ST. MARY'S COLLEGE (Autonomous)

(Re-accredited with 'A^{+}' Grade by NAAC)

Thoothukudi-628001, Tamil Nadu

(Affiliated to Manonmaniam Sundaranar University)

Syllabus

M.Sc. Chemistry

School of Physical Sciences

Outcome Based Curriculum

(W.e.f.2019)

Preamble

M.Sc. Chemistry program provides broad foundation in chemistry to the students in doing analyses and in solving analytical problems. The students will gain the integrating knowledge to apply in a variety of discipline.

Vision:

To enhance the knowledge of students and mould them for a better future.

Mission:

- To create sound knowledge of chemistry.
- To make the students to understand the life-time applications in chemistry.
- To enrich the subject related skills of the students and apply the same in their life.

Programme Outcome:

PO No.	At the end of the M.Sc. Program, the students will be able to
PO-1	obtain in-depth and detailed functional knowledge of the fundamental theoretical concepts and experimental methods in Science
PO-2	understand their subject areas more clearly and develop skills to critically reflect upon the theory they learn.
PO-3	adopt the scientific methods and hypothesis testing in designing and execution of experiments.
PO-4	think critically, work independently and focus in research oriented activities.
PO-5	inculcate an ability to engage in life-long learning to improve professional competency.
PO-6	extend and understand the impact of science on society.
PO-7	apply their professional ability for entrepreneurship and self employment.
PO-8	understand and commit to professional ethics and social responsibility.

Course structure (w.e.f. 2019)

Semester - I

Subject	Subject code	Title of the paper	Contact Hours/ week	Credits	Max. marks		
					CIA	ESE	Total
Core I	19PCHC11	Inorganic Chemistry - I	5	4	40	60	100
Core II	19PCHC12	Organic Chemistry - I	5	4	40	60	100
Core III	19PCHC13	Physical Chemistry - I	4	4	40	60	100
Elective I	19PCHE11	A.Denova Designs in Chemistry B. Chemical Instrumentation	4	4	40	60	100
Core Practical I	19PCHCR1	Inorganic Chemistry Practicals - I	4				
Core Practical II	19PCHCR2	Organic Chemistry Practicals - I	4				
Core Practical III	19PCHCR3	Physical Chemistry Practicals - I	4				
			30	**16**			

Semester - II

Subject	Subject code	Title of the paper	Contact Hours/ week	Credits	Max. marks		
					CIA	ESE	Total
Core IV	19PCHC21	Inorganic Chemistry - II	5	4	40	60	100
Core V	19PCHC22	Organic Chemistry - II	5	4	40	60	100
Core VI	19PCHC23	Physical Chemistry - II	4	4	40	60	100
Elective II	19PCHE21	A. Energy and Environmental Chemistry B.Industrial Chemistry	4	4	40	60	100
Core Practical I	19PCHCR1	Inorganic Chemistry Practical - I	4	4	40	60	100
Core Practical II	19PCHCR2	Organic Chemistry Practical - I	4	4	40	60	100
Core Practical III	19PCHCR3	Physical Chemistry Practical - I	4	4	40	60	100
			30	**28+2**			

It is mandatory for students to complete one MOOC during the first year of study. (19PCHM21) 2 credits

Semester - III

Subject	Subject code	Title of the paper	Contact Hours/ week	Credits	Max. marks		
					CIA	ESE	Total
Core VII	19PCHC31	Inorganic Chemistry - III	5	4	40	60	100
Core VIII	19PCHC32	Organic Chemistry - III	5	4	40	60	100
Core IX	19PCHC33	Physical Chemistry - III	4	4	40	60	100
Core X	19PCHC34	Research methodology	4	4	40	60	100
Core Practical IV	19PCHCR4	Inorganic Chemistry Practical – II	4				
Core Practical V	19PCHCR5	Organic Chemistry Practical - II	4				
Core Practical VI	19PCHCR6	Physical Chemistry Practical – II	4				
Self Study Course/ MOOC/ Internship	19PCHSS1/ 19PCHM31 /19PCHI31	Chemistry for National Eligibility Test	-	+2			
			30	**16+2**			

Semester - IV

Subject	Subject code	Title of the paper	Contact Hours/ week	Credits	Max. marks		
					CIA	ESE	Total
Core XI	19PCHC41	Inorganic Chemistry - IV	4	4	40	60	100
Core XII	19PCHC42	Organic chemistry - IV	4	4	40	60	100
Core XIII	19PCHC43	Physical Chemistry - IV	4	4	40	60	100
Core Practical IV	19PCHCR4	Inorganic Chemistry Practical - II	4	4	40	60	100
Core Practical V	19PCHCR5	Organic Chemistry Practical - II	4	4	40	60	100
Core Practical VI	19PCHCR6	Physical Chemistry Practical – II	4	4	40	60	100
Project	19PCHP41	Project	6	6	40	60	100
			30	**30**			

Master of Science (Chemistry)

Components	Credit per Semester	No. of Courses	Total Credits	Extra Credits
Core	4	13	52	
Practical	4 (Non-Semester)	6	24	
Core Elective	4	2	8	
Project	6	1	6	
MOOC	2	1		+2
Self Study Course/MOOC/ Internship	2	1		+2
			90	**+4**

Program Specific Outcome:

PSO No.	Students of M. Sc. Chemistry will be able to
PSO 1	gain complete knowledge about all fundamental aspects and the importance of the elements of chemistry.
PSO 2	understand the background of organic reaction mechanisms, complex chemical structures, molecular rearrangements and separation techniques.
PSO 3	appreciate the coordination chemistry and structure of molecules, properties of compounds, structural determination of complexes using theories and instruments.
PSO 4	gather attention about the physical aspects of atomic structure, dual behaviour, reaction pathways with respect to time, various energy transformations, molecular assembly in nano-level, significance of electrochemistry, molecular segregation using their symmetry.
PSO 5	learn about the potential uses of analytical, industrial and green chemistry.
PSO 6	demonstrate the ability to synthesise, separate and characterize the compounds using published reactions, protocols, standard laboratory equipments by eco-friendly chemical processes.
PSO 7	broaden their professional foundations through various activities.
PSO 8	get enormous job opportunities at all level of chemical, pharmaceutical, food products, life oriented material industries.

Semester – I			
Core I	**Inorganic Chemistry - I**		
Code : 19PCHC11	**Hrs / Week : 5**	**Hrs / Sem : 75**	**Credits : 4**

Vision:

To impart the students with basic principles and concepts in chemistry.

Mission:

- To understand the atomic structure and periodical properties of elements.
- To explain the various concepts of acids and bases.
- To know the basics of organometallic chemistry.
- To demonstrate the principle and applications of IR, Raman and Mossbauer spectroscopies.

Course Outcome:

CO No.	Upon completion of this course, students will be able to	PSO addressed	CL
CO - 1	explain about the electronic configuration, orbital stability and the reactivity	1,3	Ap
CO - 2	discuss the periodic properties of the elements	1,7	An
CO - 3	demonstrate the theories of VSEPR, Valance bond and Molecular Orbital.	1,8	Ap
CO - 4	point out Arrhenius, Bronsted - Lowry and Lewis theories of acids and bases.	2,3	Cr
CO - 5	compare the chemistry of Non-aqueous solvents such as liquid ammonia, Liquid hydrogen fluoride, Liquid Sulfur dioxide .	1,3	An
CO - 6	synthesis and discuss reactivity of metal alkyls, carbenes, carbynes, carbides, alkenes, alkynes, and arene complexes	2,3	Cr
CO - 7	predict the number of active modes of vibrations in IR and Raman spectroscopy.	2,6	Un
CO - 8	interpret the Mossbauer spectra of Iron and Tin complexes.	2,5	Ev

Semester – I			
Core I	**Inorganic Chemistry - I**		
Code : 19PCHC11	**Hrs / Week : 5**	**Hrs / Sem : 75**	**Credits : 4**

Unit I Periodic properties and Ionic Bonding

Periodic properties of elements - Ionic radii, ionization potential, electron affinity, electronegativity, Bond lengths, bond strength, bond angles, bond order, bond energies and lattice energy.

Chemical bonding - Ionic Bond - Properties of ionic substances - Lattice energy - Born-Haber cycle - Size effect: Ionic Radii - Factors affecting radii of ions - Covalent character predominantly in ionic bonds - Polarization - Fajan's rule - Results of polarization. Oxidation reduction reactions - The use of Reduction potentials to predict: Oxidising reducing species, Stability and elements having several oxidation states.

Unit II Molecular structure and Bonding

Lewis electron dot diagrams - Hybridization, Octet rule - Resonance VSEPR theory - Walsh diagram (H_2O) - Bent's rule – Apicophilicity - Valence bond theory - MO theory of homo and heteronuclear diatomic molecules and poly atomic molecules (O_2, N_2, CO, HCl and $BeCl_2$) - Geometrical isomerism - Fluxionality - Types of chemical bonds (weak and strong) - Intermolecular forces.

Unit III Acids and Bases

Acid-base theories - Arrhenius, Bronsted- Lowry theory, Factors affecting strength of acids and bases - Lewis theory - Catalytic behavior of acids and bases - The Hard soft interaction principle (HSIP), Proton affinity.

Non-aqueous solvents - Chemistry in liquid ammonia, liquid hydrogen fluoride, liquid sulfur dioxide - Super acids.

Unit IV Organometallic chemistry I

16 and 18 electron rules, synthesis, structure and bonding in mono and polynuclear metal carbonyls, carbonylate ions, carbonyl hydride complexes - Isolobal fragments - Synthesis and reactivity of metal alkyls, carbenes, carbynes, carbides, alkenes, alkynes, and arene complexes - Metallocenes and bonding in metallocenes.

Unit V Spectroscopy I

IR and Raman: Selection rules - Predicting number of active modes of vibrations - Applications of IR and Raman in the study of inorganic structures and coordination compounds - Application of isotopic substitution, detection of intra and intermolecular hydrogen bonding.

Mossbauer: Principle, conditions for Mossbauer spectroscopy - Isomer shift - Quadrupole interactions - Magnetic interactions - Interpretation of spectra of iron ($Na_2Fe(CN)_6$, $Fe(CO)_5$, $Fe_2(CO)_9$) and tin ($(C_6H_5)_3SnX$) compounds.

Text Books:

1. James E.Huheey, Ellen.A. Keiter and Richard .L. Keiter, Inorganic Chemistry: Principles of Structure and Reactivity, Harper Collins College Publishers, 4th Edition, 1993.
2. Skoog D.A, West D.M, Holler F.J, Grouch S.R., Fundamentals of Analytical Chemistry, Thomson Asia Pvt. Ltd., Eighth Edition, Third Reprint, 2005.
3. Shriver D.F., Atkins P.W. and Langford C.H., Inorganic chemistry, ELBS, Oxford University Press, 1994.

