)

On the successful completion of the course, students will be able to:

No.	Course Outcome	Knowledge Level (according to Bloom's Taxonomy)
CO 1	Analyze most common and less common ions by using semi-micro inorganic qualitative methods	K4

K1-knowledge K2-Understand K3-Apply K4-Analyze K5-Evaluate and K6-Create

Syllabus

UNIT-I

Analysis of the common cations:

Ions of the common metals: Pb, Cu, Mn, Cr, Al, Ni, Co, Ba, Sr, Mg

UNIT-II

Analysis of the common cations:

Ions of less common metals: W, Se, Te, Mo, Ce, Th, Zr, Ti, V, U, Li

UNIT- III

Analysis of mixtures containing two common and two less common cations (Practical: I to III)

UNIT- IV

Analysis of mixtures containing two common and two less common cations (Practical: IV to VI)

UNIT- V

Analysis of mixtures containing two common and two less common cations (Practical: VII to IX)

Reference Books

1. Ramanujam V.V, *Inorganic semi – micro qualitative analysis*, the National Publishing Company, 3rd Ed., 2008.
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Elective:

DEPARTMENT OF CHEMISTRY

Programme: M.Sc. Chemistry, (CBCS and Outcome Based Education (OBE)

(For those students admitted during the Academic Year 2019-20 and after)

PART – III **: Elective Theory**		SEMESTER **-I**
Course Title: **Computer applications in Chemistry**		
Course Code: 33EP1A	Hours per week:5	Credits: 5
CIA Marks: 25	ESE Marks: 75	Total Marks: 100

Preamble

Students are enabled to

- ✓ gain knowledge about the basic concepts of programming in C
- ✓ learn the basic concept of internet and their applications in chemistry

Course Outcomes (CO)

On the successful completion of the course, students will be able to

No.	Course Outcome	Knowledge Level (according to Bloom's Taxonomy)
CO 1	describe soft skills of computer	K2
CO 2	make use of internet and their applications in chemistry	K3
CO3	understand and apply the concept of programming in C	K2 & K3
CO 4	examine the chemistry parameters using software	K4
CO 5	Understand and utilize chemdraw software to draw the chemical structures	K2 & K3

K1-Knowledge **K2-Understand** **K3-Apply**
K4 –Analyze **K5 – Evaluate** **K6 - Create**

Mapping of CO with PO

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7
CO 1	3	1	1	1	1	1	3
CO 2	3	1	1	1	1	1	3
CO 3	3	1	1	1	1	1	3
CO 4	3	1	1	1	1	1	3
CO 5	3	1	1	1	1	1	3
Weightage of the course	15	5	5	5	5	5	15

9-Strong; 3-Medium; 1-Low

Mapping of CO with PSO

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO 1	3	1	1	1	1
CO 2	3	1	1	1	1
CO 3	3	1	1	1	1
CO 4	3	1	1	1	1
CO 5	3	1	1	1	1

Weightage of the course	15	5	5	5	5

9-Strong; 3-Medium; 1-Low

Syllabus

UNIT-I: INTRODUCTION TO COMPUTERS

Salient features of windows and MS word for typing texts and equation in Chemistry- tabular columns- advanced concepts. Basic concept of creating and accessing databases using MS access. Significance of chemdraw- drawing chemical structure and pasting them in the text

UNIT-II: **BASIC CONCEPT OF INTERNET AND APPLICATIONS IN CHEMISTRY**

Internet: History of the internet- the working way of internet-getting connected to internet-internet protocols-internet addressing-domain names-

WWW: Web page-home page- web browsers- search engine- internet chat- chatting on web.

E-Mail: Introduction –working way-mailing basic- e-mail ethics-advantages and disadvantages-creating e-mail- receiving and sending e-mails.

Internet: characterization advantages- drawbacks-need for intranet- extranet.

Application of internet in Chemistry:

Web site in literature survey in Chemistry-popular websites in Chemistry-data base in Chemistry URLS-WAIS- downloading the attachment/ PDF files- opening browsing and searching a website- literature searching online.

UNIT- III : BASIC CONCEPTS OF PROGRAMMING IN C

Character set – keywords and identifiers – constants, variables, data types – declaration of variables – assigning values to variables – Defining symbolic constants.

Operators

Arithmetic operators – relational operator, logical operators, assignment operators, increment and decrement operators, conditional operators, bitwise operators and special operators – Arithmetic expression – evaluation of expression, precedence of arithmetic operators – computational problems. Managing input and output operators: Reading a character – writing a character – format input – formatted output

Few selected problems – determination of molarity, molality, and normality of solutions, calculation of pH, calculation of cell parameters, calculation of concentration of Beer-Lamberts law – Determination of rate constants in

UNIT- IV : VERIFICATION OF CHEMISTRY PARAMETERS

A: Array

Introduction – one-dimensional array and two-dimensional array – initialize an arrays.

B: Functions

Introduction – different types of functions – nesting of functions – regrusion – library function.

Applications in Chemistry

Few selected problems – determination of molarity, molality, and normality of solutions, calculation of pH, calculation of cell parameters, calculation of concentration of Beer-Lamberts law – Determination of rate constants in kinetics.

UNIT- V: APPLICATIONS OF CHEMDRAW AND CHEM 3D SOFTWARE IN CHEMISTRY

Introduction – tool pallets – Construction of the molecule using chemDraw – tools – manifulating a molecule – model display – display type – structure displays – molecular surface display – NMR stimulation and interpretation –naming – IUPAC –structure from name and name from structure - Computational

concepts – computational methods – potential energy surface – geometry optimizations property – molecular mechanics theory in brief – animations – differences between chemDraw and chem 3D.

Reference Books

1. Raman K.V , "*Computers in Chemistry*", Tata-McGraw Hill Publishing Company, New Delhi, 1993.
2. Alexis Leon and Mathews Leon. *Fundamentals of Information Technology Leon TECH World*, UBS Publishers & Distributors Ltd., 1999.
3. E. Balagurusmy, *Programming with Java- A Primer*, Tata McGraw-Hill Publishing Company Ltd., New Delhi, 2nd Ed., 15th Reprint-2003
4. Barbara Kasser, "*Using the Internet*", 4thEd., New Delhi, 1998.
5. C. Xavier, *World wide web design with HTML*, Tata McGraw-Hill Publishing Company Ltd., New Delhi, 2nd Reprint 2000.
6. Margaret Levine Young, *Internet- Complete Reference*, Tata McGraw-Hill Publishing Company Ltd., New Delhi, 2001.
7. John Zukowski, *Mastering Java 2*, BPB Publications, New Delhi, 2000.
8. Patrick Naughten, *The Java Hand Book*, Tata McGraw-Hill Publishing Company Ltd., New Delhi, 11th Reprint 2002.
9. Herbert Schildt, *Java 2- The Complete Reference*, Tata McGraw-Hill Publishing Company Ltd., New Delhi, 4th Ed., 2001.
10. Harley Hahn, *The Internet Complete Reference*, Tata McGraw-Hill Publishing Company Ltd., New Delhi, 2nd Ed., 2001.
11. Chem Draw &Chem 3D –Manual
12. Shelx, Rasmol and MATLAB- Manuals.

REFERENCES in the Internet

1. http://SCS 99.unige. Che/eng/toc.html
2. http://hackberry.chem.niu.edu: to/o/webpage.html
3. http://java.Sun.Com/applet/applets/chemical Models/index.html
4. http://ccl.osc.edu/chemistry.html
5. http://www.umass.eud/microbio/rasmol/
6. http://www. Mdli.com/cgi/dynamic/welcome.html/ (for CHIME similar to Rasmol)

Core:

DEPARTMENT OF CHEMISTRY

Programme: M.Sc. Chemistry, (CBCS and Outcome Based Education (OBE)

(For those students admitted during the Academic Year 2019-20 and after)

PART – III **: Core Theory**		SEMESTER - **II**
Course Title: **Organic Chemistry - II**		
Course Code: 33CT21	Hours per week: 5	Credits: 4
CIA Marks: 25	ESE Marks: 75	Total Marks: 100

Preamble

Students are enabled to

- ✓ impart knowledge and understand the various reagents, reactions and their mechanisms
- ✓ Understand conformational analysis of acyclic and cyclic organic compounds.

Course Outcomes (CO)

On the successful completion of the course, students will be able to

No.	Course Outcome	Knowledge Level (according to Bloom's Taxonomy)

CO 1	Describe and formulate the mechanism of various nucleophilic substitution and elimination reactions	K2
CO2	Predict and analyze the conformations of acyclic and cyclic organic compounds	K3
CO 3	Understand and apply the addition reactions of alkene, carbonyl compounds to organic synthesis	K2 & K3
CO 4	Recall the name reactions and examine their mechanisms	K1& K4
CO 4	Make use of the reagent for synthetic applications	K3

K1-knowledge K2-Understand K3-Apply K4-Analyze

Mapping of CO with PO

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**
CO 1	9	1	3	1	3	1	1
CO 2	9	1	3	1	3	1	1
CO 3	9	1	3	1	3	1	1
CO 4	9	1	3	1	3	1	1
CO 5	9	1	3	1	3	1	1
Weightage of the course	45	5	15	5	15	5	5

9-Strong; 3-Medium; 1-Low

Mapping of CO with PSO

	PSO 1	**PSO 2**	**PSO 3**	**PSO 4**	**PSO 5**
CO 1	9	9	9	1	3
CO 2	9	9	9	1	3
CO 3	9	9	9	1	3
CO 4	9	9	9	1	3
CO 5	9	9	9	3	3
Weightage of the course	45	45	45	15	15

9-Strong; 3-Medium; 1-Low

Syllabus

UNIT-I: REACTION MECHANISM

Substitution Reactions: Nucleophilic substitution at saturated carbon atom– S_N1, S_N2 and S_Ni reactions– mechanism and evidences– effect of structure– solvent– nucleophile andnucleofuge– stereochemistry– S_N1, S_N2, S_Ni, S_N', S_N2', S_N1cA and S_N2cA mechanism–Neighbouring group participation– Non classical carbocations– S_NAr mechanisms.

Elimination Reactions: E_1, E_2 and E1cB – evidences – effect of structure,solvent andbase – Hoffmann and Saytzeff rules – stereochemistry of E_1 reaction – Pyrolytic elimination –

cis elimination – elimination *vs* substitution.

UNIT-II: CONFORMATIONAL ANALYSIS

Configuration and conformation – conformers, conformational isomers and atropisomers – conformational analysis of acyclic and cyclohexane systems– conformational free energy difference– Eliel-Ro equation – conformation and reactivity of mono- and di-substituted cyclohexanes– simple reactions illustrating torsional, steric and stereo electronic factors in acyclic and cyclohexane derivatives– Curtin-Hammett principle– conformation and reactivity of cyclohexenes and cyclohexanone– conformational analysis of decalins.

UNIT- III: ADDITIONS TO C=C AND C=O GROUPS

Electrophilic, nucleophilic and free radical addition –addition to conjugated systems – orientation of the addendum –stereochemical factors in reactions like addition of hydrogen, halogen, halides and hypohalous acids, hydroboration and hydroxylation – sharpless asymmetric epoxidation.

Addition to carbonyl groups: mechanism –Aldolcondensation– Perkin reaction –Knoevenagel reaction –Mannichreation–Cannizaro reaction – benzoin condensation –Claisen ester condensation –Darzen reaction –Reformatsky reaction –Wittig reaction –Grignard reagents.

Addition to α, β-unsaturated carbonyl groups: Michael addition– Diels-Alder reactions – addition to carbenes and carebenoids to double and triple bonds – addition to cyclopropane ring –esterfication of acids and hydrolysis of esters – decarboxylation of carboxylic acids.

UNIT- IV: SELECTIVE ORGANIC NAME REACTIONS AND THEIR MECHANISM

Ene reaction – Hoffmann-Loffer-Fraytag reaction – Shapiro reaction – Bayer-Villiger reaction – Chichibabin reaction – Skraup synthesis – Fischer indole synthesis – Robinson annulation – Oppennaur oxidation – Clemmenson, Wolf-Kishner, Meerwein-Ponndorf –Verley and Birch reduction– mechanism of Stobbe and Dieckman condensation.

UNIT- V: REAGENTS IN ORGANIC SYNTHESIS

Complex metal hydrides such as $LiAlH_4$, $NaBH_4$, $Na(CN)BH_3$, $Zn(BH_4)_2$, Gilman's reagent, Lithiumdimethylcuprate, Lithium disopropylamide (LDA), Dicyclohexylcarbodimide 1,3 Dithiane (reactivity umpolung), Trimethylsilyl iodide, Tri-n-butyltin hydride, Woodward and Prevost hydroxylation, osmium tetroxide, DDQ, Selenium dioxide, phase transfer catalysts, Crown ethers and Merrifield resin, Peterson's synthesis, Wilkinson's catalyst, Baker yeast.

Reference Books

1. Sykes, P. *A Guide book to Mechanism in Organic Chemistry*, 6th Ed., Orient Longman Ltd., 1997.
2. Carey, F.A. and Sunberg, R.J. *Advanced Organic Chemistry*, *Part A and Part B*, Kluwer Academic/Plenum Publishers, 2004.
3. March, J. *Advanced organic Chemistry – Reactions, Mechanism and Structure*, 4th Ed., John Wiley and sons, 2007.
4. Clayden, J. Greeves, N and Warren, S.*Organic Chemistry*, 2nd Ed., OXFORD University Press, 2014.
5. Norman, R.O.C and Coxan, J.M. *Principles of Organic Synthesis*, 3rd Ed., Nelson Thomes, 2001.
6. Carruthers, W and Coldham, I. *Moderns Methods of Organic Synthesis*, 4th Ed., Cambridge University Press, UK, 2004.
7. Smith, M.B. *Organic Synthesis*, 3rd Ed., Academic Press, 2011.
8. Brukner, R. *Organic Mechanisms Recation, Stereochemistry and Synthesis*, 3th Ed., SpektrumAkademischerVerlag, 2007.
9. Kalsi, P.S. *Organic Reactions Stereochemistry and Mechanisms*, 4th Ed., New Age International Pub. 2008.
10. Sanyal, S.N. *Reactions, Rearrangements and Reagents*, Bharati Bhawan Pub & Dis. New Delhi, 2014.

Core:

DEPARTMENT OF CHEMISTRY

Programme: M.Sc. Chemistry, (CBCS and Outcome Based Education (OBE)

(For those students admitted during the Academic Year 2019-20 and after)

PART – III **: Core Theory**		SEMESTER **- II**
Course Title: **Inorganic Chemistry - II**		
Course Code: 33CT22	Hours per week: 5	Credits: 4
CIA Marks: 25	ESE Marks: 75	Total Marks: 100

Preamble

Students are enabled to

- ✓ Learn and understand the nomenclature, isomerism, bonding, reaction mechanism, magnetic property and electronic spectra of coordination compounds.
- ✓ Gain knowledge about the basics of lanthanides and actinides.

Course Outcomes (CO)

On the successful completion of the course, students will be able to

No.	Course Outcome	Knowledge Level (according to Bloom's Taxonomy)
CO 1	Recall the basic terminology and isomerism in coordination compounds.	K1
CO2	Explain and compare the bonding theories of valence bond theory and crystal field theory and construct the molecular orbital diagrams of complexes	K2,
CO 3	Analyze and interpret the electronic spectra of coordination complexes	K4 & K2
CO 4	Develop and formulate the reaction mechanism of coordination compounds	K3
CO 5	Outline the basic chemistry of lanthanides and actinides	K2

K1-knowledge K2-Understand K3-Apply K4-Analyze

Mapping of CO with PO

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**
CO 1	9	1	3	1	1	1	3
CO 2	9	1	3	1	1	1	3
CO 3	9	1	3	1	1	1	3
CO 4	9	1	3	1	1	1	3
CO 5	9	1	3	1	1	1	3
Weightage of the course	45	5	15	5	5	5	15

9-Strong; 3-Medium; 1-Low

Mapping of CO with PSO

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO 1	9	9	3	1	3
CO 2	9	9	3	1	3
CO 3	9	9	3	1	3
CO 4	9	9	3	1	3
CO 5	9	9	3	1	3
Weightage of the course	45	45	15	5	15

9-Strong; 3-Medium; 1-Low

Syllabus

UNIT-I: COORDINATION CHEMISTRY-I

Introduction: Types of ligands, coordination sphere, coordinationnumber, nomenclature of mononuclear and dinuclear complexes, chelate effect, Werner's theoryand Sidgwick theory, EAN and formation of metal-metal bond in dimers, stability of complexes,determination of stability constants, Jobs method, stepwise stability constant, overall stabilityconstant, factors affecting stability of coordination compounds, charge of central metal ion, sizeof central metal ion, chelate ring size, steric effects.

Isomerism: linkage, ionization, hydrate, coordination, coordination position isomerism,geometrical (*cis* and *trans*, and *fac*and *mer*) and optical isomerism.

UNIT- II: COORDINATION CHEMISTRY-II

Valence bond theory: hybridization, geometry, magnetism, drawbacks of VBT.

Crystal field theory: crystal field effects, assumptions of crystal field theory, crystal fieldsplitting in octahedral and tetrahedral geometries, qualitative crystal field splitting diagrams,high-spin and low-spin complexes, factors affecting the magnitude of Δ, calculation of CFSE,spectrochemical series, Jahn- Teller theorem, crystal fieldsplitting in tetragonally distorted octahedral geometry and in square planar geometry. Applications of CFT.

Molecular orbital theory: molecular orbital diagram of $[Co(NH_3)_6]^{3+}$ and $[CoF_6]^{3-}$.

UNIT-III:COORDINATION CHEMISTRY-III

Electronic spectra of coordination complexes, quantum numbers of multi electron atoms, microstates of electron configuration in free atoms and ions, RS coupling, spin-orbit coupling, spin multiplicity, ground state terms for p^1–p^6 and d^1 – d^{10}states, selection rules for d-d spectra, width and shapes of d-d spectra, effect of John Teller effect on the width of the spectrum.

Splitting of free ion terms in octahedral field, correlation diagram, Orgel diagrams for d^1 – d^9 ions for tetrahedral and octahedral complexes. Calculation of 10Dq and assignment of transitions to the spectra of complexes: $[Fe(H_2O)_6]^{2+}$, $[Cu(H_2O)]^{2+}$, $[V(H_2O)_6]^{3+}$, $[Co(H_2O)_6]^{2+}$, $[Cr(H_2O)_6]^{2+}$, $[CoCl_4]^{2-}$, Nephelauxetic ratio and its effect, Racah parameter, Tanabe-Sugano diagram for d^6 ion.

Charge transfer spectra and its types (MLCT AND LMCT)

UNIT-IV: COORDINATION CHEMISTRY-IV

Labile and inert complexes, ligand substitution reactions in octahedral and square planar complexes, S_N1, S_N2 and S_N1CB mechanisms, acid hydrolysis and base hydrolysis reactions.

Trans effect, theories of trans effect, pi-bonding theory and polarization theory, applications trans effect, cis effect.

Redox reaction-electron transfer reaction, mechanisms of inner sphere and outer sphere electron transfer reactions.

Magnetic properties of tetrahedral and octahedral complexes: para, dia, ferromagnetism and antiferro magnetism, determination of magnetic properties, orbital contribution to a magnetic moment Spin only formula,Gouy's method.

UNIT-V: LANTHANIDES AND ACTINIDES

Lanthanides: lanthanide series, abundance and natural isotopes, lanthanide contraction, similarity in properties, occurrence, oxidation states, chemical properties of Ln(III) cations, magnetic properties, colour and electronic spectra of lanthanide compounds, separation of lanthanides, solvent extraction, ion exchange, chemical properties of Ln(III) metal ions.

Actinides: actinide series, abundance and natural isotopes, occurrence, preparation of actinides, oxidation states, general properties, the later actinide elements, uranium-occurrence, metallurgy; chemical properties of hydrides, oxides, and halides, complexes of lanthanides and actinides.

Reference Books

1. Huheey, J.E., Keiter, E.A. and Keiter, R.L., *Inorganic chemistry: Principles of structure and reactivity*, 4th Ed., Pearson Education Pte. Ltd., Delhi, 2004.
2. Shriver, D.F. and Atkins, P.W., Inorganic chemistry, 3rd Ed., Oxford University Press, London, 2001.
3. Purcell K.F. and Kotz J.C., Inorganic chemistry, Cengage Learning India Private Limited, Delhi, 2017.
4. Meissler, G.L. and Tarr, D.A., Inorganic chemistry, 3rd Ed., Pearson India Education Services Pvt Ltd., 2015.
5. Weller, M., Overton, T., Rourke, J. and Armstrong, F., Inorganic chemistry, 6th Ed., Oxford University Press, Delhi, 2015.
6. Lee, J.D, *Concise Inorganic chemistry*, 5th Ed, Blackwell Science Ltd., 1996.
7. Puri, B.R., Sharma, L.R. and Kalia, K.C., *Principles of inorganic chemistry*, Vishal Publishing, 2017.
8. Cotton, F.A., Wilkinson, G. and Gaus, P.L., *BasicInorganic Chemistry*, 3rd Ed., John Wiley, New York, 2008.
9. Douglas, B., McDaniel, D. and Alexander, J., *Concepts and Models of Inorganic Chemistry*, 3rd Ed., Wiley, 2013.
10. Greenwood, N.N. and Earnshaw, A., *Chemistry of the Elements*, 2nd Ed., Pergamon Press, Oxford, 2005 (Reprint)

Core:

DEPARTMENT OF CHEMISTRY

Programme: M.Sc. Chemistry, (CBCS and Outcome Based Education (OBE)

(For those students admitted during the Academic Year 2019-20 and after)

PART – III **: Core Theory**		SEMESTER - **II**
Course Title: **Physical Chemistry - II**		
Course Code: 33CT23	Hours per week: 5	Credits: 4
CIA Marks: 25	ESE Marks: 75	Total Marks: 100

Preamble

Students are enabled to

- ✓ know about the applications of quantum mechanics
- ✓ understand the principles and instrumentation of various spectroscopic techniques
- ✓ gain knowledge about surface chemistry and its role in catalysis
- ✓ understand the principles of photochemistry

Course Outcomes (CO)

On the successful completion of the course, students will be able to

No.	Course Outcome	Knowledge Level (according to Bloom's Taxonomy)

CO 1	apply the concepts of quantum mechanics	K3
CO 2	understand and apply the concepts of Microwave and IR spectroscopy	K1 & K3
CO 3	understand and apply the concepts of Raman, photo acoustic spectroscopy and photoelectron spectroscopy	K1
CO 4	understand the different concepts of adsorption isotherm	K2
CO 5	describe the principles of photochemistry and its significance	K1& K3

K1-Knowledge K2-Understand K3-Apply K4 – Analyse

Mapping of CO with PO

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**
CO 1	9	1	3	3	3	1	3
CO 2	9	1	3	3	3	1	3
CO 3	9	1	3	3	3	1	3
CO 4	9	1	3	3	3	1	3
CO 5	9	1	3	3	3	1	3
Weightage of the course	45	5	15	15	15	5	15

9-Strong; 3-Medium; 1-Low

Mapping of CO with PSO

	PSO 1	**PSO 2**	**PSO 3**	**PSO 4**	**PSO 5**
CO 1	9	9	3	1	1
CO 2	9	9	3	1	1
CO 3	9	9	3	1	1
CO 4	9	9	3	1	1
CO 5	9	9	3	1	1
Weightage of the course	45	45	15	5	5

9-Strong; 3-Medium; 1-Low

Syllabus

UNIT-I: QUANTUM MECHANICS – III

The variation method and perturbation theory, Application to the helium atom, Slater orbital, Self-Consistent Field (SCF) method,antisymmetry and exclusion principle, Slater determinatal wave functions. Term symbols and spectroscopic states of atoms and diatomic molecules. Born–Oppenheimer approximation, Hydrogen molecule ion. LCAO MO and VB treatments of the hydrogen molecule, electron density, forces and their role in chemical binding. Hybridization and valence MOs of H_2O, NH_3 and CH_4 Huckel pi-electron theory and its application to ethylene, butadiene and benzene.