Books for Reference:

1. Lee J.D., Concise Inorganic Chemistry, Blackwell Science Ltd., 5th Edition, 2003.
2. Albert Cotton F., Geoffrey Wilkinson, Carlos. A.Manic and Manfred Bochman, Advanced Inorganic Chemistry, Wiley Interscience Publication, 6th Edition, 1999.
3. James E. House Inorganic chemistry, Elsevier Publications, 2008.
4. Purcell K.F. and Kotz J.C, Inorganic Chemistry, WB Saunders Company, Philadelphia, 1977.
5. Drago R.S., Physical Methods in Inorganic Chemistry, WB Saunders Company, 3rd Edition, 1977.
6. Ebsworth David E.A.V., Rankin Stephen Credock W.H., Structural Methods in Inorganic Chemistry, ELBS, IV, 1988.

Semester – I			
Core II	**Organic Chemistry - I**		
Code : 19PCHC12	**Hrs / Week : 5**	**Hrs / Sem : 75**	**Credits : 4**

Vision:

The department values teaching and research as equal and essential components of the education of our students and seeks to integrate research with teaching at every possible opportunity in the curriculum.

Mission:

- To acquire excellence in Organic Chemistry
- To comprehend the various factors that operate in organic reactions.
- To appreciate the stereochemical aspects of a reaction.

Course Outcome:

CO No.	Upon completion of this course, students will be able to	PSO addressed	CL
CO - 1	simulate the nomenclature of different compounds	1, 7	Ev
CO - 2	illustrate the basic of aromaticity	5	Un
CO - 3	apply Huckel's 4n+2 electron rule for benzene and non benzenoid aromatic compounds.	6	Ap
CO - 4	understand the various types of aliphatic nucleophilic substitution reactions	5	Un
CO - 5	explain neighbouring group participation in aliphatic electrophilic substitution.	5	Ap
CO - 6	explain the generation, detection, structure, stability and reactions of carbocations, carbanions, carbenes, nitrenes and free radicals	6	Ap
CO - 7	learn the concept of stereochemistry and its importance	7	Re
CO - 8	identify the stereochemistry notations	1,7	Ap

Semester – I			
Core II	**Organic Chemistry - I**		
Code : 19PCHC12	**Hrs / Week : 5**	**Hrs / Sem : 75**	**Credits : 4**

Unit I Nomenclature of the Organic Compounds

Anatomy of IUPAC name of the compound- Mnemonic- Several functional groups and names in IUPAC nomenclature- nomenclature of alicyclic compounds- Polycyclic compounds- aromatic compounds- Monosubstituted benzene compounds- Fused ring polycyclic aromatics- Annulenes- Ansa, cyclophanes, Biphenyls, Allene and helix - Inclusion compounds- Cage or clathrates compounds- Heterocyclic compounds- Homomers-compounds having two or more functional groups- Construction of the structural formula from IUPAC name.

Unit II Aromaticity and Ring System

Aromatic character – Huckel's rule – Aromatic, Antiaromatic and Non aromatic – Molecular orbital description of aromaticity, antiaromaticity and homoaromaticity - Aromatic and antiaromatic ions – Alternate and Non-alternate hydrocarbons - Antiaromatic compounds – Paratopic compounds - Aromaticity of azulene - Tropones – Annulene - Higher annulenes - Fullerenes – Sydnones – Structure, stereochemistry and synthesis of Adamantane, Diamantane and Cubane.

Unit III Aliphatic Nucleophilic and Electrophilic Reactions

Aliphatic Nucleophilic Substitution: S_N1 S_N2 and S_Ni mechanisms - Effect of substrate structure, effect of leaving group, effect of attacking nucleophile and effect of the reaction medium- Neighbouring group participation - substitution at vinylic and allylic carbons and reactivity - Ambient nucleophiles and Ambient substrates - Hydrolysis of esters.
Electrophilic substitution – SE_1 and SE_2 mechanism - Effect of substrate structure, effect of leaving group and effect of leaving group.

Unit IV Reactive Intermediates and Rearrangements

Carbenes - Generation, stability, structure, reactions and stereochemistry of carbenes - Wolff rearrangement and its synthetic applications.

Nitrenes - Generation, stability, reaction of nitrenes - Mechanism of rearrangements through Nitrene intermediate – Schmidt rearrangement - Hoffmann rearrangement.

Carbanion - Mechanism of rearrangements involving carbanion as intermediate - Steven, Sommelet-Hauser and Favorskii rearrangements.

Arynes - Generation, Structure, Stability, reactions and trapping of arynes – Cine substitution.

Free radicals - Generation, Stability, reactions and mechanism of rearrangement through free radical intermediate - Sandmeyer, Gomberg reactions.

Unit V Stereochemistry

Molecular symmetry and Chirality - Stereoisomerism- Classification- Stereoisomerism, Conformation and Chirality- Configurational nomenclatures of acyclic and cyclic molecules - Cis- Trans; E-Z ; D-L; R-S; erythro and threo; syn and anti; endo and exo.

Stereoisomerism - Principles of axial chirality - Stereochemistry of allenes and spiranes and analogues, Atropisomerism in compounds other than biphenyls- Stereochemistry of Ansa compounds. Helicity - Topicity of ligands and faces - Homotopic ligands and faces - Enantiotopic ligands and faces - Diastereotopic ligands and faces. Racemisation methods of Resolution- Mechanisms of racemization through carbocations and free radicals - Methods of resolution.

Text Books:

1. Tnaya Das, Amalendu Banerjee, Nomenclature of the organic compounds for the beginners, New Central Book Agency, 2013.
2. Ahluwalia V.K and Parshar R.K, Organic Reaction Mechanism, Fourth Edition, Narosa Publishing House, 2013.
3. Mukherjee K.S, Mechanism of Organic reactions, Books and Allied Ltd, Kolkota, 2010.
4. Kalsi P S, Organic Reaction & Mechanism, 4th Edition, New Age International Publishers, New Delhi 2011.
5. Raj K Bansal, Organic reaction mechanism, 4th edition, New Age international publishers, New Delhi, 2012.
6. Kalsi P S, Stereochemistry: Conformation and Mechanism, 4th Edition, New-Age International Publishers, New Delhi, 1997.

Books for Reference:

1. March J, Advanced Organic Chemistry, Fourth Edition, John-Wiley and Sons, New York, 1992.
2. Eliel E L, Stereochemistry of Carbon Compounds, Tata-McGraw Hill Publishing Company, New Delhi, 1975.
3. Nasipuri D, Stereochemistry of Carbon Compounds, Third Edition, New-Age International Publishers, New Delhi, 2011.
4. Clayden, Greeves,Warren and Wothers, Organic Chemistry, Oxford University Press, New York, 2006.

Semester – I			
Core III	**Physical Chemistry - I**		
Code : 19PCHC13	**Hrs / Week : 5**	**Hrs / Sem : 75**	**Credits : 4**

Vision

To achieve base knowledge about the concepts of physical chemistry.

Mission

- To solve Schrodinger equations for a particle moving in different dimensions.
- To demonstrate and prepare the polymer molecules by various methods.

Course Outcome:

CO No.	Upon completion of this course, students will be able to	PSO addressed	CL
CO - 1	have a good foundation in understanding the physical and mathematical aspects of quantum mechanics.	1	Un
CO - 2	know the limitations of quantum chemistry and classical thermodynamics in the evaluation of macroscopic properties.	4	An
CO - 3	apply the approximation methods to different atoms and find the dissociation energy and bond order for various molecules by applying Huckel molecular orbital theory.	7	Ap
CO - 4	discuss in detail about partial molar properties.	1	Ap
CO - 5	explain different types of methods of preparation of polymers.	6	Un
CO - 6	prepare the polymer molecule and determine the molecular weight of polymer.	6	Cr
CO - 7	classify the molecules according to their moment of inertia.	1	An
CO - 8	explain the fundamentals of molecular spectroscopy.	4	Un

Semester – I			
Core III	**Physical Chemistry - I**		
Code : 19PCHC13	**Hrs / Week : 4**	**Hrs / Sem : 60**	**Credits : 4**

Unit I Quantum Chemistry – I

Limitations of classical mechanics – Schrodinger equation - Postulates of quantum mechanics - Operators and their algebra - linear operator, Hermitian operators - Eigen functions and Eigen values - Schrodinger equations (Time dependent and Time independent) – Particle in a box (1D and 3D) - Hydrogen atom - Rigid rotor and simple harmonic oscillator - Quantum mechanical tunneling.

Unit II Quantum Chemistry – II

Pauli exclusion principle - Slater determinant – Approximation methods - Variation theorem - Application of variation method to helium atom - Perturbation theory (First order) - Application to helium atom - Hartree Fock Self consistent field method (HF-SCF) to helium atom - Born-Oppenheimer approximations – MO and VB treatments of H_2^+ molecular ion and H_2 molecule - Huckel Molecular Orbital theory - Application to ethylene, butadiene and benzene.

Unit III Thermodynamics

Concepts of partial molar properties – Partial molar free energy, chemical potential, partial molar volume and its significance - Gibbs-Duhem equation - Gibbs-Duhem-Margulus equation - Determination of partial molar volume - Graphical method, intercept method and apparent molar volume method. Concept of fugacity - Determination of fugacity by graphical method and compressibility factor method - Concept of Activity and activity coefficient - Determination of activity and activity coefficients for non-electrolytes.

Unit IV Polymer Chemistry

Polymerization in homogeneous and heterogeneous phases – Kinetics and mechanism of addition polymerization (Free radical and cationic) and condensation – Kinetics of copolymerization – Molecular weights – Distribution and methods of determination - light scattering, ultracentrifuge, viscosity, osmometry and gel permeation chromatography. Conducting polymers - Factors affecting the conductivity of conducting polymers - Doping of conducting polymers - solitons , polarons and bipolarons.

Unit V Rotational Spectroscopy

Electromagnetic radiation - Quantization of energy - rotational, vibrational, and electronic energy levels and transitions in molecules - Regions and representation of spectra – Width of spectral lines - Collision broadening, Doppler broadening, Heisenberg uncertainty principle - Intensity of spectral lines - Transition probability - Diatomic molecules as rigid rotors - Rotational energy levels, intensity of spectral lines, selection rules - Effect of isotopic

substitution - Diatomic molecules as non-rigid rotors - Rotational transitions - Rotational spectra of linear and symmetric top polyatomic molecules.

Text Books:

1. A. K. Chandra, Introductory Quantum Chemistry; 4th Ed., Tata McGraw Hill, Noida, 1994.
2. Aruldhas.G., Quantum Mechanics, Prentice Hall of Indian Pvt. Ltd, , New Delhi, 2006.
3. R. K. Prasad, Quantum Chemistry, 4th Ed., New Age International Publishers, New Delhi, 2014.
4. K. Rajaram and J.C. Kuriacose, Thermodynamics for Students of Chemistry, 2nd Edition, S.L.N. Chand and Co, Jalandhar, 1986.
5. C. N. Banwell, Fundamentals of Molecular Spectroscopy, 4th Ed., McGraw Hill Education, Noida, 1994.

Books for Reference:

1. D. A. Mcquarrie, Quantum Chemistry, University Science Books, Sausalito, 2008.
2. I. N. Levine, Quantum Chemistry, 5th Ed., Prentice Hall, New Jersey, 2000.
3. Atkins P W, Molecular Quantum Mechanics, Clarendon, 1973.
4. Anatharaman R, Fundamentals of Quantum Chemistry, McMillan, NewDelhi, 2001.
5. I. N. Levine, Quantum Chemistry, Prentice Hall India, 1994.
6. Moore.W.J, Physical chemistry, Prentice-Hall of India Pvt. Ltd. 1962.
7. Atkins.P.W - Physical chemistry, ELBS edition of third edition, 1987.
8. M. Ladd, Introduction to Physical Chemistry, Cambridge, 1998.
9. S.H. Maron and J.B. Lando, Fundamentals of Physical chemistry, MacMillan Publishers, New York, 1974.
10. J. Rajaram and J. C. Kuriacose, Thermodynamics for Students of Chemistry - Classical, Statistical and Irreversible, Pearson Education, New Delhi, 2013.
11. I.M. Klotz and R.M. Rosenberg, Chemical thermodynamics, 6th Edition, W.A. Benjamin Publishers, California, 1972.
12. G. M. Barrow, Introduction to Molecular Spectroscopy, McGraw Hill, New York, 1964.

Semester – I			
Elective I A	**Denova Designs In Chemistry**		
Code : 19PCHE11	**Hrs / Week : 4**	**Hrs / Sem : 60**	**Credits : 4**

Vision:

To develop better predictability of human pathophysiology and biological pathways underlying specific diseases and train the students to innovate new medicines.

Mission:

- To understand about molecular modelling and drug designing.
- To have depth knowledge about host-guest molecules.
- To create awareness about common diseases and their treatments.

Course Outcome:

CO No.	Upon completion of this course, students will be able to	PSO addressed	CL
CO - 1	formulate molecular dynamics in drug design.	5	Ap
CO - 2	perform docking using Autodock virtual screening and De nova designs.	6,8	Cr
CO - 3	develop recent trends in the synthesis of crown ethers.	6	Cr
CO - 4	design a green method for the synthesis of compounds using twelve principles of Green chemistry.	5,6	Cr
CO - 5	organise C++ programming for the determination of some Chemical properties.	8	An
CO - 6	calculate the delocalisation energy for aromatic system.	4	Ev
CO - 7	acquire knowledge about common diseases due to insects, animals, air and water borne diseases.	1,8	Un
CO - 8	compare different dosage forms of drugs such as solid, semisolid, liquid and gaseous dosage form.	8	An

Semester – I			
Elective I A	**Denova Designs in Chemistry**		
Code : 19PCHE11	**Hrs / Week : 4**	**Hrs / Sem : 60**	**Credits : 4**

Unit I Molecular modelling and Drug designing

Introduction to Molecular modelling - Drug discovery: the Evolution and process - The role of Computer assisted drug design- the process of drug discovery- Bioassay- Lipinski's rule of five. Quantum mechanical simulations - *Ab Initio* methods, Semi Empirical methods- Molecular dynamics in drug design. Docking- types of searching methods in Docking, docking methods, the scoring function, docking using Auto Dock, Virtual screening, De novo design. Cheminformatics - SMILES (Simplified Molecular Input Line Entry Specification) - Applications of Cheminformatics in Drug discovery.

Unit II Supramolecular chemistry

Introduction - Development, Classification - Based on cavity, Based on forces - Recent developments in Supramolecular compounds - Molecular self assembly - Self replicating molecular systems - Molecular self assembly based on hydrogen bond - Metal coordinated self assembly - Catenenes and Rotaxanes - Recent developments in the synthesis of crown ethers - Synthesis of Cryptands - Metal complexes with Crown ethers and Cryptands.

Unit III Green chemistry

Twelve principles - atom economy - Addition and rearrangement reaction, substitution reaction, elimination reaction - Green solvents - Supercritical CO_2, H_2O, Ionic liquids.
Solid state and non solid state microwave assisted reaction – Stille reaction, Suzuki reaction – Krohnke reaction – Hiyama reaction - Sonogashira reaction.

Unit IV Computational chemistry

Introduction - Character set in C++ - Tokens - Keywords, identifiers and constants, variables, operators (Input/Output) - Cascading - Selection of statements - IF, IF …..ELSE, SWITCH, WHILE, DO…..WHILE, FOR, BREAK, CONTINUE and GOTO - Functions - Arrays - Classes - Pointers - Inheritance.

C++ programming for the determination of electronegativity of an atom - Lattice energy using Born - Lande equation - Normality, Molarity and Molality of solutions - Solubility of sparingly soluble salts - Molecular weights of organic compounds - Calculation of delocalisation energy values for aromatic systems.

Unit V Pharmaceutical Chemistry

Introduction - Drugs for common diseases due to insects & animals, Air borne diseases, Water borne diseases, Respiratory diseases & Diseases of the Nervous system - Pharmaceutical Aids - Preservative, Anti oxidants, Sequestrants - Colouring agents, Flavouring agents and

artificial sweetening agents added in drugs. Different dosage forms of Drugs - Solid (Tablet), Semisolid (Paste, Cream), Liquid (Solution, Suspension, Emulsion), Gaseous dosage form.

Text Books:

1. Anand Solomon K, Molecular modelling and Drug Design, MJP publishers, 2016.
2. P.S.Kalsi, J.P.Kalsi, Bioorganic, Bioinorganic and Supramolecular Chemistry, New Age International publishers, Second Edition, 2010.
3. Ramesh Kumari, Computers and their Applications to Chemistry, Narosa Publishing House, New Delhi, Second Edition, 2005.
4. K. V. Raman, Computers in Chemistry, Tata McGraw-Hill Publishing Company Limited, New Delhi, Eighth Edition, 2005.

Books for Reference:

1. S.M. Khopkar, Analytical chemistry of Macrocyclic and Supramolecular compounds, Narosa Publishing House, Delhi, Second edition, 2008.
2. Ahluwalia, V. K and Rajender S. Varma, Green Solvents for Organic synthesis, Narosa Publishing House Pvt. Ltd., 2009.
3. Paul T Anastas, Text Book on Green Chemistry, OUP, 2006.
4. Raghupati Mukhopadhyay, Sriparna Datta, Rajib Kumar Das, Textbook of Pharmaceutical chemistry & Medicinal Chemistry, Books and Allied (P) Ltd, First Edition, 2011.

Semester – I			
Elective I B Chemical Instrumentation			
Code : 19PCHE11	**Hrs / Week : 4**	**Hrs / Sem : 60**	**Credits : 4**

Vision:

To impart the students with basic principles and concepts in Instrumental techniques.

Mission:

- To understand the nature and Choice of methods of measurements.
- To learn the limits of detection and amplification.
- To demonstrate the concepts of Operational amplifiers.

Course outcome:

CO No.	Upon completion of this course, students will be able to	PSO addressed	CL
CO - 1	demonstrate automatic operation and computer control	1,5	Ap
CO - 2	precise control of current and voltage.	6,8	Ap
CO - 3	differentiate modulation and demodulation	5	An
CO - 4	point out limitation on amplifier performance	1	Cr
CO - 5	predict binary logic concepts, logic gates and multi-vibrators	7	Un
CO - 6	distinguish visual, filter and spectrophotometers.	6	Ap
CO - 7	control noise level in a system.	1,7	Cr
CO - 8	interpret the optimal value of adjustable parameters	7,8	Ev

Semester – I			
Elective I B Chemical Instrumentation			
Code : 19PCHE11	**Hrs / Week : 4**	**Hrs / Sem : 60**	**Credits : 4**

Unit I Measurement and Instrumentation

Introduction - The nature of a measurement - Choice of a method of measurement - Control of variables - Basic design patterns - General properties of modules - Propagation of uncertainity - Single channel design - Limit of detection and amplification - Automatic operation and computer control.

Unit II Operational amplifiers

The operational amplifiers - Limitations on amplifier performance - Mathematical operations - Differentiation - Integration - Measurement of current and voltage - Precise control of current and voltage.

Unit III Signal-to-Noise Optimisation

Sensitivity and detection limits - Noise - Minimising Noise in a system - Signal averaging - Modulation: Chopping - Demodulation: Phase sensitive detection - Other methods of Optimising Signal-to-Noise ratio.

Unit IV Digital Electronics

Binary logic concepts - Logic gates - Multivibrators - Counters - Wave shaping - Analog to digital convertors - Instruments and Digital computers.

Unit V Instrumentation for Optical Absorption Spectrometry

Visual Photometres - Filter Photometers - Spectrophotometer - Double beam Spectrophotometer - Recording Spectrophotometers - Optimal value of adjustable parameters - Multiple internal reflection assembly - Rapid scanning spectrometer - Non dispersive Photometers - Photometric titration equipment - Fourier transform Spectrometers.

Text book:

1. Strobel H A, Chemical instrumentation - A systematic approach to Instrumentational analysis, 2nd Edition, Addison- Wesley Publishing company Inc, Phillipines, 1973.

Books for reference:

1. Jeffery G H, Bassett J, Mendham J and Denney R C, Vogels Textbook of Qualitative chemical analysis, 5th Edition, Longman Scientific and technical, Essex, 1989.
2. Skoog D A, Hollar F J, Crouch S R, Principles of Instrumental analysis, 6th Edition, Thompson Brooks/ Cole, Belmont CA, 2007.

Semester – II			
Core IV	**Inorganic Chemistry - II**		
Code : 19PCHC21	**Hrs / Week : 5**	**Hrs / Sem : 75**	**Credits : 4**

Vision:

To promote the advance knowledge about complexes and spectroscopy**.**

Mission:

- To discuss the stability and bonding in Co-ordination compounds.
- To understand the chemistry of inner transition elements.
- To explain the principle and applications of photoelectron and auger spectroscopy.