UNIT-II: SPECTROSCOPY-I

A: MICROWAVE SPECTROSCOPY

Classification of molecules, rigid rotor model, effect of isotopic substitution on the transition frequencies, intensities, non-rigid rotor, Stark effect- applications.

B: INFRARED SPECTROSCOPY

Review of linear harmonic oscillator, vibrational energies of diatomic molecules, zero-point energy, force constant and bond strength,anharmonicity, Morse potential energy diagram, vibration–rotation spectroscopy, P, Q, R branches, Fortrat diagrams, Breakdown of Born-Oppenheimer approximation-vibrations of polyatomic molecules. selection rules, normal modes of vibration, group frequencies, overtones, hot bands.

UNIT- III SPECTROSCOPY-II

RAMAN SPECTROSCOPY Classical and quantum theories of Raman effect. Pure rotational, vibrational and vibrational-rotational Raman Spectra, selection rules, mutual exclusion principle. Resonance Raman spectroscopy, introduction and application to [W $(CO)_4$(phen)]

i) MOLECULAR SPECTROSCOPY

Energy levels, molecular orbitals, vibronic transitions, vibrational progressions and geometry of the excited states,

ii) PHOTOELECTRON SPECTORSCOPY Basic principles, Photo electric effect, ionization process, Koopman's theorem. Photo electron spectra of simple molecules, ESCA, Chemical information from ESCA. Aguer effect, basic idea.

iii) PHOTO ACOUSTIC SPECTROSCOPY Basic principles of photo acoustic spectroscopy (PAS), PAS,gases and condensed systems, chemical and surface applications.

UNIT- IV: CATALYSIS AND SURFACE CHEMISTRY

Homogeneous catalysis, acid-base catalysis, acidity function,Michaelis-Menton kinetics, fast reaction techniques, chemical relaxation methods, T-jump and p-jump methods, ultrasonic absorption techniques, reaction in a flow system, continuous and stopped flow methods.

Physisorption and chemisorption, Langmuir, BET and Gibbs adsorption isotherm, insoluble surface films,electro kinetic phenomena,zeta potential, Heterogeneous catalysis, unimolecular and bimolecular reactions and their kinetics - micellar Chemistry (Introduction and basic aspects)

UNIT- V: PHOTOCHEMISTRY

Photophysical response from electronically excited molecules, radiative and radiationless transitions, internal conversion and intersystem crossing, fluorescence, phosphorescence, Jablonski diagram, and delayed fluorescence, life time of excited molecules,quenchingproess, Stern-Volmer equation- principles of energy transfer-spin –orbit coupling, eximers and exciplexes.Properties of excited states-excited state acidity constant. Kasha's tests for identification of $n\rightarrow\pi^*$ and $\pi\rightarrow\pi^*$transitions.Applications of photochemistry, photosynthesis, solar energy conversions and storage, photochemical fast reactions- Flash photolysis technique.

Reference Books

1. Puri, B. R. Sharma L.R and Pathania, M.S. *Principles of Physical Chemistry*, 46th Ed.,Vishal Publishing Co., 2014.
2. Prasad R.K., *Quantum chemistry*, 4th Ed., New Age International (P) Ltd., Publishers, 2010.
3. McQuarrie D. A. *Quantum Chemistry*, 2nd Ed., University Science Books, California, 2008.
4. Atkins P.W. and Friedman.R.,*Molecular Quantum Mechanics*, 5th Ed., Oxford university Press, 2011.
5. C.N. Banwell and E. M. McCash, *Fundamentals of Molecular Spectroscopy*,4th Ed.,Tata McGraw Hill, New Delhi, 2008.
6. P. Atkins and J. de Paula, *Physical Chemistry*, 7th Ed., Oxford University Press, Oxford,2002.

7. Rohatgi–Mukheriji K.K., *Fundamentals of Photochemistry*, Wiley-Eastern.- 2000Chandra A.K., *Introductory quantum Chemistry* – Fourth edition – Tata McGraw Hill publishing Co.Ltd. New Delhi. – 1996
8. Sen B.K, *Quantum Chemistry*, Tata McGraw Hill Co. Ltd., New Delhi. 1992
9. Samuel H. Maron and Carl M. Prutton, *Principle of physical Chemistry*,4th ed, Oxford and IBH Pub. Pvt. Ltd. New Delhi. 1976
10. Prasad R.K. *Quantum Chemistry*, Wiley Eastern. Third edition- 2000
11. Cotton F.A., *Chemical application of group theory*, 2nd ed, Wiley Eastern Ltd.- 1997
12. Cox and T. Camp, *Introductory photoChemistry*, McGraw-Hill publishing Co.Ltd. New Delhi. – 1996
13. Drago R.S, *Physical methods in Chemistry*, Sainderscollege. 1987
14. Barrow G.M., *Introduction to molecular spectroscopy*, MC Graw Hill publishing Co.Ltd. New Delhi.- 1994
15. Chang R., *Basic Principles of spectro*scopy, Mc Graw Hill publishing Co.Ltd. New Delhi.-1992

Lab:

DEPARTMENT OF CHEMISTRY

Programme: M.Sc. Chemistry, (CBCS and Outcome Based Education (OBE)

(For those students admitted during the Academic Year 2019-20 and after)

PART – III **: Core Lab**		SEMESTER **-II**
Course Title **:** Organic preparation and Quantitative Estimation		
Course Code: 33CP24	Hours per week: 5	Credits:4
CIA Marks: 40	ESE Marks: 60	Total Marks: 100

Preamble

Students are enabled to

- ✓ develop analytical skill in organic quantitative estimation
- ✓ impart the skills in organic preparation

Course Outcomes (CO)

On the successful completion of the course, students will be able to

CO Number	CO Statement	Knowledge Level
CO 1	estimate and analyze the organic compounds	K2
CO 2	Make use of lab skill in the preparation of organic compounds	K3
CO 3	Demonstrate the recrystallization of organic compounds	K3
CO 4	Demonstrate the estimation of alcohol ,amine and Ketone	K4
CO 5	Demonstrate the estimation of Carbohydrate and amino acid	K4

Syllabus

I. Organic Quantitative Estimation

UNIT I

1. Estimation of Phenol
2. Estimation of Aniline

UNIT II

1. Estimation of Ethyl Methyl Ketone
2. Estimation of Glucose

3. Estimation of Glycine

II. Organic Preparation, Involving two stages

UNIT III

1. *Sym*–Tribromobenzene from aniline.
2. *meta*–Nitrobenzoic acid from methyl benzoate.

UNIT IV

1. *para* – Nitroaniline from acetanilide.
2. Benzanilide from benzophenone.

UNIT V

1. Anthraquinone from phthalic anhydride.
2. *para* – Bromoaniline from acetanilide

Reference Books

1. Gnanapragasam. N.S, and Ramamuthy.G., *Organic Chemistry – lab manual*,S.Viswanatahan Co. Pvt., Ltd,1998.
2. Vishnoi.N. K., *Advanced Practical Organic Chemistry*, Vikas Publishing House Pvt.Ltd.,1982.
3. Vogel. A. I.*Vogel's Textbook of Practical Organic Chemistry*, 4th Ed., Longmann group, 2008.
4. LAB MANUAL - Prepared by Faculty, Department of Chemistry, Vivekananda College.

Lab:

DEPARTMENT OF CHEMISTRY

Programme: M.Sc. Chemistry, (CBCS and Outcome Based Education (OBE)

(For those students admitted during the Academic Year 2019-20 and after)

PART – III **: Core Lab**		SEMESTER **-II**
Course Title **: Experiments in Physical Chemistry**		
Course Code: 33CP25	Hours per week: 5	Credits:4
CIA Marks: 40	ESE Marks: 60	Total Marks: 100

Preamble

Students are enabled to

- ✓ understand the principle of thermochemistry, chemical kinetics, potentiometric and conductometric titrations.
- ✓ gain knowledge about the phase transformations of different systems.

Course Outcomes (CO)

On the successful completion of the course, students will be able to

CO Number	CO Statement	Knowledge Level
CO1	understand the enthalpy of solubility of solution	K4
CO2	examine the strength of the solutions and K_a values by kinetic methods	K3
CO3	analyse the molecular weight of chemical compounds from K_f values by Rast micro method	K4
CO4	create and analyze Phase diagrams	K4 & K3
CO5	analyse the conductometric and potentiometric titration	K4

K1-Knowledge K2-Understand K3-Apply K4 – Analyze

Mapping Syllabus

UNIT-I

Basic concepts of volumetric titration, thermochemistry, surface chemistry, colligative properties Phase rule, electrochemistry and chemical kinetics

UNIT-II

1. Thermochemistry Enthalpy of solution by solubility method – unknown concentration.
2. Rast Micro Method Determination of K_f and molecular weight by micro method.
3. Adsorption of acetic acid/oxalic acid on activated charcoal. Freundlich adsorption isotherm – determination of unknown concentration.

UNIT- III

4. Viscosity- Variation of viscosity of liquids with temperature
5. Three Component Liquid systems: Acetic acid, Benzene and Water
6. Activation Energy for the Acid –Catalyzed Hydrolysis of ethyl acetate.

UNIT- IV

COUNDUCTIVITY EXPERIMENTS

7. Determination of cell constant
8. Determination of relative strength of two acids by conductance measurements. (Acid Vs. base strong acid, weak acid strong base and mixture of acid)
9. Conductometric displacement titration (NH_4Cl Vs NaOH)
10. Determination of λ_a for acetic acid using Kholrausch's law.
11. Saponification of ester followed by counductometric method solubility products of sparingly soluble salts.

UNIT- V

POTENTIOMETRIC EXPERIMENTS

12. Potentiometric Acid -base Titration
13. Measurnment of standard electrode potential
14. Determination of pH using quinhydrone electrode
15. Potentiometeric redox titration (KI Vs $KMnO_4$ Vs KI)
16. Determination of dissociation constant of weak acids by potentiometry.

Reference Books

1. Thomas, A.O., *Text Book of Practical Chemistry* Scientific Publication, 4th Revised Edition, 1976.
2. Viswanathan B. &Raghavan P.S. *Practical Physical Chemistry Viva Books*,3rd Ed 2009
3. Levitt B.P. *Findlay's Practical Physical Chemistry*, 9th Ed., Longman Publications1973,
4. Palmer G. *Experimental Physical Chemistry,* 1st Ed., Cambridge University Press1964.
5. Yadav J. B., *Advanced Practical Physical Chemistry*, 22ndEd., GOEL publishing House, Krishna Prakashan Media Ltd, 2005.
6. VenkatesanV.Veeraswamy R. and Kulandaivelu A.R. *Basic Principles of Practical Chemistry*, 2nd Ed., Sultan Chand and Sons Publication, New Delhi,1997.

7. B. P. Levitt, Findlay's *Practical Physical Chemistry*, 9th Ed., Longman, London, 1985
8. Lab Manual-*Prepared by Faculty*, Department of Chemistry, Vivekananda College

Elective:

DEPARTMENT OF CHEMISTRY

Programme: M.Sc. Chemistry, (CBCS and Outcome Based Education (OBE)
(For those students admitted during the Academic Year 2019-20 and after)

PART – III **: Elective Theory**		SEMESTER **-II**
Course Title: **Medicinal and Pharmaceutical Chemistry**		
Course Code: 33EP2A	Hours per week:5	Credits: 5
CIA Marks: 25	ESE Marks: 75	Total Marks: 100

Preamble

Students are enabled to

- ✓ Learn the medicinal values of various drugs, its actions and metabolism of drugs.
- ✓ gain basic knowledge about common diseases and their treatments.

Course Outcomes (CO)

On the successful completion of the course, students will be able to

No.	Course Outcome	Knowledge Level (according to Bloom's Taxonomy)
CO 1	Outline the terminologies of pharmaceutics	**K2**
CO 2	Find the uses of medicinal herbs	**K1**
CO 3	Summarize the different types of drugs and their functions	**K1, K4**
CO 4	Categorize the common body ailments in pharmaceutics	**K4**
CO 5	Describe the various therapeutic agents for good health	**K2**

K1-Knowledge K2-Understand K3-Apply
K4 –Analyze K5 – Evaluate K6 - Create

Mapping of CO with PO

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7
CO 1	9	1	3	3	3	1	3
CO 2	9	1	3	3	3	1	3
CO 3	9	1	3	3	3	1	3
CO 4	9	1	3	3	3	1	3

CO 5	9	1	3	3	3	9	3
Weightage of the course	45	5	15	15	15	13	15

9-Strong; 3-Medium; 1-Low

Mapping of CO with PSO

	PSO 1	**PSO 2**	**PSO 3**	**PSO 4**	**PSO 5**
CO 1	9	3	3	1	3
CO 2	9	3	3	1	3
CO 3	9	3	3	1	3
CO 4	9	3	3	1	3
CO 5	9	3	3	1	3
Weightage of the course	45	15	15	5	15

9-Strong; 3-Medium; 1-Low

Syllabus

UNIT-I: INTRODUCTION

Common diseases-infective disease- Insect-borne,air- borne and water borne- hereditary disease terminology-drug, pharmacology, pharmacognesy, pharmacodynamics, pharmacokinetics, antimetabolites absorption of drugs- routes of administration of drugs, factors affecting absorption - Assay of drugs - chemical, biological, immunological assays, LD_{50} and ED_{50} therapeutic index, drug dosage. Drug analysis and Design of Drugs

UNIT-II:**DRUGS AND THEIR FUNCTIONS**

Various source of drugs, pharmacologically active constituents in plants, Indian medicinal plants- tulsi, neem, keezhanelli- their importance –Classification of drugs- biological chemical- Mechanism of drug action- Action at cellular and extra cellular sites. Drug receptor and biological responses- Metabolism of drug through oxidation, reduction, hydrolysis and conjugate processes factors affecting metabolism.

UNIT- III:**CHEMOTHERAPY**

Designation of drug based on physiological action; Definition and two examples each of Anaesthetic-General, and local-Analgesics- Narcotic and synthetic-Antipyretics and anti inflammatory agents-Antibiotics- penicillin, streptomycin, chloraphenicol, tetracyclins-Antivirals, AIDS-symptoms, prevention, treatment – Cancer and neoplastic agents.

UNIT- IV:**COMMON BODY AILMENTS**

Diabetes – Causes, hyper and hypoglycemic drugs – Blood pressure – sistolie& Diastolic Hypertensive drugs – Cardiovascular drugs – antiarrhythmic, antianginals, vasodilators –CNS depresents and stimulants – Psychedelic drugs, hypnotics, sedatives (barbiturates, LSD) – Lipid profile – HDL, LDL cholesterol, lipid lowering drugs.

UNIT- V:HEALTH PROMOTING DRUGS

Nutraceuticals – Vitamins A B C D E and K, micronutrients Na K Ca Cu Zn I - Medicinally important inorganic compounds of Al P As Hg Fe – examples for each their role and applications – Organic Pharmaceutical acids; Agents for kidney function(Aminohippuric acid); Agents for liver function (Sulfobromophthalein); Agents for pituitary function (metyrapone) – Organic pharmaceutical bases – antioxidants, treatment of ulcer and skin diseases.

Reference Books

1. Pharmaceutical Chemistry, Jayashree Ghosh, S.Chand and Company Ltd., New Delhi.2006,
2. Lakshmi S, *Pharmaceutical Chemistry*, S.Chand & Sons, New Delhi, 1995.
3. Ashutoshkar, *Medicinal Chemistry*, Wiley Eastern Ltd., New Delhi. 1993.
4. David William & Thomas Lemke, Foyes, *Principles of Medicinal Chemistry*, Bl publisher.,5th Ed., 2000.
5. Kadam. S.S., Mahadik.K.R and Bothara K.G, Principles of Medicinal Chemistry" Vol. II Nirali Prakashan, Pune.
6. Charles. R.Craig, Robert E .Stitzel , Modern Pharmacology with clinical applications, 6th Ed., Lippincott Williams and Wilkins, New York.

Core:

DEPARTMENT OF CHEMISTRY

Programme: M.Sc. Chemistry, (CBCS and Outcome Based Education (OBE)

(For those students admitted during the Academic Year 2019-20 and after)

PART – III **: Core Theory**		SEMESTER **- III**
Course Title: **Organic Chemistry - III**		
Course Code: 33CT31	Hours per week: 5	Credits: 4
CIA Marks: 25	ESE Marks: 75	Total Marks: 100

Preamble

Students are enabled to

- ✓ Understand the principle and applications of UV-Vis, IR, NMR and Mass spectrometry.
- ✓ Explain the basic principle of pericyclic reactions.
- ✓ Have knowledge on photochemical reactions.

Course Outcomes (CO)

On the successful completion of the course, students will be able to

No.	Course Outcome	Knowledge Level (according to Bloom's Taxonomy)
CO1	Define, outline, apply and examine the principle and applications of UV and IR spectra to organic molecules	K1, K2, K3 & K4
CO2	Define the terminology and explain, utilize and analyze the principle of NMR to organic compounds	K1, K2, K3 & K4
CO3	Define the principle and illustrate, apply and analyze the applications of Mass spectra to organic compounds	K1, K2, K3 & K4
CO4	Relate, explain, apply and analyze the orbital symmetry concept to pericylic reactions	K1, K2, K3& K4
CO5	Define the basics of photochemistry and illustrate, apply and analyze the mechanism of photochemical reactions	K1, K2, K3 & K4

K1-Knowledge K2-Understand K3-Apply K4-Analyze

Mapping of CO with PO

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7
CO 1	9	1	3	1	1	1	3
CO 2	9	1	3	1	1	1	3
CO 3	9	1	3	1	1	1	3
CO 4	9	1	3	1	1	1	3
CO 5	9	1	3	1	1	9	3
Weightage of the course	45	5	15	5	5	13	15

9-Strong; 3-Medium; 1-Low

Mapping of CO with PSO

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO 1	9	9	3	1	3
CO 2	9	9	3	1	3
CO 3	9	9	3	1	3
CO 4	9	9	3	1	3
CO 5	9	9	3	1	3
Weightage of the course	45	45	15	5	15

9-Strong; 3-Medium; 1-Low

Syllabus

UNIT I: UV-VISIBLE AND IR SPECTROSCOPY

UV-VISIBLE SPECTROSCOPY: Brief introduction – types of electronic transitions – intensity of bands - calculation of λ_{max} for dienes and dienones (Woodward – Fieser rule) – effect of solvent and pH on the absorption maxima of molecules – stereochemical factors in electronic spectroscopy – UV- Vis – spectra of aromatic and heterocyclic compounds.

IR SPECTROSCOPY: Introduction **–** finger print region – identification of functional groups and interpretation of IR spectra – Factors (hydrogen bonding, electronic effects, mass effects, conjugation and ring strain) influencing vibrational frequencies – inter and intra molecular hydrogen bonding.

UNIT II: NMR SPECTROCOPY

Introduction **–** chemical shift – factors influencing chemical shift – chemical and magnetic equivalence – spin-spin coupling – vicinal and germinal coupling – coupling constants – Karplus equation – proton-deuterium exchange phenomenon – first order and non-first order spectra – simplification of complex spectra using double resonance techniques – shift reagents and increased field strength – nuclear overhauser effect (NOE) – applications of NMR to compounds such as ethanol, acetaldehyde, toluene, 1,1,2-trichloroethane, cinnamic acid, ethyl acetate, furfuraldehyde and α-chloro propinonic acid – ^{13}C NMR – basic principles – off resonance and broad band decoupling techniques – γ-gauche effect.

2D NMR– ^{1}H-^{1}H correlation spectroscopy (COSY) – ^{1}H-^{13}C COSY and nuclear overhauser effect spectroscopy (NOSEY).

UNIT III: MASS SPECTROMETRY

Basic principles – ionization techniques (electronic ionization and chemical ionization) - fragmentation processes of organic molecules – molecular ion peak – base peak – metastable peak – isotopic peak – Nitrogen rule – McLafferty rearrangement – Retro Diels Alder rearrangement – interpretation of mass spectra of simple organic compounds such as acetone, ethyl bromide, ethyl acetate, ethylamine, cyclohexanol, toluene, anisole, benzaldehyde, acetophenone and aniline – combined problems based on UV, IR, NMR and mass for simple molecules.

UNIT IV: PERICYCLIC REACTIONS

Pericyclic Reactions: General characteristics – molecular orbital symmetry, frontier orbitals of ethylene, 1, 3-butadiene and 1, 3, 5- hexatriene.

Electrocyclic reactions –Woodward-Hoffmann selection rules, correlation diagram approach of cyclobutene to 1,3-butadiene system – frontier molecular orbital (FMO) approach of 1, 3, 5-trienes to cyclohexadiene system.

Cycloadditions: Woodward-Hoffmann rules, Antarafacial and suprafacial additions, [2+2] and [4+2]-cycloaddition – correlation and FMO approach of ethylene to cyclobutene system – 1, 3- dipolar addition – cheletropic reactions.

Sigmatropic Rearrangements: Woodward-Hoffmann rules, [1,3], [1,5] and [1,7]-sigmatropic rearrangements – Cope, oxy-Cope, aza-Cope and Claisen rearrangements.

UNIT V: PHOTOCHEMISTRY

Photochemistry of alkenes – cis-trans isomerisation – photochemistry of dienes – photosensitization – photochemical reactions of ketones – Norrish type I and type II reactions, Paterno-Buchi reaction – dienone photochemistry – photoreduction, photochemical oxidation – Barton reaction – Di-pi methane rearrangements – photochemical rearrangements – photochemistry of α and β-unsaturated carbonyl compounds – photochemistry of aromatics.

REFERENCE BOOKS

1. Silverstein, R.M., Bassler, G.C., and Morrill, T.C., *Spectrometric Identification of Organic Compounds*, 8th Ed., John Wiley, 1986.
2. Kemp, W, *Organic Spectroscopy*, 3rd Ed., McMillan, 1986.
3. Jag Mohan, *Organic Spectroscopy: Principles and Applications*, 2nd Ed., Alpha Science, 2004.
4. Pavia, D.L., Lampman, G.M., and Kriz, G.A., *Introduction to Spectroscopy*, 4th Ed., Cengage Learning, 2009.
5. Kalsi, P.S., *Spectroscopy of Organic Compounds*, 6th Ed., New Age International, 2004.
6. Macomber, R.S., *A Complete Introduction to Modern NMR Spectroscopy*, Wiley, 1998.
7. Mukheriji, S.M. and Singh, S.P., *Reaction Mechanism in Organic Chemistry*, 3rd Ed., Macmillan India Ltd, 1998.
8. Arora, M.G., *Organic Photochemistry and Pericyclic Reactions*, 1st Ed., Anmol Publications Pvt Ltd., New Delhi, 2004.
9. Kar, R.K., *Frontier Orbital and Symmetry Controlled Pericyclic Reactions*, 1st Ed., Books and Allied Publisher, 2010.
10. Jagdamba Singh and Jaya Singh, *Photochemistry and Pericyclic Reactions*, 3rd Ed., New Age International Publishers Ltd., New Delhi, 2012.
11. Turro, N.J., Ramamurthy, V. and Scaiano, J.C., Modern Molecular Photochemistry, University Science Books, 2010.