Course outcome:

CO No.	Upon completion of this course, students will be able to	PSO addressed	CL
CO - 1	judge about the stability and factors affecting the stability of the coordination complexes.	1,2	Ev
CO – 2	catagorise the ligands into strong and weak by Irving William series and the spectrochemical series.	2,3	An
CO - 3	discuss the various features of Valence bond, Crystal field and Molecular orbital theories.	1,7	An
CO - 4	measure Crystal Field Stabilisation Energy (CFSE) (10Dq or Δ_0) of coordination complexes.	4	Ev
CO - 5	summarise the substitution, oxidative addition, reductive elimination, nucleophilic and electrophilic reactions of organometallic complexes.	2,3	Un
CO - 6	compare the properties of elements present in Lanthanides and Actinides.	1,5	An
CO - 7	calculate the Microstates and Term symbols for Transition metal complex.	4,8	Ev
CO - 8	discuss the applications of XPES and UVPES to inorganic spectra.	5,6	An

Semester – II			
Core IV	**Inorganic Chemistry - II**		
Code : 19PCHC21	**Hrs / Week : 5**	**Hrs / Sem : 75**	**Credits : 4**

Unit I Stability of Co-Ordination compounds

Coordination numbers and structures, isomerism- Stability constants of complexes and their determination – Solubility method, Ion exchange method, Job's method and Bjerrum's method –Stabilisation of Unusual oxidation state - Irving William series and the spectrochemical series – Factors affecting stability constant - Chelate and Macrocyclic effect.

Unit II Bonding in Co-ordination compounds

Valence bond theory - Crystal field theory – Crystal Field Stabilisation Energy (CFSE) – Measurement of 10Dq or Δ_0 – Determination of factors affecting magnitude of Δ_0 or 10Dq: geometry of the complex, oxidation state of the central metal ion, principal quantum number of the d-orbital and nature of ligands – Consequences of crystal field splitting: ionic radii of transition metal ions, hydration energy, lattice energy, unusual oxidation states and CFSEs - Spinels and inverse spinels – Jahn-Teller effect - Molecular orbital theory (sigma as well as Pi bonding).

Unit III Organometallic chemistry II

Reactions of organometallic complexes - Substitution, oxidative addition, reductive elimination, nucleophilic and electrophilic displacement of coordinated ligands, Homogeneous Catalysis - Hydrogenation, Hydroformylation, Monsanto process, Wacker process, Alkene metathesis, heterogeneous catalysis - Fischer-Tropsch process, Ziegler-Natta polymerization.

Unit IV Lanthanides and Actinides

Occurrence, properties of the elements - Common and uncommon oxidation states - Absorption and emission Spectra - magnetic properties - Separation of lanthanide elements - lanthanide and actinide contraction - similarities between actinides and lanthanides - Coordination complexes and Organometallic compounds of lanthanides and actinides - Uses of lanthanide compounds as shift reagents.

Unit V Spectroscopy II

Electronic spectroscopy - Microstates, Term symbols, selection rules - Orgel and Tanabe-Sugano diagrams - Charge transfer spectra - Electronic spectra for 1^{st} row transition metal complexes - Calculation of Dq, B for octahedral d^2 and d^8 systems - Nephelauxetic ratio - Electronic spectra of lanthanide and actinide.

Photo electron spectroscopy – UVPES - Principle, spin-orbit coupling – XPES – Principle, chemical shift in XPES - Koopman's theorem - Applications of XPES and UVPES to inorganic spectra - Auger electron spectroscopy

Text Books:

1. James.E.Huheey, Ellen.A.Keiter and Richard.L.Keiter, Inorganic Chemistry: Principles of Structure and Reactivity, Harper Collins College Publishers, 4th Edition, 1993.
2. Shriver D.F., Atkins P.W. and Langford C.H., Inorganic chemistry, ELBS, Oxford University Press, 1994.
3. R.Gopalan, Textbook of Inorganic chemistry, Universities Press (India) Private Limited, 2012.
4. Skoog D.A, West D.M, Holler F.J, Grouch S.R., Fundamentals of Analytical Chemistry, Thomson Asia Pvt. Ltd., Eighth Edition, Third Reprint, 2005.

Books for Reference:

1. Robert H. Crabtree The Organometallic Chemistry of the Transition Metals, John Wiley & Sons, Inc., Publication, 4th Edn, 2014.
2. Gary L. Miessler, Donald A. Tarr, Inorganic chemistry. Pearson Publications, 5th edition, 2014.
3. Catherine Housecroft, Alan G. Sharpe, Inorganic Chemistry, 3rd Edition, Prentice Hall, 2007.
4. Albert Cotton F., Geoffrey Wilkinson, Carlos .A.Manic and Manfred Bochman, Advanced Inorganic Chemistry, Wiley Interscience Publication, 6th Edition , 1999.
5. Purcell K.F. and Kotz J.C, Inorganic Chemistry, WB Saunders Company, 1977.
6. Bertini I., Gray H.B, Lippard S.J. and Valantine J.S, Bioinorganic Chemistry, Viva Books Pvt. Ltd, 1998.
7. H.H., .Merritt L.L and Dean J.A, Instrumental Methods of Analysis, CBS Publishers, 6th edition, 1986.
8. Frank A. Settle, Handbook of instrumental techniques for analytical chemistry, Prentice hall, 1997
9. Drago R.S., Physical Methods in Inorganic Chemistry, W.B. Saunders Company, 1977.
10. Ebsworth David E.A.V., Rankin Stephen Credock W.H., Structural Methods in Inorganic Chemistry, ELBS, IV, 1988.

Semester – II			
Core V	**Organic Chemistry - II**		
Code : 19PCHC22	**Hrs / Week : 5**	**Hrs / Sem : 75**	**Credits : 4**

Vision:

To inspire a knowledge platform that supports an inventive culture. Educate future leaders about how chemistry underlies living systems and physical processes.

Mission:

- To support and advance the worldwide community of chemistry scholars.
- To enhance the basic and applied research framework in the Chemistry Department.
- To understand the principle behind thermal and photochemical organic reactions.

Course Outcome:

CO No.	Upon completion of this course, students will be able to	PSO addressed	CL
CO - 1	organize the various methods of determination of reaction mechanism	6	Cr
CO - 2	comprehend the various factors that operate in organic reactions	3	An
CO - 3	use relevant concepts and terminology in a correct fashion	8	Re
CO - 4	understand the isolation and structural determination of alkaloids	5	Un
CO - 5	determine structure and stereochemistry of Morphine and quercetin	6	Cr
CO - 6	gain knowledge of photochemical organic reactions	5	Ap
CO - 7	discuss the Photochemistry of (n-π*) transitions with particular reference to Norrish type I , Norrish II type reactions, Paterno Bucchi reactions & photochemistry of nitrites.	8	An
CO - 8	understand the applicability of the spectroscopic techniques	4	Un

Semester – II			
Core V	**Organic Chemistry - II**		
Code : 19PCHC22	**Hrs / Week : 5**	**Hrs / Sem : 75**	**Credits : 4**

Unit I Study of Organic Reaction Mechanism

Mechanistic Classification- Thermodynamic requirements for reaction -Kinetic requirements for reactions - Reaction rates- Transition state theory - Hammond Postulate- Microscopic reversibility - Methods of Determining Mechanism: Identification of products, determination of the presence of intermediate, isotopic labelling, Stereochemical evidence, Kinetic evidence, Isotope effects. Reactive intermediates, LFER - Hammett equation – Physical significance of σ and ρ – Applications and Limitations – Taft equation.

Unit II Molecular Rearrangement

Migration of Carbon – Wagner - Meerwein rearrangement, Pinacol-Pinacolone rearrangement, Benzil-Benzilic acid rearrangement and Dienone-Phenol rearrangement. Migration of heteroatoms - Migration to electron deficient nitrogen, Beckmann rearrangement, Curtius rearrangement and Lossen rearrangement.
Migration to electron deficient oxygen – Baeyer-Villiger oxidation, Hydroperoxide rearrangement and Dakin reaction. Migration to electron rich carbon – Neber rearrangement and Tiffenev-Demjanov rearrangement.

Unit III Alkaloids and Flavonoids

Alkaloids – Introduction - General methods of extraction – Classification - Degradation studies - HEM, Emde and Von-Braun - Structural elucidation of papaverine, morphine and quinine, Reserpine.

Flavonoids - Introduction- Properties- Isolation- General methods for the elucidation of structure of flavones, flavonols, Quercetin.

Unit IV Photochemistry Analysis

Photochemical excitation - Experimental techniques; electronic, transitions; Jablonskii diagram; Intersystem crossings; Energy transfer process, Stern-Volmer equation. Reactions of electrically excited ketones; π–π^* triplet; Norrish type I and II cleavage reactions – Photo reductions; Paterno-Buchi reactions, Photochemistry of α, β- unsaturated ketones; cis – trans isomerisation. Photon energy transfer reactions – Photocycloadditions - Photochemistry of aromatic compounds - Barton's reaction and di- π methane rearrangement.

Unit V Ultra Violet – Visible and Infra - Red Spectroscopy

UV – Visible spectroscopy - Absorption laws - Types of electronic transitions – Instrumental and Sampling – Solvent effect – Application of Woodward- Fieser rules for calculating absorption maximum in conjugated diene, triene, polyenes, α and β unsaturated carbonyl compounds.

Optical rotatory dispersion and circular dichroism - Octant rule, α-haloketone rule and their applications.

IR spectroscopy – Basic theory and Instrumentation - Characteristics of IR absorption of different functional groups - Factors influencing vibrational frequencies – Applications of Infra-red spectroscopy - Identification of Organic compound, Structure determination, Qualitative analysis of functional groups, Distinction between two types of hydrogen bonding, Quantitative analysis, study of a chemical reaction, study of Keto-enol tautomerism, Complex molecules, Conformational analysis, Geometrical isomerism, Rotational isomerism, Detection of impurity in a compound.

Text Books:

1. Kalsi P S,Organic Reaction & Mechanism, 4th Edition,New-Age International Publishers, New Delhi, 2011.
2. Ahluwalia V.K and Parshar R.K, Organic Reaction Mechanism Fourth Edition , Narosa Publishing House, 2013.
3. Mukherjee K.S, Mechanism of Organic reactions, Books and Allied Ltd, Kolkota, 2010.
4. Raj K Bansal, Organic reaction mechanism, 4th edition, New Age international publishers, New Delhi, 2012.
5. Gurdeep Chatwal, Organic Chemistry of Natural Products, Vol II, Himalaya Publishing House, Bombay, 2003.
6. Sharma Y.R, Elementry Organic spectroscopy, S.Chand & Company, New Delhi, 2011.
7. Jag Mohan, Organic spectroscopy Principles and Applications, Narosa Publishing House, New Delhi. Second Edition, 2011.