Core:

DEPARTMENT OF CHEMISTRY

Programme: M.Sc. Chemistry, (CBCS and Outcome Based Education (OBE)

(For those students admitted during the Academic Year 2019-20 and after)

PART – III **: Core Theory**	SEMESTER **- III**
Course Title: **Inorganic Chemistry - III**	

Course Code: 33CT32	Hours per week: 5	Credits: 4
CIA Marks: 25	ESE Marks: 75	Total Marks: 100

Preamble

Students are enabled to

- ✓ Understand the structure, bonding, reaction mechanism and applications of organometallic compounds

Course Outcomes (CO)

On the successful completion of the course, students will be able to

No.	Course Outcome	Knowledge Level (according to Bloom's Taxonomy)
CO 1	Calculate 18/16-electron rule and predict the number of M-M bond in metal clusters.	K4
CO2	Discuss and illustrate the structure, bonding, preparation and properties of metal carbonyls and metal nitrosyls.	K2& K4
CO 3	Explain the reaction mechanisms of organometallic compounds.	K2
CO 4	Summarize and illustrate basics of organometallic compounds of carbene, carbyne, alkene, alkyne and metallocene	K3 & K4
CO 5	Describe the applications of organometallic compounds in catalysis and coupling reactions.	K1 & K2

K1-knowledge K2-Understand K3-Apply K4-Analyze

Mapping of CO with PO

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7
CO 1	9	1	3	1	3	1	3
CO 2	9	1	3	1	3	1	3
CO 3	9	1	3	1	3	1	3
CO 4	9	1	3	1	3	1	3
CO 5	9	1	3	1	3	1	3
Weightage of the course	45	5	15	5	15	5	15

9-Strong; 3-Medium; 1-Low

Mapping of CO with PSO

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO 1	9	9	3	1	1
CO 2	9	9	3	1	1

CO 3	9	9	3	1	1
CO 4	9	9	3	1	1
CO 5	9	9	3	1	1
Weightage of the course	45	45	15	5	5

9-Strong; 3-Medium; 1-Low

Syllabus

UNIT- I: ORGANOMETALLIC CHEMISTRY

Introduction – classification of organometallic compounds based on the nature of metal-carbon bond – classification of ligands based on hapticity – electron count in complexes: eighteen electron rule, sixteen electron rule and exception to 18 and 16 electron rule – A brief applications of organometallic compounds.

Cluster compounds: metal carbonyl clusters – calculation of number of M-M bonds using 18/16-electron rule in low nuclearity carbonyl clusters (LNCC) – electron counting schemes for high nuclearity carbonyl clusters – Capping rules – Mingo's rule – the isolobal analogy.

UNIT- II: METAL CARBONYLS AND NITROSYLS

Metal carbonyl: Classification of metal carbonyl – bonding in metal carbonyls – evidence for synergistic bonding (π-back bonding) – factors affecting the magnitude of stretching frequency – bonding modes of CO – number and intensity of infrared bands – preparation, properties and structure of nickel tetracarbonyl, iron pentacarbonyl, chromium hexacarbonyl and dicobalt octacarbonyl.

Metal nitrosyl: Structure and nature of M-NO bonding in nitrosyls – preparation, properties and structure of sodium nitroprusside.

UNIT- III: REACTIONS OF ORGANOMETALLIC COMPOUNDS

Oxidative addition reactions and its salient features – mechanisms for oxidative addition reaction (concerted, S_N2 & radical reactions and ionic mechanisms) – reductive elimination reactions and its salient features – migratory insertion reaction and its mechanism – insertion of alkenes – salient features of the migratory insertion reaction – β-H elimination and α-H abstraction reactions.

UNIT- IV: METAL CARBENES, CARBYNES, ALKENES, ALKYNES AND METALLOCENE

Metal carbenes: Fischer carbenes, Schrock carbenes, Tebbe's reagent, comparison between Fischer carbenes and Schrock carbenes – metal carbynes complexes – metal alkene complexes – metal alkyne complexes – metal allyl complexes and its synthesis – buta-1,3-diene complexes – Davies-Green-Mingos (DGM) rule.

Metallocene: Definition and examples – preparation, properties, structure and bonding of ferrocene.

UNIT- V: CATALYSIS AND COUPLING REACTIONS

Catalysis: mechanisms of Wilkinson's catalytic process, hydroformylation or oxo process, Wacker process, Ziegler-Natta catalytic process, Monsanto acetic acid process, olefin metathesis, Fischer-Tropsch process and synthetic gasoline process.

Coupling reactions: Mechanism of Tsuji-Trost reaction, Heck reaction, Miyaura-Suzuki coupling and Stille coupling reaction.

Reference Books

1. Ajai Kumar, *Organometallic and bioinorganic chemistry,* 2nd Ed., Aaryush Educations, Ghaziabad, 2016.
2. Gupta, B.D. & Elias, A. J., *Basic organometallic chemistry: concepts, synthesis and applications,* 2nd Ed., University Press (India) Pvt Ltd, Hyderabad, 2013.
3. Crabtree, R.H., *The organometallic chemistry of the transition metals,* 3rd Ed., John Wiley & Sons, Inc. 2001.
4. Mehrotra, R.C. & Singh, A., *Organometallic chemistry-A unified approach,* 2nd Ed., New age international publications, New Delhi, 2000.
5. Huheey, J.E., Keiter, E.A. and Keiter, R.L., *Inorganic chemistry: Principles of structure and reactivity*, 4th Ed., Pearson Education Pte. Ltd., Delhi, 2004.
6. Shriver, D.F. and Atkins, P.W., Inorganic chemistry, 3rd Ed., Oxford University Press, London, 2001.

7. Purcell K.F. and Kotz J.C., Inorganic chemistry, Cengage Learning India Private Limited, Delhi, 2017.
8. Meissler, G.L. and Tarr, D.A., Inorganic chemistry, 3rd Ed., Pearson India Education Services Pvt Ltd., 2015.
9. Puri, B.R., Sharma, L.R. and Kalia, K.C., *Principles of inorganic chemistry*, Vishal Publishing, 2017.
10. Malik, W.U., Tuli, G.D. and Madan, R.D., 17th Ed., Selected topics in inorganic chemistry, S. Chand Publications, 2014.

Core:

DEPARTMENT OF CHEMISTRY

Programme: M.Sc. Chemistry, (CBCS and Outcome Based Education (OBE)

(For those students admitted during the Academic Year 2019-20 and after)

PART – III **: Core Theory**		SEMESTER **- III**
Course Title: **Physical Chemistry - III**		
Course Code: 33CT33	Hours per week: 5	Credits: 4
CIA Marks: 25	ESE Marks: 75	Total Marks: 100

Preamble

Students are enabled to

- ✓ obtain the knowledge on chemical applications of group theory
- ✓ acquire knowledge about multiplication table for point groups
- ✓ understand the principles, instrumentation and determine the structure of unknown compounds by spectral analysis
- ✓ provide physical explanations for the ways in which important biological systems function

Course Outcomes (CO)

On the successful completion of the course, students will be able to

No.	Course Outcome	Knowledge Level (according to Bloom's Taxonomy)
CO 1	classify molecules into point groups	K1 & K3
CO 2	construct the character table for point groups	K2,K4 & K6
CO 3	Relate the g factor, nuclear spin, and hyperfine coupling constant with structure of the complexes	K1, K2 & K3
CO 4	study the internal structure of matter by ESR, NQR and Mössbauer spectroscopy	K1,K4 & K5
CO 5	Understanding of biological system by physicochemical phenamena	K1 & K2

K1-knowledge K2-Understand K3-Apply K4-Analyze K5-Evaluate and K6-Create

Mapping of CO with PO

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**
CO 1	9	1	3	3	3	1	3

CO 2	9	1	3	3	3	1	3
CO 3	9	1	3	3	3	1	3
CO 4	9	1	3	3	3	1	3
CO 5	9	1	3	3	3	1	3
Weightage of the course	45	5	15	15	15	5	15

9-Strong; 3-Medium; 1-Low

Mapping of CO with PSO

	PSO 1	**PSO 2**	**PSO 3**	**PSO 4**	**PSO 5**
CO 1	9	9	3	3	3
CO 2	9	9	3	3	3
CO 3	3	3	3	9	3
CO 4	3	3	3	9	3
CO 5	9	9	3	9	3
Weightage of the course	33	33	15	33	15

9-Strong; 3-Medium; 1-Low

UNIT I: GROUP THEORY- I

Symmetry elements and symmetry operation – point groups – symmetry number from point groups – matrix representation of symmetry operations – reducible and irreducible representations –Great orthogonality theorem – character tables and their constructions – C_{2v}, C_{3v}, C_{2h} point groups.

UNIT II: GROUP THEORY-II

Application of group theory to normal mode analysis – symmetry selection rules for IR and Raman active fundamentals – symmetry of molecular orbitals – symmetry selection rules for electronic transitions for simple molecules (Ethylene, Formaldehyde and Benzene) – projection operators – SALC procedure – evaluation of energies and HMO's for ethylene and butadiene – application of group theory to solve hybridization problems (sp^2 and sp^3).

UNIT III: NUCLEAR MAGNETIC RESONANCE SPECTROSCOPY

Introduction – nuclear spin – relaxation processes – shielding and deshielding of magnetic nuclei – chemical shift and its measurements – spin-spin interactions – spin decoupling – selective decoupling – spin tickling – Nuclear Overhauser Effect (NOE) – NMR studies of nuclei other than proton – ^{13}C NMR - advantages of FT NMR.

UNIT IV: ESR, NQR and MÖSSBAUER SPECTROSCOPY
ELECTRON SPIN RESONANCE SPECTROSCOPY

Basic principles – zero field splitting – Kramer's degeneracy – factors affecting the 'g' value – anisotropy in 'g' – hyperfine coupling constants – applications.

NUCLEAR QUADRUPOLE RESONANCE SPECTROSCOPY

Basic principles – Quadruple nuclei – quadruple moments – electric field gradient – coupling constant – splitting – applications.

MÖSSBAUER SPECTROSCOPY

Basic principles – Mössbauer Effect – Doppler Effect – isomer shift – quadrupole splitting – magnetic hyperfine splitting – applications

UNIT V: BIOPHYSICAL CHEMISTRY **Buffers:**

Buffers and their action – Henderson-Hasselbach equation – Buffer capacity – Buffering of blood.

Viscosity: Definition – significance of viscosity in biological systems – Nature of blood flow through different vessels – plot of apparent viscosity of erythrocytes in physiological saline against haematocrit – amoeboid movement.

Surface tension: Definition – Role of pulmonary surfactant – Stability of alveoli – Interfacial tension and Danieli and Davson model.

Isotopes in biology: Tracer technique – meaning – General tracer requirements – Advantages of tracer experiments – Limitations of tracer experiments – Clinical applications.

Reference Books

1. F.A. Cotton, Chemical application of group theory, 2nd edn, Wiley Eastern Ltd.1997
2. K.V. Raman, Group theory and its application to chemistry, Tata McGrawHill, Comp. Ltd., New Delhi 1990.
3. Ramakrishnan and Gopinathan, Group theroy in chemistry, Vishal Publications.1998
4. B.K. Bhattacharya, Group theory and its chemical applications Himalayan, Publishing House.-1990
5. Colin N.Banwell Fundamentls of Molecular Spectroscopy ,Tata Mc Graw Hill Comp. Ltd., New Delhi-1997
6. R.S. Drago, Physical methods in Chemistry, Sainders college. 1987
7. G.M. Barrow, Introduction to molecular spectroscopy, MC Graw Hill publishing Co.Ltd. New Delhi.- 1994
8. R. Chang, Basic Principles of spectroscopy, Mc Graw Hill publishing Co.Ltd. New Delhi.-1992
9. Upadhyay,Upadhyay and Nash, Biophysical Chemistry, Himalaya Publishing House. III edition 1997.

Lab:

DEPARTMENT OF CHEMISTRY

Programme: M.Sc. Chemistry, (CBCS and Outcome Based Education (OBE)

(For those students admitted during the Academic Year 2019-20 and after)

PART – III **: Core Lab**		SEMESTER **-III**
Course Title **: Ino**rganic Quantitative Estimation		
Course Code: 33CP34	Hours per week: 5	Credits:4
CIA Marks: 40	ESE Marks: 60	Total Marks: 100

Preamble

Students are enabled to

- ✓ Estimate the amount inorganic salt present in the whole of the given solution.
- ✓ Experience hands on training in different types of titration.

Course Outcomes (CO)

At the end of the practical course, the students will be able to

CO Number	CO Statement	Knowledge Level
CO1	Demonstrate the complexometric Titration	K1,K2,
CO2	Interpret the principles and terminology involved in volumetric estimation	,K3
CO3	Understand the principles of gravimetric estimation	K3
CO4	Estimate the amount of Barium ,Iron and Copper, by Volumetrically	K3
CO5	Estimate the amount of Nickel, Magnesium and Zinc, by Gravimetrically	K3

Syllabus

COMPLEXOMETRIC TITRATION
(Demonstration only – any two experiments)

Unit 1.
1. Estimation of Zinc.
2. Estimation of Magnesium.

Unit 2
3. Estimation of Copper.
4. Estimation of Nickel.
   a) By direct method.
   b) By indirect method.

Unit-3
ESTIMATION
(The first metal ion should be estimated by Volumetric and the second by Gravimetric)
1. Estimation of Copper and Nickel.
2. Estimation of Calcium and Magnesium.

Unit-4
3. Estimation of Barium and Zinc.
4. Estimation of Iron and Nickel

Unit-5
5. Estimation of Copper and Zinc.

Text Books

1.Venkateswaran, V., Veerasamy, R. & Kulandaivelu, A.R., *Basic Principles of Practical Chemistry*, Sultan Chand & Sons, New Delhi, 2017.

Reference Books

1. Vogel A.I, *Elementary Practical inorganic Chemistry*,– Longmann London, 4th Ed., 1987.

Non Major Elective:

DEPARTMENT OF CHEMISTRY

Programme: M.Sc. Chemistry, (CBCS and Outcome Based Education (OBE)
(For those students admitted during the Academic Year 2019-20 and after)

PART – IV **: Non Major Elective**		SEMESTER **-III**
Course Title: **Forensic Chemistry**		
Course Code: 07NE3A	Hours per week:5	Credits:5
CIA Marks: 25	ESE Marks: 75	Total Marks: 100

Preamble

Students are enabled to

- ✓ Understand the disciplines of forensic chemistry and various divisions in central forensic laboratory.
- ✓ Explain the basic techniques and analysis of forensic chemistry.
- ✓ Have knowledge on autopsy and death investigation procedures.

Course Outcomes (CO)

On the successful completion of the course, students will be able to

No.	Course Outcome	Knowledge Level (according to Bloom's Taxonomy)
CO 1	Understand the disciplines in forensic chemistry and divisions in central forensic laboratories.	K1,K2,K3,K4
CO 2	Explain and utilize the diverse techniques for crime investigation	K1,K2,K3,K4
CO3	Illustrate the role of forensic scientist and study the theory behind variety of analysis.	K1,K2,K3,K4
CO 4	Relate the concept of different blood groups and apply to paternity blod tests.	K1,K2,K3,K4
CO 5	Understand the documentation and reports of postmortem.	K1,K2,K3,K4

K1-Knowledge K2-Understand K3-Apply K4-Analyze

Syllabus

UNIT I – **FORENSIC DISCIPLINES**

Forensic science disciplines: pathology, anthropology, entomology, odontology, toxicology, psychiatry-various divisions in central forensic science laboratory: biology, serology, physics, ballistics, documents, chemistry, fingerprint, lie detection, photo and scientific aids.

UNIT II– **FORENSIC TECHNIQUES**

Introduction- narco-analysis test, polygraph/lie detector test- modern advances in recognition of dishonesty- brain mapping- DNA- profiling – paternity, fingerprints types- brain and ballistic fingerprinting- other techniques- relation with crime investigation- an analysis.

UNIT III – FORENSIC ANALYSIS

Role of a forensic scientist- forensic generalist and specialist- theory of forensic analysis- classification and individualization of a crime- fingerprint development- presumptive drug analysis- crime incident soil analysis- size, density, pH comparison of microscopic analysis.

UNIT IV – FORENSIC SEROLOGY

Definiton-expert-blood stain pattern analysis- blood flight characteristics- transfer and spatter, its three types: low, medium and high force velocity impact spatter- target surface texture- blood group- paternity blood tests- semen identification and presumptive tests.

UNIT V– FORENSIC AUTOPSY

Medicolegal death investigation- forensic autopsies- identification procedures- disposition of unidentified bodies- External examination : general and specific procedures – Internal examination- ancillary and support services- documentation and reports of postmortem.

REFERENCE BOOKS

1. Nbabr BS, Forensic Science, SVP national police academy, Hyderabad 2005.
2. T.H.James, Forensic Sciences, Stanley Thomas Ltd.2000.
3. Richard, Criminalistics- An introduction to forensic science, 8th Edition, sofestein, Prince Hall, 2006.
4. Nanda and Tewari, Forensic Science in India- A vision for the 21st century, select publisher, 2001.

Core:

DEPARTMENT OF CHEMISTRY

Programme: M.Sc. Chemistry, (CBCS and Outcome Based Education (OBE)

(For those students admitted during the Academic Year 2019-20 and after)

PART – III **: Core Theory**		SEMESTER **- IV**
Course Title: **Organic Chemistry - IV**		
Course Code: 33CT41	Hours per week: 5	Credits: 4
CIA Marks: 25	ESE Marks: 75	Total Marks: 100

Preamble

Students are enabled to

- ✓ Understand organic chemical reactions involving structural changes.
- ✓ Know the various organic protection and deprotection reagents in organic synthesis.
- ✓ Know various strategies used in retro synthetic analysis.
- ✓ Understand synthetic aptitude on the heterocyclic compounds.
- ✓ Know the chemistry of selected steroids and hormones

Course Outcomes (CO)

On the successful completion of the course, students will be able to

No.	Course Outcome	Knowledge Level (according to Bloom's Taxonomy)
CO 1	Develop and understanding of the free radical processes of synthesis and rearrangement mechanisms of reactions in organic chemistry	K2 and K3
CO 2	Formulate the chemistry of protection and deprotection strategies involved in hydroxyl group by ether and ester, carbonyl group and amino groups	K6
CO 3	Describe the important concept of the organic chemistry	K2 and K4

	for the synthesis of new molecule, introduction of different functional group.	
CO 4	Predict the chemistry and reactions of heterocyclic compounds	K2
CO 5	Describe the chemistry and structure of cholesterol and oxytocin	K2

K1-Knowledge; K2-Understand; K3-Apply; K4-Analyzing

Mapping of CO with PO

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**
CO 1	9	1	3	1	3	1	3
CO 2	9	1	3	1	3	1	3
CO 3	9	1	3	1	3	1	3
CO 4	9	1	3	1	3	1	3
CO 5	9	1	3	1	3	1	3
Weightage of the course	45	5	15	5	15	5	15

9-Strong; 3-Medium; 1-Low

Mapping of CO with PSO

	PSO 1	**PSO 2**	**PSO 3**	**PSO 4**	**PSO 5**
CO 1	9	1	1	1	3
CO 2	9	3	9	1	3
CO 3	3	1	1	1	1
CO 4	3	1	9	9	1
CO 5	9	3	3	3	3
Weightage of the course	33	9	23	15	11

9-Strong; 3-Medium; 1-Low

Syllabus

UNIT-I: FREE RADICAL REACTIONS AND MOLECULAR REARRANGEMENTS

FREE RADICAL REACTIONS: Allylic halogenation N-Bromosuccinimide (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.

MOLECULAR REARRANGEMENTS: Hoffmann, Schmidt, Lossen, Curtius, Beckmann, Fries, Favorski, Bayer-Villiger rearrangements.

UNIT- II: PROTECTION AND DEPROTECTION CHEMISTRY IN ORGANIC SYNTHESIS

Protection and cleavage of hydroxyl groups (by ethers): Chloromethoxymethyl ether (MOM-Cl), Chloromethoxyethoxymethyl ether (MEM-Cl), Tetrahydropyranyl ether (THP), Allyl, Benzyl, *t*-Buthyldimethylsilyl ether (TBDMS).

Protection and cleavage of hydroxyl groups (by esters): Trichloroacetate, Phenoxyacetate, Pivaloate, 2,4,6-trimethylbenzoate.

Protection and cleavage of 1,2 and 1,3-Diols-methylene dioxy derivative: Methoxy methylene acetal, Ethyledineacetal, Cyclic carbonates.

Protection and cleavage of carbonyl groups: 1,3-Dioxanes, 1,3-Dithianes, 2,4-Dinitrophenyl hydrazones.

Protection and cleavage of Amino groups: t-Butyl carbamate (Boc), Benzyl carbamate (CBz), 9-Fluorenylmethyl carbamate (Fmoc), N-Acetyl, N-Benzyl.

UNIT-III: RETERO SYNTHETIC ANALYSIS

Synthons (nucleophilic and electrophilic synthons) and synthetic equivalents – disconnection approach – functional group interconversion of halides, nitriles, azides, amines, and esters – importance of order of events in organic synthesis – linear and convergent synthesis –Umpolong reactions – one group disconnections: alcohol, olefin, ketone, acids – two group disconnections – 1,2- and 1,3-difunctionalised compounds – α and β unsaturated carbonyl compounds – 1,4-difuctionalised compounds – Diels-Alder reactions and Michael additions.

UNIT-IV: HETEROCYCLIC COMPOUNDS

Heterocyclics – nomenclature – compounds containing two hetero atoms: Synthesis and reactivity of pyrazole, imidazole, oxazole, isoxazole, thiazole, isothiazole, quinoline and isoquinoline. **diazines**: the chemistry of pyridazine, pyrimidine and pyrazine – comparison of basicity of diazines chemistry of anthrocyanins and flavonoids.

UNIT-V: STEROIDS AND HORMONES

STEROIDS: Classification – configurational and conformational aspects of cis-trans steroids – synthesis of cholesterol – conversions of cholesterol to Androsterone, Testosterone, Progesterone and Bile acids.

HORMONES: Chemistry and structure of oxytocin.

Reference Books

1. Sanyal, S. N. *Reactions, Rearrangements and Reagents*, BharatiBhavan, 4th Ed., 2013.
2. Mukheriji, M. and Singh, S. P. *Reaction mechanism in organic chemistry*, Macmillan India Ltd, 3rd Ed., 1998.
3. Clayden, Greeves, Warren and Worthers, *Organic Chemistry*, OXFORD University Press, 2nd Ed., 2007.
4. Norman, R.O.C. and Coxon, J.M. *Principles of Organic Synthesis*, CRC Press, 3rd Ed., 2012.
5. Wyatt, P. and Warren, S. *Organic Synthesis: Strategy and Control*, Wiley, Publications, 2013.
6. Warren, S. and Wyatt, P. *Organic Synthesis: The Disconnection Approach*, John Wiley & amp; Sons, 2nd Ed., 2008.
7. Jerry March, *Advanced organic Chemistry – Reactions, Mechanism and structure*, John Wiley and sonspvt.Ltd. 4th Ed., 2007.
8. Finar, I.L. *Organic Chemistry*, Vol. II, ELBS, 5th Ed., 1974.
9. Agarwal O.P. *Chemistry of organic Natural products*, Vol. I 34th and II 37th edition GOEL publishing House, Meerut. 2008.
10. Ireland, R.E. *Organic Synthesis*, Prentice Hall of India Pvt. Ltd., 1975.