Books for Reference:

1. March J, Advanced Organic Chemistry, Fourth Edition, John-Wiley and Sons, New York, 1992.
2. Clayden, Greeves, Warren and Wothers, Organic Chemistry, Oxford University Press, New York, 2006.
3. Finar I L, Organic Chemistry Volume I and II, Sixth Edition, ELBS with Longmann, Singapore, 1997.
4. Sykes P, Guide Book to Mechanism in Organic Chemistry, Sixth Edition, ELBS with Longmann, 1997.
5. Norman R.O.C, J.M. Coxon, Principles of Organic synthesis, Third edition, Chapman and Hall, 1994.

Semester – II			
Core VI	**Physical Chemistry- II**		
Code : 19PCHC23	**Hrs / Week : 4**	**Hrs / Sem : 60**	**Credits : 4**

Vision

To synthesise the nanomaterials by eco-friendly methods, characterise the synthesized nanomaterials and apply in different fields for the welfare of society.

Mission

To introduce and give an insight into the fascinating area of Nanoscience.

Course Outcome:

CO No.	Upon completion of this course, students will be able to	PSO addressed	CL
CO - 1	recall a thorough knowledge of basics of nanoscience and nanotechnology	4	Re
CO - 2	explain the preparation, characterization and properties of nanomaterials	6	Un
CO - 3	analyze the types and properties of carbon nanotubes	1	An
CO - 4	assimilate existing and new concepts, methodology and researches and apply them in their academic research environment	7	Ev
CO - 5	aware of challenges, risks and promises of nano technological development	6	Cr
CO - 6	synthesise the nanomaterials by physical, chemical and biological methods.	6	Cr
CO - 7	characterise the synthesized nanomaterials by various techniques.	5	Ev
CO - 8	apply the nanomaterials in energy storage, food and in day-to-day life.	8	Ap

Semester – II			
Core VI	**Physical Chemistry- II**		
Code : 19PCHC23	**Hrs / Week : 4**	**Hrs / Sem : 60**	**Credits : 4**

Unit I Introduction

Definition – Nanoscience and Nanochemistry - Four generations of Nanotechnology development - Definitions of Nanotechnology – Nanostructures (Nanoparticles, Nano scale in one dimension, two dimension and three dimension) - Classification of nanoparticles - Properties of nanomaterials – Surface property, Physico-chemical, Electrical and electronic, Redox, Optical, Mechanical and Magnetic properties.

Unit II Synthesis and characterisation

Synthesis of nanomaterials - Top down and Bottom up approach - Physical methods (Laser Ablation, Evaporation, Sputtering and Gas condensation) - Chemical methods (Thermolysis, Sonochemical approach and Sol-gel synthesis) - Biosynthesis (Elementary idea only) - Structural characterisation of nanomaterials - X-ray diffraction, Scanning Tunneling Microscopy and Atomic force microscopy.

Unit III Carbon nanotube

Carbon nanotube - Carbon allotropes (Diamond ,Graphite, Carbon nanotubes) - Types of Carbon nanotubes - Synthesis of carbon nanotubes - Electric arc Discharge method, Laser method, Chemical vapour deposition method (CVD) - Purification methods, properties and applications of Carbon nanotubes – Fullerenes - Synthesis and purification - Properties and applications of Fullerenes.

Unit IV Nanocomposites

Definition – Ceramic-matrix nanocomposites – Nanocomposites by mechanical alloying – Metal-matrix nanocomposites – Poymer nanomaterials – Synthesis methods - Solution intercalation – Melt intercalation – Emulsion polymerization – In-situ polymerization – Properties of polymer nanostructured materials – Material properties – Thermoplastic nanocomposites – Nylon 6 nanocomposites – Thermoset nanocomposites – Epoxy nanocomposites – Elastomer nanocomposites – TPO nanocomposites.

Unit V Applications of Nanotechnology

Chemistry and Environment – Water purification - Energy storage - Rechargeable batteries, Hydrogen storage - Information and Communication - Heavy industry - Consumer goods (food, textiles and cosmetics) - Nano medicine - medical applications of molecular nanotechnology (Nanorobots, Cell repair machines, nanonephrology).

Text Books:

1. Khanna.O P, A Text Book of Nanochemistry, Astha Publishers & Distributors, New Delhi, 2014.
2. Shanmugam S, Nanotechnology, MJP Publishers, Chennai, 2011.

Books for Reference:

1. Parthasarathy. B.K, Nanostructure and Nanomaterials, Isha Books, Delhi, 2007.
2. Uday Kumar, Concepts in Nanochemistry, Anmol Publications Pvt. Ltd, New Delhi, 2013.
3. Bandyopadhyay A K, Nano Materials, New Age International Publishers, 2nd Edn, 2012.
4. Viswanathan B, Nano Materials, Narosa Publishing House, New Delhi, 2013.
5. Guozhong Cao, Nanostructures & Nanomaterials - Synthesis, Properties & Applications, Imperial College Press, 2004.

Semester – II			
Elective II A	**Energy and Environmental Chemistry**		
Code : 19PCHE21	**Hrs / Week : 4**	**Hrs / Sem : 60**	**Credits : 4**

Vision:

To protect and improve the environment as a valuable asset against hazardous chemicals and energy resources.

Mission:

- To learn the various types of sonochemical reactions.
- To summarise renewable and non renewable energy resources.
- To gain knowledge about Environment and its problem solving techniques.

Course outcome:

CO No.	Upon completion of this course, students will be able to	PSO addressed	CL
CO - 1	compare heterogeneous liquid- liquid and heterogeneous solid- liquid reactions	2	An
CO - 2	distinguish between renewable and non- renewable energy resources.	5,6	An
CO - 3	explain the construction, working and applications of primary and secondary batteries.	4,8	Ap
CO - 4	classify and compare the fuels based on their appearance such as solid, liquid and gas.	7	Cr
CO - 5	demonstrate the Orsat process for flue gas analysis.	8	Ap
CO - 6	identify a catalyst used in fine chemical synthesis.	4,6	Un
CO - 7	sketch the natural cycles of environment such as the hydrological, oxygen and nitrogen cycles.	6	Cr
CO - 8	differentiate chemical and photochemical reactions occurs in atmosphere.	1,5	An

Semester – II			
Elective II A	**Energy and Environmental Chemistry**		
Code : 19PCHE21	**Hrs / Week : 4**	**Hrs / Sem : 60**	**Credits : 4**

Unit I Sonochemistry

Introduction Instrumentation (Whistle reactor, Ultrasonic cleaning bath, Direct Immersion Sonic horn, The Cup horn) Types of Sonochemical reactions - Homogeneous reaction (Strecker, Solvolysis and Hydrolysis) - Heterogeneous liquid-liquid reactions (Hydrolysis, Solvolysis, Saponification and Esterification), Heteogeneous solid-liquid reactions, Induced Organic reactions (Bouveault reactions, Cannizzaro reaction, Strecker Synthesis, Reformatsky reaction, Barbier reaction of carbonyl compounds, Dickmann reaction)

Unit II Energy resources

Introduction - classification of energy resources - Renewable - Solar energy (Solar cells, Solar batteries, Solar heat collector and Solar water heater), Wind energy (Wind mills and Wind farms), Ocean energy (Tidal energy, Ocean thermal energy and geothermal energy) and Bio mass energy (Bio fuel and Hydrogen fuel).

Non Renewable - Batteries- Construction, Working and Applications: Primary battery - Leclanche Cell, Alkaline battery, Lithium ion; Secondary battery - NICAD, Lead Acid , Nickel metal hydride cell - Fuel cell - Use of alternate energy sources – Energy Conversion process: Anaerobic digestion and bio gas.

Unit III Fuels and combustion

Introduction - Classification of fuels - Calorific values - Solid fuel - Classification of coal by rank - Metallurgical coke and its manufacture (Otto Hoffmans method) - Liquid fuel - Petroleum - synthetic petrol and its manufacture (Bergius process) - Knocking - Octane number and Cetane number. Gaseous fuel - Liquid Petroleum gas, Natural gas, Compressed natural gas - Ignition temperature - Explosive range - Analysis of flue gas (Orsat process).

Unit IV Recent developments in catalysis

Introduction - Reactions over Solid - Acid catalyst (Alkylation, Cracking & Hydrocracking, Isomerisation), Catalyst in Fine Chemical synthesis (Halogenation, Amination, Condensation, selective Oxidation reactions), Photocatalyst - Introduction - Semiconductor as photocatalyst - Water splitting by Semiconductor Particle - Photocatalysis in the removal of Organic and Inorganic pollutants - Photocatalytic reduction of Dinitrogen, Photocatalysis of Organic reactions.

Unit V Environmental chemistry

Environmental Segments - The natural cycles of environment: the hydrological, oxygen and nitrogen cycles - Chemical and Photochemical reactions in atmosphere: SO_2, O_2 and O_3

chemistry, nitrogen oxides and organic compounds - Greenhouse effect - Ozone hole - El Nino phenomenon.

Microorganisms - the catalysts of aquatic chemical reactions - Acid-base and ion exchange reactions in soil - Nitrogen pathways and NPK in soil - Waste classification and disposal - Solid waste management.

Text Books:

1. Ahluwalia V.K & Varma R.S, Alternate Energy Process in Chemical Synthesis,1st Edition,Narosa Publishing House, Delhi, 2008.
2. Jain P.C and Monika Jain, Engineering Chemistry, 15th edition, Dhanpat Rai Publishing company Pvt. Ltd, New Delhi, 2011.

Books for Reference:

1. B.Viswanathan, S.Sivasanker, A.V.Ramaswamy, Catalysis-Principles and Applications, Fourth edition, Narosa Publishing House, Delhi, 2011.
2. Harish Kumar Chopra, Anupama Parmar, A textbook of Engineering Chemistry, Narosa Publishing House, 1st edition, New Delhi, 2008.
3. Dr.A.Ravikrishnan, Environmental Science & Engineering, Sri Krishna High tech Publishing Company Pvt. Ltd, Eleventh edition, 2015.
4. A.K.DE, Environmental Chemistry, New age international publishers, 6th edition, 2006.