Core:

DEPARTMENT OF CHEMISTRY

Programme: M.Sc. Chemistry, (CBCS and Outcome Based Education (OBE)

(For those students admitted during the Academic Year 2019-20 and after)

PART – III **: Core Theory**		SEMESTER **- IV**
Course Title: **Inorganic Chemistry - IV**		
Course Code: 33CT42	Hours per week: 5	Credits: 4
CIA Marks: 25	ESE Marks: 75	Total Marks: 100

Preamble

Students are enabled to

- ✓ understand the key role of various elements in the living systems.
- ✓ acquire basic knowledge about the structure and functions of certain metallo-enzymes.
- ✓ study about the X-ray crystal structure of the compounds.
- ✓ develop problem solving skills from various type of spectra.
- ✓ study in detail the fundamental aspects of various instrumental methods in chemistry

Course Outcomes (CO)

On the successful completion of the course, students will be able to

No.	Course Outcome	Knowledge Level (according to Bloom's Taxonomy)
CO1	acquire intense knowledge about role of metal ions in biological systems, functions and deficiency.	K1, K2, K3 and K4
CO2	understand the key functions of hemerythrin, hemocyanin, cytochromes, iron sulfur proteins etc and metals in medicine	K1, K2, K3 and K4
CO3	student will know through knowledge about the basics of solid state chemistry, X-ray diffraction, types of crystals, learn band theory and various defects in crystals.	K1, K2, K3 and K4
CO4	know the concepts of C^{13}, F^{9}, P^{31}. NMR, ESR and Mossbauer spectra and its applications	K1, K2, K3 and K4
CO5	familiarize the Thermogravimetric Analysis and redox system.	K1, K2, K3 and K4

K1-Knowledge; K2-Understand; K3-Apply; K4-Analyze

Mapping of CO with PO

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7
CO 1	9	1	3	1	3	1	3
CO 2	9	1	3	1	3	1	3
CO 3	9	1	3	1	3	1	3
CO 4	9	1	3	1	3	1	3
CO 5	9	1	3	1	3	1	3
Weightage of the	45	5	15	5	15	5	15

course							

9-Strong; 3-Medium; 1-Low

Mapping of CO with PSO

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO 1	9	9	3	3	3
CO 2	9	9	3	3	3
CO 3	9	9	3	3	3
CO 4	9	9	3	3	3
CO 5	9	9	3	3	3
Weightage of the course	45	45	15	15	15

9-Strong; 3-Medium; 1-Low

Syllabus

UNIT – I: BIO-INORGANIC CHEMISTRY – I

Essential and trace elements: Role of metal ions in biological systems – Functions and deficiency symptoms of zinc, copper, cobalt, iron.

Metalloporphyrins: Role of iron in living system, structural features, functions and physiology of hemoglobin and myoglobin – co-operativity effect – Bohr Effect – Hill's constant – poisoning effect of CO and CN^- on hemoglobin.

Metalloenzyme: carboxy peptidase and carbonic anhydrase and superoxide dismutase

UNIT – I: BIO-INORGANIC CHEMISTRY – II

Structure and functions of hemerythrin and hemocycnin – cytochromes – cytochrome P-450 – iron-sulphur proteins: ruberodoxin and ferredoxins – blue copper protein – iron storage and transport: ferritin and transferrin – Nitrogen fixation – photosynthesis (photosystem I and II) – Structure and functions of vitamin B_{12} – Structure and functions of cholorophyll – Metals in medicine.

UNIT III: SOLID STATE CHEMISTRY

X-ray diffraction: Derivation of Bragg equation – experimental method (rotating crystal and powder) – X-ray diffraction patterns of a cubic system – X-ray diffraction patterns for Tungsten crystal – Electron diffraction – Neutron diffraction.

Types of crystal: Molecular crystal- Covalent crystal – Metallic crystal – Ionic crystal: perovskite and spinel structure.

Energy Band theory: Conductors, Semiconductors and Insulators – Superconductors – Low and high temperature super conductivity.

Imperfection in a crystal: Point defects: calculations of number of Schottky and Frenkel defects Metal excess defect and metal deficiency defect – Line defects: Edge dislocation, Screw dislocation – Plane defects: Grain boundary and Stacking faults – Imperfections due to transient atomic displacement.

UNIT IV: APPLICATION OF SPECTROSCOPY TO INORGANIC COMPLEXES

Nuclear magnetic resonance (NMR)

Classification of the spinning nuclei - Applications in structure determination of Carbon – 13 (cis and trans isomers of $[RuCl(NO)(bpy)_2]^+$ - Phosphorus- 31 (HPF_2, H_3PO_3 and $Rh(PPh_3)Cl_3$) – Fluorine – 19 (ClF_3, ClF_5, PF_5 and XeF_6) – Boron compounds (B_2H_6 and $(CH_3)_4B_2H_2$) - NMR spectrum of Paramagnetic complexes ($Ru_2Cl_4(CO)(PPh_3)_4$– Contact shifts.

Electron spin resonance (ESR)

Application to transition metal complexes – [d^1 (VO(II), d^5 Low spin $[Fe(CN)_6]^{3-}$, d^5 High spin (Mn(II), d^7 High and Low spin Co(II), d^8 Ni(II) and d^9 (Cu(II)] – Bissalicylaldiminecopper(II) complexes.

Mossbauer spectroscopy (MB)

Applications to metal carbonyls [$Fe(CO)_5$, $Fe_2(CO)_9$ and $Fe_3(CO)_{12}$] – nitrosyls (sodium nitroprusside) – Tin complexes – Characterization of magnetic state.

UNIT V: ANALYTICAL METHODS IN CHEMISTRY

Coulometry, amperometry and cyclic voltammetry - principles and applications. Thermal Characterization techniques, Principle and applications of Differential Thermal Analysis (DTA), Differentials Scanning Calorimetry (DSC) and Thermogravimetric Analysis (TGA) Thermometric titration.

REFERENCE BOOKS:

1. Ajai Kumar, *Organometallic and bioinorganic chemistry*, Aaryush Educations, Ghaziabad, 2014.
2. Bestini, Gray, Lippard, Vlentine, *Bioinorganic chemistry*, 1st South asian Edn, Viva books pvt.ltd. 1980.
3. R Gopalan and V Ramalingam, *Concise Coordination Chemistry*, Vikas Publishing House Pvt Ltd.
4. D.F. Shriver and P.W. Atkins, *Inorganic chemistry*, Oxford University Press, 3rd edition, 1998.
5. L.V. Azaroff , *Introduction to solids*, 1977, TMH edition, Tata. Mc.Graw Hill.
6. R.S. Drago, *Physical methods in Inorganic chemistry*, Affiliated East West press.1965
7. A. Abdul Jameel, *Application of Physical methods to Inorganic compounds*, JAN publications, Tiruchirappalli, 2nd edition-2012.
8. H.K.Keer. *Principles of solid state*, New Age International Pvt.Ltd, New Delhi. 2005.
9. James E. Huheey, *Inorganic Chemistry, Principles of structure and Reactivity*, Dorling Kindersely (India) Pvt Ltd, IVth Edition, 2007.
10. J.D.Lee, *Concise Inorganic Chemistry*, ELBS, Chapman and Hall Londen ,Vth edition., 2006.
11. VOGEL's Text book of *Quantitative Chemical Analysis*. G.H. Jeffery, J. Bassett, J. Mendnam and R.C. Denney. Addison-Wesley Longman Inc. Fifth edition – 1989.
12. Douglas A.Skoog and M. Donald, *Fundamentals of Analytical Chemistry*, Harcourt Asia (P) Ltd, Asia 7th edition, 1995.
13. B.K. Sharma, *Instumental techniques for analytical Chemistry*, Editor – Prentice Hall Inc . 1997.
14. Willard, H.H., Merit L.L., Dean J.A Seattle F.L., *Instrumental Methods of Analysis*, CBS publishing and Distribution, 2004.
15. Gray.D.Christian, P.K.Dasgupta, K.A.Schug. *Analytical chemistry*, John Wiley and sons publishing. 2014.
16. G.R.Chatwal, S.K.Anand. *Instrumental Methods of Chemical Analysis*, 5th Edition, Himalaya Publishing House, 2005.
17. A.K. Srivastava, P.C Jain. *Instrumental Approach to Chemical Analysis*, 4th Edition , S Chand and Company Ltd, New Delhi, 2012.

Core:

DEPARTMENT OF CHEMISTRY

Programme: M.Sc. Chemistry, (CBCS and Outcome Based Education (OBE)

(For those students admitted during the Academic Year 2019-20 and after)

PART – III **: Core Theory**		SEMESTER **- IV**
Course Title: **Physical Chemistry - IV**		
Course Code: 33CT43	Hours per week: 5	Credits: 4
CIA Marks: 25	ESE Marks: 75	Total Marks: 100

Preamble

This course is offered for the II year students to provide a strong foundation on concepts and theories of Physical chemistry. It also helps the students to understand the concept.

Course Outcomes (CO)

On the successful completion of the course, students will be able to

No.	Course Outcome	Knowledge Level (according to Bloom's Taxonomy)
CO 1	To explain the basic idea of the electrochemistry	K1,K2,K3& K4
CO 2	List the principles and applications of the electrochemistry.	K1,K2,K3& K4
CO 3	To explain concept of statistical thermodynamics.	K1,K2,K3& K4
CO 4	Point out the derivation of statistical thermodynamics.	K1,K2,K3& K4
CO 5	To analyze the polymer chemistry.	K1,K2,K3& K4

K1-knowledge K2-Understand K3-Apply K4 – Analyzing

Mapping of CO with PO

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**
CO 1	9	1	3	1	3	1	3
CO 2	9	1	3	1	3	1	3
CO 3	9	1	3	1	3	1	3
CO 4	9	1	3	1	3	1	3
CO 5	9	1	3	1	3	1	3
Weightage of the course	45	5	15	5	15	5	15

9-Strong; 3-Medium; 1-Low

Mapping of CO with PSO

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO 1	9	9	3	3	3
CO 2	9	9	3	3	3
CO 3	9	9	3	3	3
CO 4	9	9	3	3	3
CO 5	9	9	3	3	3
Weightage of the course	45	45	15	15	15

9-Strong; 3-Medium; 1-Low

Syllabus

UNIT I: ELECTROCHEMISTRY- I

Electrode,electrolyte interfaces, polarisable and non-polarisable interfaces, structure of electrical double layer. Electro capillary and double layer capacity measurements, double layer models, Helmholtz, Guoy–Chapman and Stern models, specific adsorption of ions and molecules.

Kinetics of electrode process, current–potential curves, Butler–Volmer relation and its approximations, Tafel relation, charge transfer resistance, Nernst equation from Butler – Volmer equation, electro catalysis.

UNIT II: ELECTROCHEMISTRY – II

Over voltage, theories of overvoltage – bubble formation, combination of atoms, ion discharge, proton transfer - applications of overvoltage. Principles, instrumentation and applications of polorography. Principles, instrumentation of cyclicvoltametry - general discussion of the cyclicvoltammograms of one electron reversible process (potassium ferrocyanide/potassium ferricyanide), irreversible one electron transfer process and quasireversible reactions. Hydrogen-Oxygen fuel cell.

UNIT III: STATISTICAL THERMODYNAMICS - I

Aim of statistical thermodynamics, definition of state of a system, ensembles, and micro ensembles, micro-canonical and canonical. Boltzmann distribution law and its derivation, population inversion, absolute negative Kelvin temperature. Boltzmann-Planck equation, partition functions, thermodynamic properties from partition function and equilibrium constant.

UNIT IV: STATISTICAL THERMODYNAMICS - II

Quantum statistics, Fermi-Dirac and Bose-Einstein statistics, photon gas, electron gas according to such statistics, Heat capacity of diatomic gases including hydrogen molecule, Einstein's and Debye's theories of heat capacities of solids.

UNIT V: POLYMERS

Introduction , structures of polymers. Kinetics and mechanisms of polymerization - free radical, ionic and Coordination polymerization , Zeigler–Natta catalysis – condensation polymerization - degree of polymerization, chain length – copolymerization – determination of molecular weight – light scattering, viscosity methods. Process of polymerization – bulk solution, suspension and emulsion polymerization. Polymer additives –use of fillers in plastics- conducting polymers.

Text Books

1. Bockris and Reddy, *Electrochemistry, Vol I and II,* Rosetta edition.2002
2. Kuriacose and Rajaram, J. *Thermodynamics,* Shoban Lal Nagin Chand.1993
3. Gowariker, V.R. Viswanathan N.V. and *Jeyadev Sreedhar Polymer science, Wiley,*1986

REFERENCES

1. Glasstone, Von Nostrand *Introduction to electrochemistry,* 1993
2. Crow, *Principles and applications of Electrochemistry,* Chapman and Hall.1988
3. Castellan, Addision Wesley *Physical chemistry,* ,1983
4. Hill, Addision–Wesley. *Introduction to statistical thermodynamics*, 3rd Ede,.1983
5. Walter J. Moore, Orient Longmans. *Physical chemistry*, V Edition - 1976
6. Daniels and Alberty, *Physical chemistry* John Willey and sons.1993
7. Billmeyer. JV., Wiley. *Textbook of polymer science* 1984
8. Allcock and P.W. Lampc, Prentice Hall, *Contemporary polymer chemistry* 1981

Elective:

DEPARTMENT OF CHEMISTRY

Programme: M.Sc. Chemistry, (CBCS and Outcome Based Education (OBE)

(For those students admitted during the Academic Year 2019-20 and after)

PART – III **: Elective Theory**		SEMESTER **-IV**
Course Title: **Chemistry for Nationality Eligibility Test**		
Course Code: 33EP4B	Hours per week:5	Credits: 5
CIA Marks: 25	ESE Marks: 75	Total Marks: 100

Preamble

Students are enabled to

- The students will be trained to face entrance examinations for admission towards Research and also to compete the entrance examinations conducted by CSIR,TNPSC, SET, GATE and private industries.

Course Outcomes (CO)

On the successful completion of the course, students will be able to

No.	Course Outcome	Knowledge Level (according to Bloom's Taxonomy)
CO 1	To develop the basic knowledge in Organic chemistry in the following topics like IUPAC nomenclature, aromaticity, stereochemistry, common organic reactions, synthesis and their mechanisms	K2 and K3
CO 2	To understand usage of the selected naming reactions, organic rearrangements, some important catalysts and specific synthetic reagents in the organic synthesis	K2 and K3

CO 3	To describe the important concepts like chemical periodicity, main group elements, inner transition elements and organometallic compounds in Inorganic chemistry in Inorganic chemistry.	K2 and K3
CO 4	To apply the outcome of the analytical techniques for the characterization of organic and inorganic compounds	K2, K3 and K4
CO 5	To create the strong basic ideas in selected physical chemistry topics like quantum mechanics, group theory, thermodynamics, electrochemistry, chemical kinetics, catalysis, colloids & surfaces and polymer chemistry	K2 and K3

K1-Knowledge; K2-Understand; K3-Apply; K4-Analyzing

Mapping of CO with PO

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**
CO 1	9	1	3	3	3	1	3
CO 2	9	1	3	3	3	1	3
CO 3	9	1	3	3	3	1	3
CO 4	9	1	3	3	3	1	3
CO 5	9	1	3	3	3	9	3
Weightage of the course	45	5	15	15	15	13	15

9-Strong; 3-Medium; 1-Low

Mapping of CO with PSO

	PSO 1	**PSO 2**	**PSO 3**	**PSO 4**	**PSO 5**
CO 1	9	1	1	1	3
CO 2	9	3	9	1	3
CO 3	3	1	1	1	1
CO 4	3	1	9	9	1
CO 5	9	3	3	3	3
Weightage of the course	33	9	23	15	11

9-Strong; 3-Medium; 1-Low

UNIT I

IUPAC nomenclature: IUPAC nomenclature of organic molecules including regio- and stereoisomers

Aromaticity: Benzenoid and non-benzenoid compounds – generation and reactions

Organic reactive intermediates: Generation, stability and reactivity of carbocations, carbanions, free radicals, carbenes, benzynes and nitrenes

Principles of stereochemistry: Configurational and conformational isomerism in acyclic and cyclic compounds – stereoselective, stereospecific, regioselective and regiospecific reactions – asymmetric synthesis – homotopic, enantiotopic and diastereotopic atoms, groups and faces

Reaction Mechanisms: Basic mechanistic concepts – kinetic *versus* thermodynamic control, Hammond's postulate and Curtin-Hammett principle – nucleophilic and electrophilic substitution reactions – addition reactions to carbon-carbon multiple bonds

Organic Synthesis: Carbon-carbon bond formation: Heck, Suzuki, Stille and Sonogoshira – retrosynthesis, disconnection, synthons, linear and convergent synthesis, umpolung of reactivity, protecting and deprotecting groups, carbon-carbon bond forming reactions through enolates (including boron and silicon enolates), enamines and silyl enol ethers – Michael addition reaction – stereoselective addition to C=O groups.

UNIT II

Common named reactions, rearrangements, catalysts and reagents

Pericyclic Reactions and Photochemistry: Electrocyclic, cycloaddition and sigmatropic reactions – orbital correlations – FMO and PMO treatments – photochemistry of alkenes, arenes and carbonyl compounds – Norrish type I and II reactions – Paterno-Buchi reaction – photooxidation and photoreduction – di-π-methane rearrangement – Barton reaction.

Heterocyclic Compounds: Structure, preparation, properties and reactions of furan, pyrrole, thiophene, pyridine, indole, quinoline and isoquinoline.

Chemistry of Natural Products: Carbohydrates, proteins and peptides, fatty acids, nucleic acids, terpenes, steroids and alkaloids

Spectroscopy: Applications of UV-Visible, IR, NMR and Mass spectrometry in the structural determination of organic molecules.

UNIT –III

Chemical periodicity: Structure and bonding in homo- and heteronuclear molecules, including shapes of molecules (VSEPR Theory) - Various Concepts of acids and bases.

Main group elements and their compounds: Allotropy, synthesis, structure and bonding, industrial importance of the compounds. Transition elements and coordination compounds: structure, bonding theories, spectral and magnetic properties, reaction mechanisms.
Inner transition elements: spectral and magnetic properties, redox chemistry, analytical applications.

Organometallic compounds: synthesis, bonding and structure, and reactivity. Organometallics in homogeneous catalysis.Cages and metal clusters.

UNIT –IV

Analytical chemistry: separation, spectroscopic, electro- and thermoanalytical methods.

Bioinorganic chemistry: photosystems, porphyrins, metalloenzymes, oxygen transport, electron- transfer reactions; nitrogen fixation, metal complexes in medicine.

Characterisation of Inorganic compounds by IR, Raman, NMR, EPR, Mössbauer, UV-vis, NQR, MS, electron spectroscopy and microscopic techniques.

Nuclear chemistry: nuclear reactions, fission and fusion, radio-analytical techniques and activation analysis.

UNIT –V

Basic principles of quantum mechanics: Schrodinger Equation- Particle in a 1D box- Harmonic Oscillator-.Variational and perturbational methods

Chemical applications of group theory: Point group- Character tables- -reducible and irreducible representations and Applications. Basic principles and application of spectroscopy – rotational, vibrational, electronic, Raman, ESR, NMR.

Chemical thermodynamics: Various Law, state and path functions and their applications-Maxwell's relations; spontaneity and equilibria; temperature and pressure dependence of thermodynamic quantities; Le Chatelier principle; elementary description of phase transitions; phase equilibria and phase rule; thermodynamics of ideal and non-ideal gases, and solutions.

Statistical thermodynamics: Boltzmann distribution; kinetic theory of gases; partition functions and their relation to thermodynamic quantities – calculations for model systems.

Electrochemistry – Nernst equation, electrode kinetics, electrical double layer, Debye-Hückel theory. Kohlrausch's law and its applications.

Chemical kinetics: empirical rate laws, Arrhenius equation, theories of reaction rates, determination of reaction mechanisms, experimental techniques for fast reactions.

Catalysis: Homogenous and Heterogeneous catalysis - Hammett acid-base catalysis - rate of acid and base catalysis - Enzyme catalysis.

Colloids and surfaces: Stability and properties of colloids; isotherms and surface area. Solids - structural classification of binary and ternary compounds, diffraction techniques, bonding, thermal, electrical and magnetic properties.

Polymer chemistry: Molecular weights and their determinations. Kinetics of chain polymerization.

REFERENCE BOOKS:

1. Clayden, J., Greeves, N., Warren, S., Wothers, P., *Organic Chemistry*, 2nd Ed., Oxford University Press, 2014.
2. Carruthers, W and Coldham, I., *Modern Methods of Organic Synthesis*, 4th Ed., Cambridge University Press, 2006.
3. Francis A. Carey, Richard J. Sundberg, *Advanced Organic Chemistry, Part-A: Structure and Mechanism*, 5th Ed., Springer, New York, 2008.

4. Smith, M.B. and March, J., *Advanced Organic Chemistry: Reactions, Mechanisms, and Structure*, 6th Ed., Wiley, 2007
5. Eliel, E.L., and Wilen, S.H., *Stereochemistry of Organic Compounds*, 1st Ed., John Wiley and Sons, 1994
6. Kalsi, P.S., Stereochemistry , conformation and mechanism, IV th edition Wiley Eastern Ltd 2006.
7. Nasipuri, D., StereoChemistry of organic compounds, Principles and application, IInd edition.. Wiley Eastern Ltd., 2006.
8. Pavia, D.L., Lampman, G.M., and Kriz, G.A., *Introduction to Spectroscopy*, 4th Ed., Cengage Learning, 2009.
9. Mukheriji, S.M. and Singh, S.P., *Reaction Mechanism in Organic Chemistry*, 3rd Ed., Macmillan India Ltd, 1998.
10. Jagdamba Singh and Jaya Singh, *Photochemistry and Pericyclic Reactions*, 3rd Ed., New Age International Publishers Ltd., New Delhi, 2012.
11. Finar, I.L., *Organic Chemistry, Volume 2: Stereochemistry and the Chemistry Natural Products*, 5th Ed., Pearson, 2002.

Inorganic chemistry:

1. Tarr, D.A., Miessler, G.L., Inorganic Chemistry, vth edition, 2013.
2. Huheey, J.E. Inorganic Chemistry: Principles Of Structure And Reactivity 4th Edition, Pearson Education, 2007.
3. Shriver, D.F., Atkins, P.W., Inorganic Chemistry, 1st Edition - Oxford University Press, 1993.
4. Jeffery, G.H., Bassett, J., Mendnam, J., Denney, R.C. VOGEL's Text book of Quantitative Chemical Analysis, 5th edition, Addison-Wesley Longman Inc, 1989.
5. Douglas, A. S., Donald, M. Fundamentals of Analytical Chemistry, 7 th Edition, Harcourt Asia (P) Ltd, Asia, 1995.
6. Sharma, B.K., Instumental techniques for analytical Chemistry, Editor – Prentice Hall Inc, 1997.

Physical chemistry:

1. Glasstone, Von Nostrand., Introduction to electrochemistry, 1993.
2. Bockris and Reddy., Electrochemistry, Vol I and II, Rosetta edition., 2002.
3. Crow, Chapman and Hall., Principles and applications of Electrochemistry, 1988.
4. Kuriacose and J. Rajaram, Shoban Lal Nagin Chand.,Thermodynamics, 1993.
5. Castellan, Addision Wesley., Physical chemistry, 1983.

6. Hill, Addision–Wesley., Introduction to statistical thermodynamics, 3rd Edition, 1983.
7. Walter J. M., Orient Longmans., Physical chemistry, 5th Edition, 1976.
8. Daniels and Alberty, John Willey and sons., Physical chemistry, 1993.
9. Billmeyer. J.V., Textbook of polymer science, Wiley. 1984.
10. Allcock and Lampc, P.W., Contemporary polymer chemistry, Prentice Hall, 1981.
11. Gowariker, V.R., Viswanathan N.V., and Jeyadev Sreedhar., Polymer science, Wiley,1986.