Semester – II			
Elective II B	**Industrial Chemistry**		
Code : 19PCHE21	**Hrs / Week : 4**	**Hrs / Sem : 60**	**Credits : 4**

Vision:

To develop better predictability of human health maintenance and prevention of various hazards.

Mission:

- To gain knowledge on industrial products.
- To create awareness regarding adulterants, radiation and its toxicity.

Course Outcome:

CO No.	Upon completion of this course, students will be able to	PSO addressed	CL
CO - 1	learn some of the industrial products like cosmetics, paints, dyes and pigments and their manufacturing	1, 5	An
CO - 2	test the adulterants present in cosmetics and take care of skin and hair	6	An
CO - 3	get to know various types of alloys and its manufacture and applications	5	Ap
CO - 4	have sufficient knowledge on corrosion and the methods for preventing corrosion	1, 5	Ap
CO - 5	discuss the basic concepts of radiation chemistry	1	An
CO - 6	understand the concepts, importance and need of nuclear energy	1	Ev
CO - 7	aware of disposal techniques of nuclear wastes and safety in working with nuclear energy	6	An
CO - 8	know various power projects in India.	7	An

Semester – II			
Elective II B	**Industrial Chemistry**		
Code : 19PCHE21	**Hrs / Week : 4**	**Hrs / Sem : 60**	**Credits : 4**

Unit I Cosmetics and Personal Care

Cosmetic formulations – Skin care - Hair care - Deodarants and Antiperspirants - Colour cosmetics - Sun protection aerosols - Nail cosmetics - Mouth cosmetics - Perfumes and fragrances.

Basic ingredients - Additives and flavours used in soaps, tooth pastes, lipsticks, perfumes, colognes, deodorants and antiperspirants - Harmful beautifying practices and their chemistry (Keratin depletion in hair – colouring - cleaning and curling of hair) - Basic tests for identifying good and bad cosmetics – pH Test.

Unit II Alloys and Corrosion

Alloys – Introduction - General characteristics of Alloys – manufacture – purpose of alloying - the Iron-Carbon Alloys - Carbon steels - Types of alloys - Heat treatment of alloys (Hardening of steel and Annealing) – Steel - Alloy steel – Stainless steel – Cast iron – Brass – Bronze – Nichrome.

Corrosion – Definition - Rusting of iron - Chemical corrosion - electrochemical corrosion - Factors influencing corrosion - Atmospheric and soil corrosion - Corrosion control - Hot dipping (galvanizing and tanning), Electroplating and Anodizing.

Unit III Pigments, Dyes and Paints

Pigments – Classification - Manufacture and uses of White lead, Lithopone, Ultramarine blue, Chrome green.

Dyes – Classification, preparation and dyeing processes.

Paints – Composition, manufacture and testing of paints - Special paints – temperature indicating paints, fire retardant paints, water repellant paints.

Unit IV Radiation Chemistry

Interaction of radiation with matter - primary effect due to charged particle - Radiation tracks, spurs and delta rays - linear energy transfer (LET) - Bethe's equation for LET for charged particles due to collisions with electrons **-** Radiation dosimetry - Units of radiation energy (Rad, Gray, Rontgen, RBE Rem, Sivert) - Radiolysis of water.

Unit V Applications of Nuclear chemistry and Trace elements

Chararacterisation of fission reactions - Product distribution, Theories of fission - Fissile and fertile isotopes - Synthetic elements - Nuclear reprocessing - Radiation hazards and prevention - Applications of isotopes - Neutron activation analysis - Isotopic dilution analysis -

Uses of traces in structural and mechanistic studies, agriculture, medicine and industry - Radio carbon dating - Hot atom energy - Atomic power projects in India.

*** Students may visit Industries / premier Institutions.**

Text books:

1. Jain & Jain, Engineering Chemistry, S.Chand Publications, New Delhi, 2007.
2. Sharma B.K, Industrial Chemistry, Goel Publishing House, 2000.
3. Siva kumar.R, Siva Kumar. N, Engineering Chemistry, The Mc Graw-Hill companies, New Delhi, 2009.

Books for Reference:

1. Kirpal Singh, Chemistry in Daily Life, Prentice Hall of India Pvt. Ltd., New Delhi, 2nd Edn., 2008.
2. Charkarabarthy.B.N, Industrial Chemistry, Oxford and IBH Prb.Co., 2005.
3. Gopalan.R,Venkappayya .D, Sulochana Nagarajan, Engineering Chemistry II, Vikas Publications, New Delhi, 2011.
4. V. Srinivasa, S.D.Uma Mageswari, M.Meena, Engineering Chemistry, Scietech Publications, 2002.
5. Arnikar.H.J, Essentials of Nuclear Chemistry, Wiley Eastern Ltd., 1988.

Semester – I & II			
Core Practical I	**Inorganic Chemistry Practical – I**		
Code : 19PCHCR1	**Hrs / Week : 4**	**Hrs / Sem : 60**	**Credits : 4**

1. Qualitative analysis of inorganic mixture containing two familiar and two less familiar cations Pb, Cu, Bi, Cd, Zn, Co, Ni, Mn, Ca, Ba, Sr, W, Te, Se, Mo, Ce, Zr, V, Ti and Li.
2. Complexometric titrations – Estimation of Cu, Zn and Mg by EDTA titration in presence of either Pb or Ba.

Course Work

1. Photocolorimetric estimation of Fe, Ni, Cr, Mn, Cu and NH_4^+.

Book for Reference:

1. Revised by Svehla. G, Vogel's Qualitative Inorganic Analysis, Pearson Education, 7th edition, 2004.

Semester – I & II			
Core Practical II	**Organic Chemistry Practical - I**		
Code : 19PCHCR2	**Hrs / Week : 4**	**Hrs / Sem : 60**	**Credits : 4**

1. Micro Qualitative Analysis of an organic binary mixture

i) Pilot separation
ii) Bulk separation
iii) Determination of melting and boiling points
iv) Analysis of organic compounds
v) Derivatization

2. Single stage preparation of Organic compounds

1. Preparation of Benzoic acid from benzyl Chloride.
2. Preparation of Resacetophenone from resorcinol.
3. Preparation of dibenzalacetone from benzaldehyde.
4. Preparation of 2, 4, 6-tribromoaniline from aniline.
5. Preparation of Tetrahyrocarbazole from cyclohexanone.
6. Preparation of Picric acid from phenol.
7. Preparation of Iodoform from acetone.

3. Course work

Chromatographic techniques
i) TLC
ii) Paper chromatography

Books for Reference:

1. B.S. Furniss, A.J. Hannaford, P.W.G. Smith, and A.R. Tatchell, Vogel's Textbook of Practical Organic Chemistry, V Edition, Pearson Education Ltd., 2008.
2. Ganapragasm and Ramamurthy, Organic Chemistry Lab Manual, Second Edition, S. Vishwanathan Printers and Publishers (P) Ltd., Chennai, 2007.
3. Ragupathi Mukhopadhyay, Pratul Chatterjee, Advanced Practical Chemistry, Books and Allied (p) Ltd., Third edition, 2007.
4. Bidhan Chandra Ray, Satyanarayan Das, A textbook on Chemistry Practical, New Central Book Agency Ltd, London, 2014.

Semester – I & II			
Core Practical III	**Physical Chemistry Practical - I**		
Code : 19PCHCR3	**Hrs / Week : 4**	**Hrs / Sem : 60**	**Credits : 4**

I Conductometry

1. Determination of solubility product of a sparingly soluble silver salt.
2. Determination of dissociation constant of a weak acid.
3. Conductometric Titrations

i) Estimation of HCl and CH_3COOH in a mixture (vs NaOH)

ii) Estimation of HCl and NH_4Cl in a mixture (vs NaOH)

iii) Estimation of CH_3COOH and CH_3COONa in a mixture (vs NaOH)

iv) Estimation of CH_3COOH and CH_3COONa in a mixture (vs HCl)

II Distribution

1. Distribution of Benzoic acid between Toluene and Water.

III Thermometry

Determination of solution enthalpy

i) Oxalic acid – Water

ii) Ammonium oxalate – Water

iii) Naphthalene – Toluene

IV. Kinetics

i) Study of Kinetics of primary salt effect on $K_2S_2O_8$

ii) Study of Kinetics of KI - $K_2S_2O_8$ system.

Books for Reference:

1. Viswanathan.B and Raghavan.P.S, Practical Physical Chemistry , Viva Books Pvt. LTD., 2005.
2. Michell.J.Sienko, Robert.A. Plane, Stanley.T. Martu, Experimental Chemistry, International student edition, 1984.
3. Peter Mathews.G, Experimental Physical Chemistry, Clarendan Press Oxford, 1985.

Semester – III			
Core VII	**Inorganic Chemistry - III**		
Code : 19PCHC31	**Hrs / Week : 5**	**Hrs / Sem : 75**	**Credits : 4**

Vision:

To provide the impetus in the young minds to face the challenging competitive exams.

Mission:

- To sketch the various crystal structures of the compounds.
- To explain the various electronic theories involved in conducting and semiconducting materials.
- To discuss the synthesis, properties and structures of inorganic rings, chains, cages and clusters.

Course Outcome:

CO No.	Upon completion of this course, students will be able to	PSO addressed	CL
CO - 1	demonstrate the Electrical properties and applications of semiconductors.	1,4	Ap
CO - 2	discuss the high temperature super conductors and their applications in Levitation.	4,7	An
CO - 3	compare various techniques involved in single crystal growth.	6,8	An
CO - 4	sketch the crystal structures of some Ionic compounds.	1,2	Cr
CO - 5	sketch the electron transfer mechanism for Inner and outer sphere complexes.	2	Ap
CO - 6	distinguish between homocyclic and heterocyclic inorganic ring systems.	1,3	An
CO - 7	calculate STYX notation for boranes and carboranes.	4	Ap
CO - 8	coin the Isolobal relationships between main group and transition metal fragments.	6,8	Cr

Semester – III			
Core VII	**Inorganic Chemistry - III**		
Code : 19PCHC31	**Hrs / Week : 5**	**Hrs / Sem : 75**	**Credits : 4**

Unit I Solid state I

Types of close packing - hcp and ccp - packing efficiency, radius ratios - Methods of Single crystal growth - Bridgeman, Czochralski, Verneuil - Chemical vapour transport - Hydrothermal method - Dislocations in solids - Point defects - Schottky and Frenkel defects - Line defects - Surface Defects – Dislocations - Grain Boundary and Stacking Fault - Crystal structures of common ionic compounds NaCl, Na_2O, Zinc blende, Wurtzite, Nickel arsenide, CsCl, Rutile, CdI_2, $CdCl_2$, and CaF_2, Perovskite, K_2NiF_4, Spinels.

Unit II Solid state II

Electronic structure of solids - Band theory, Free electron theory, Insulators and Semiconductors and its types - Electrical properties (Thomson effect, Peltier effect, Seeback effect, Hall effect) - Dielectric, Ferroelectric, Piezoelectric and Pyrroelectric materials and their and applications - Optical and electronic properties of semiconductors – Photovoltaic effect, Hall effect - p-n junction and n-p-n junction and their applications as rectifiers and transistors - Solid electrolytes, Superconductors, High-temperature superconductors, BCS theory, Cooper electrons - Meissner effect and Levitation.

Unit III Inorganic reaction mechanism

Labile and inert complexes - Thermodynamic and kinetic stability of complexes - mechanism of substitution reactions of metal complexes – D, Id, A and Ia mechanisms - Substitution reactions in octahedral and square planar complexes, Acid-catalyzed reactions, Base - catalyzed reactions - Trans effect and its influence, water exchange, anation, isomerization reactions - Redox reactions - Inner and Outer sphere electron transfer mechanism - Template reactions.

Unit IV Inorganic chains and rings

Chains - Chain catenation - Heterocatenation - Homocyclic and heterocyclic inorganic ring systems - Isopoly and heteropoly anions - Silicate minerals – Classification - Aluminosilicates - Sulphur nitrides.

Rings - Borazines, Phosphazenes, Phosphazene polymers - Intercalation compounds.

Unit V Inorganic cages and clusters

Cages - Synthesis, properties and structure of boranes [styx notation], heteroboranes, metalloboranes and carboranes, metallocarboranes, silicones.

Clusters - Carbonyl clusters, anionic and hydrido clusters, carbide clusters, sulphur metal clusters, Wade's rule - Isolobal relationships between main group and transition metal fragments - Zintl ions.

Text Books:

1. West A.R., Solid State Chemistry and its Application, John Wiley & Sons (Asia), 1998.
2. James.E.Huheey, Ellen.A.Keiter and Richard.L. Keiter, Inorganic Chemistry: Principles of Structure and Reactivity, Harper Collins College Publishers, 4th Edition, 1993.

Books for Reference:

1. Wells A.F, Oxford University Press, Structural Inorganic Chemistry, 1984
2. Azaroff L.V, Introduction to Solids, Tata McGraw Hill publishing Ltd, 2000.
3. Kittel C, Introduction to Solid State Physics, Wiley Eastern Ltd, 7th Edn, 2006.
4. Shriver D.F, Atkins P.W. and Langford C.H, Inorganic Chemistry, ELBS, Oxford University Press 1994.
5. Gary L.Miessler, Donald A. Tarr, Inorganic Chemistry, Pearson Publications, 5th edition, 2014.
6. Albert Cotton F, Geoffrey Wilkinson, Carlos.A.Manic and Manfred Bochman, Advanced Inorganic Chemistry ,Wiley Interscience Publication, 6th edition, 1999.
7. Lee J.D, Concise Inorganic Chemistry, Blackwell Science Ltd., 5th Edition, Reprint 2003.
8. Drago R.S, Physical Methods in Inorganic Chemistry, W.B.Saunders, 1977.
9. Ebsworth David E.A.V, Rankin Stephen Credock W.H, Structural Methods in Inorganic Chemistry, ELBS, IV 1988.

SEMESTER – III			
Core VIII	**Organic Chemistry - III**		
Code : 19PCHC32	**Hrs / Week : 5**	**Hrs / Sem : 75**	**Credits : 4**

Vision:

To be employed in industry and/or enter into nationally recognized graduate and professional programs.

Mission:

- To receive professional training to enhance employability and success in a doctoral program.
- To carry out independent laboratory investigations of research problems.
- To contribute to the advancement of knowledge in the chemical sciences.

Course Outcome:

CO No.	Upon completion of this course, students will be able to	PSO addressed	CL
CO - 1	familiarize the various types of aromatic substitution reactions	2	Re
CO - 2	compare neighbouring group participation and Ambident nucleophiles in aromatic Electrophilic substitution	4	Ev
CO - 3	discuss the Conformational analysis of cyclic molecules and the factors governing the reactivity of axial and equatorial substituents in cyclohexanes.	5	An
CO - 4	discuss optical rotatory dispersion and how it is used for the determination of structure of chiral molecules.	6	Ap
CO - 5	know the reagents which causes oxidation and reduction reactions	4	Un
CO - 6	acquire knowledge about the reagents specificity	4	An
CO - 7	know about the NMR spectroscopy	6	Un
CO - 8	analyse spin-spin coupling and apply it to organic structures	2	An

SEMESTER – III			
Core VIII	**Organic Chemistry - III**		
Code : 19PCHC32	**Hrs / Week : 5**	**Hrs / Sem : 75**	**Credits : 4**

Unit I Aromatic Electrophilic aand Nucleophilic Substitution Reaction

Aromatic Electrophilic substitution - Arenium ion mechanism – Selected reactions and Reactivity - Nitration - Nitrosation - Sulphonation – Halogenation - Friedel Craft's alkylations and arylations - Vilsmeir Haack reaction - Jacobsen reaction - Bischler Napieralski reaction - Pechman reaction – Houben Hoesch reaction.

Aromatic Nucleophilic Substitution - S_NAr mechanism - S_N1 (Aromatic) mechanism with evidences - Benzyne mechanism - Effect of substrate structure, leaving group, attacking nucleophile and solvent - Selected reactions - Von Richter and Smiles rearrangements.

Unit II Conformational Analysis

Conformations of cyclohexanes - Ring inversion and stabilisation of the flexible conformation, monosubstituted cyclohexanes - Conformational free energy, Determination of conformational energy, disubstituted cyclohexanes - Conformation of poylsubstituted cyclohexenes - Conformational analysis of fused bicyclic systems - Decalin and perhydrophenanthrene - Curtin-Hammett principle.

Unit III Addition and Elimination Reaction

Addition reaction - Addition to C=C bonds - electrophilic, nucleophilic and free-radical additions - Additions to conjugated systems – Carbene addition to double bonds - Hydration of olefins. Reactions - Birch reduction – Hydroboration - Michael reaction – Diels-Alder reactions - Mannich reaction - Meerwein- Pondorf reduction – Reformatsky - Claisen – Stobbe - Darsen – Wittig – Thorpe and Benzoin condensations.

Elimination reactions - E1, E2 and E1CB mechanisms – orientations - Hofmann and Saytzeff rules - mechanism and orientation in pyrolytic elimination - Chugaev reaction – Cope elimination - dehydration of alcohols – dehydrohalogenation -. Elimination versus substitution

Unit IV Reagents in Organic Reactions

Synthetic applications of the following - Gilman, Diazomethane, 2,3- Dichloro-5,6-dicyano-1,4-benzoquinone (DDQ), N,N-Dicyclohexylcarbodiimide (DCC), PCC, Osmium tetroxide, 1,3-dithiane, Fetizon's reagent, Lemieux-Johnson reagents, Prevost and Woodward reactions, Jones reagent, Wilkinson's catalyst, Ziegler-Natta catalyst.

Unit V NMR and C^{13} Spectroscopy

PMR spectroscopy - Basic principle - Number of signals - Chemical shift Chemical shift parameters and Internal Standards - Factors influencing chemical shift - Spin–spin coupling in AX, ABX type molecules – Coupling Constant - Geminal, vicinal and long range coupling – Nuclear Overhauser Effect(NOE) - FT-NMR - C^{13} NMR - 2D NMR - 2D-pulse sequences COSY – NOESY - INEPT and DEPT.

Text Books:

1. Mukherjee K.S, Mechanism of Organic reactions, Books and Allied Ltd, Kolkota, 2010.
2. Kalsi P S,Organic Reaction & Mechanism, 4th Edition,New-Age International Publishers, New Delhi, 2011.
3. Ahluwalia V.K and Parshar R.K, Organic Reaction Mechanism Fourth Edition, Narosa Publishing House, 2013.
4. Raj K Bansal, Organic reaction mechanism, 4th edition, New Age international publishers, New Delhi, 2012.
5. Sharma Y.R, Elementry Organic Spectroscopy, S.Chand & Company, New Delhi, 2011.
6. Jag Mohan, Organic Spectroscopy Principles and Applications, Second Edition, Narosa Publishing House, New Delhi, 2011.
7. Nasipuri D, Stereochemistry of Carbon Compounds, Second Edition, New Age International Publishers, New Delhi, 1996.

Books for Reference:

1. March J, Advanced Organic Chemistry, Fourth Edition, John-Wiley and Sons, New York, 1992.
2. Clayden, Greeves,Warren and Wothers, Organic Chemistry, Oxford University Press, New York, 2006.
3. Eliel E L, Stereochemistry of Carbon Compounds, Tata-McGraw Hill Publishing Company, New Delhi, 1975.
4. Kalsi P S, Stereochemistry: Conformation and Mechanism, 4th Edition, New Age International Publishers, New Delhi, 1997.
5. Norman R.O.C, J.M. Coxon, Principles of Organic synthesis, 3rd edition, Chapman and Hall, 1994.

Semester – III			
Core IX	**Physical Chemistry - III**		
Code : 19PCHC33	**Hrs / Week : 4**	**Hrs / Sem : 60**	**Credits : 4**

Vision

To demonstrate the various types of symmetry elements present in the molecules.

Mission

- To learn the concepts of Group Theory.
- To apply the different kinds of spectroscopy, give the structure of molecules.
- To understand the Principles and applications of various spectroscopy.

Course Outcome:

CO No.	Upon completion of this course, students will be able to	PSO addressed	CL
CO - 1	assign the symmetry elements and so that the point group of the given molecule.	1	An
CO - 2	construct the character table for various point groups.	7	Cr
CO - 3	apply the principles of group theory in determining hybridization and symmetries of vibrational modes in linear and non-linear molecules.	5	Ap
CO - 4	outline the behaviour of elctrolytes in solutions.	4	Un
CO - 5	predict the structure of the electrode surface and the applications of elctrode process.	7	Cr
CO - 6	identify vibrational course structure and rotational fine structure of electronic band and differentiate the molecules whether they are IR active or Raman active.	1	Ap
CO - 7	illustrate different types of electronic spectroscopy and draw the structures of various molecules.	4	Un
CO - 8	appreciate the quadrupole interaction and applications of mössbauer spectroscopy	3	Ev

Semester – III			
Core IX	**Physical Chemistry - III**		
Code : 19PCHC33	**Hrs / Week : 4**	**Hrs / Sem : 60**	**Credits : 4**

Unit I Group Theory- I

Symmetry elements and symmetry operations - Group postulates and types of group - Group multiplication table - Construction of multiplication table for C_{2v}, C_{3v} and C_{2h} - Point group - Schoenflies symbols – Matrix representations of symmetry operations - Reducible and irreducible representations – The Great Orthogonality theorem (GOT) - Properties of Reducible and irreducible representations - Construction of character tables for point groups (C_{2V}, C_{3v} and D_{2h}) by using the Great Orthogonality theorem.

Unit II Group Theory - II

Applications of Group theory - Standard reduction formula relating reducible and irreducible representations - Determination of Hybridisation of atomic orbitals in linear and non-linear molecules (AB_4 tetrahedral, AB_3 triangular planar, AB linear molecules) - Symmetries of vibrational modes in non-linear molecules (H_2O, NH_3 and BF_3) - Symmetries of vibrational modes in linear molecules (HCN, CO_2) - Symmetry selection rules for infrared and Raman spectra - Mutual exclusion principle.

Unit III Electrochemistry

Debye-Huckel theory of inter-ionic attraction – Debye-Huckel-Onsager equation and its validity- Debye-Falkenhagen and Wein effects - Debye-Huckel limiting law - Electrode-electrolyte interface - Electrical double layer - Polarization and overpotential - Kinetics of electrode reaction - Butler-Volmer equation - Tafel equation - Corrosion - Pourbaix diagrams - Evan's diagram - Potentiometry - Principle, Instrumentation and Applications.

Unit IV Vibrational and Raman Spectroscopy

Infrared spectroscopy – Polyatomic molecules - Fundamental vibrations and their symmetry - overtone and combination frequencies - Concept of group frequencies - Fermi resonance and FT-IR.

Raman Spectroscopy – Rayleigh scattering - Raman Scattering - classical and quantum theories of Raman effect - Rotational Raman spectra for linear and symmetric top molecules - Vibrational Raman spectra - Rotational fine structure - Polarization of light and the Raman effect - Technique and instrumentation - Laser Raman spectrometer - Structure determination from Raman and Infra-red spectroscopy.

Unit V Electronic Spectroscopy and Mossbauer Spectroscopy

Electronic spectroscopy - Electronic spectrum of diatomic molecules - Born-Oppenheimer approximation - Sequences and Progressions - The Frank-Condon principle - Dissociation energy and dissociation products - The fortrat diagram - Predissociation.

Photoelectron spectroscopy - Principle - XPES, UVPES and Chemical information from photoelectron spectroscopy - Applications of ESCA.

Mössbauer spectroscopy - Theory and Principle of Mössbauer spectroscopy - Isomer shift - Quadrupole interactions - Magnetic hyperfine interaction - Doppler shift - Recoil energy - Chemical applications.

Text Books:

1. Raman K V, Group Theory and its Applications to Chemistry, Tata McGraw Hill Co, 1994.
2. Glasstone S, An Introduction to Electrochemistry, East West Press Pvt. Ltd, New Delhi, 1956.
3. Gurdeep R Chatwal and Sham K Anand, Spectroscopy, Himalaya Publishing House, 2009.

Books for Reference:

1. Cotton. F.A, Chemical applications of group theory, Wiley Third edition, 2003.
2. Mark Ladd, Symmetry and Group Theory in Chemistry, Woodhead Publishing, New Delhi, 2013.
3. Antorpov L, Theoretical Electrochemistry, Mir Publishers, Moscow, 2nd Edition, 1977.
4. Bockris J O'M and Reddy A K N, Modern Electrochemistry Vol 1 & 2, Second Edition, Plenum Press, New York, 1998.
5. D.A. McQurrie and J.D. Simon, Physical Chemistry - A Molecular Approach, Viva Books Pvt. Ltd., New Delhi, 1999.
6. J.Rajaram and J.C. Kuriakose, Kinetics and Mechanism of Electrochemical Transformations, Ch-13, Macmillan India Ltd., New Delhi, 1993.
7. C. N. Banwell, Fundamentals of Molecular Spectroscopy; 4th Ed., McGraw Hill Education, Noida, 1994.
8. G. M. Barrow, Introduction to Molecular Spectroscopy; McGraw Hill, New York, 1964.
9. Drago R S, Physical Methods in Inorganic Chemistry, New Delhi, East West Press Ltd, 1971.
10. Straughan B P and Walker S, Spectroscopy Volume 1,2,3, New York, London Chapman and Hall, A Halstet Press Book, John Wiley & Sons Ins., 1975.

Semester – III			
Core X	**Research Methodology**		
Code : 19PCHC34	**Hrs / Week : 4**	**Hrs / Sem : 60**	**Credits : 4**

Vision:

To provide resources to the students to stimulate their basic research interest and other creative endeavors that promote entrepreneurial culture.

Mission:

- To explain about various thermal and electrochemical instrumentation techniques.
- To learn about all the hyphenated techniques used for the separation of compounds.
- To interpret the results of analysis with accuracy.

Course Outcome:

CO No.	Upon completion of this course, students will be able to	PSO addressed	CL
CO - 1	select the research topic and able to survey the literature.	3	Ev
CO - 2	submit the project proposals to the funding agency.	8	Ap
CO - 3	explain the principle, instrumentation and applications of TGA, DTA and DSC.	3,6	Un
CO - 4	compare principle, instrumentation and applications of potentiometry, coulometry and voltammetry.	5	An
CO - 5	describe the different types of Atomic spectroscopy.	1,5	Un
CO - 6	interpret the data using TEM, SEM, XRD and EDAX techniques.	5,7	Ev
CO - 7	Separate the compound from a mixture using various chromatographic techniques.	3,4	An
CO - 8	improve the accuracy of data in chemical analysis.	5	Ev

Semester – III			
Core X	**Research Methodology**		
Code : 19PCHC34	**Hrs / Week : 4**	**Hrs / Sem : 60**	**Credits : 4**

Unit I Research methodology

Introduction of research- selection of a research topic- Surveying the literature - Sources- primary source and secondary source - Identification of research problem - Assessing the status of the problem guidance from the supervisor - Actual investigation and analysis of experimental results - Reporting the results in the form of communication, paper etc - Dissertation and thesis writing - Project proposals to the funding agency.

Unit II Thermo and electro analytical methods

Thermoanalytical Methods - Principle, instrumentation and applications of Thermogravimetry (TGA), Differential Thermal Analysis (DTA) and Differential Scanning Calorimetry (DSC).

Electroanalytical Techniques – Coulometry - Principle, Instrumentation and Applications - Voltammetry - Types (Stripping voltammetry, Cyclic voltammetry, Amperometry) - Principle, instrumentation and applications.

Unit III Spectroscopic techniques

Atomic spectroscopy - Classification (Absorption, emission and fluorescence methods), Principle, Instrumentation and Application.

Principle, instrumentation and data interpretation of Transmission electron microscopy (TEM), Scanning electron microscope (SEM), Energy dispersive spectroscopy (EDAX) and X-ray diffraction (XRD) analysis.

Unit IV Chromatography techniques

Principle, instrumentation and specific applications of Column chromatography, Thin layer chromatography, Gas Chromatography (GC-MS, GC-FTIR), High Performance Liquid Chromatography (HPLC), Size-Exclusion Chromatography (SEC), Ion Chromatography (IC).

Unit V Data analysis

Errors in chemical analysis – Classification of errors – Determination of accuracy of methods – Improving accuracy of analysis - Comparison between precision and accuracy – Significant figures – Mean, median and standard deviation – Comparison of results - “t” test, “f” test and “chi” square test – Rejection of results – Presentation of data - Correlation and linear regression.

Text Books:

1. Gurdeep R. Chatwal, Sham K.Anand, Instrumental Methods of Chemical Analysis, 5th edition, Himalaya Publishing House, Mumbai, 2014.
2. Skoog.D.A, West.D.M F, Holler.J, Crouch.S.R, Fundamentals of Analytical Chemistry, Thomson Asia Pvt. Ltd., Eighth Edition, Third Reprint, 2005.
3. Banwell. C.N, Fundamentals of molecular spectroscopy, 4th Edition, McGraw Hill Education, Noida, 1994.

Books for Reference:

1. Anderson. J, Durston. B. H, Poole. M, Thesis and Assignment Writing, Wiley Eastern, New Delhi, 1986.
2. Sharma. B.K, Instrumental Methods of Chemical Analysis, Goel Publishing House, 23rd Edition, 2004.
3. Willard. H, Merrit Jr. L and Dean. A, Instrumental methods of analysis, CBS Publishers and Distributers, 2004.
4. http://www.dst.gov.in/whats_new/whats_n07/tsd-format.pdf
5. http://www.ugc.ac.in/financialssupport/xiplan/mrpxiplan.pdf

Semester – III		
Self Study	**Chemistry For National Eligibility Test**	
Code : 19PCHSS1		**Credits : 2**

Inorganic Chemistry

1. Chemical periodicity
2. Structure and bonding in homo- and heteronuclear molecules, including shapes of molecules (VSEPR Theory).
3. Transition elements and coordination compounds: structure, bonding theories, spectral and magnetic properties
4. Inner transition elements: spectral and magnetic properties, redox chemistry, analytical applications.
5. Organometallic compounds: synthesis, bonding and structure and reactivity.
6. Analytical chemistry - separation, spectroscopic, electro- and thermoanalytical methods.
7. Bioinorganic chemistry: metalloenzymes, metal complexes in medicine.
8. Characterisation of inorganic compounds by IR, Raman, Mössbauer, UV-vis, MS, electron spectroscopy and microscopic techniques.

Organic Chemistry

1. IUPAC nomenclature of organic molecules including regio and stereoisomers.
2. Principles of stereochemistry: Configurational and conformational isomerism in acyclic and cyclic compounds; stereogenicity, stereoselectivity, enantioselectivity, diastereoselectivity and asymmetric induction.
3. Aromaticity: Benzenoid and non-benzenoid compounds – generation and reactions.
4. Organic reactive intermediates: Generation, stability and reactivity of carbocations, carbanions, free radicals, carbenes, benzynes and nitrenes.
5. Organic reaction mechanisms involving addition, elimination and substitution reactions with electrophilic, nucleophilic or radical species. Determination of reaction pathways.
6. Common named reactions and rearrangements – applications in organic synthesis.
7. Organic transformations and reagents: Functional group interconversion including oxidations and reductions; common catalysts and reagents (organic, inorganic, organometallic and enzymatic). Chemo, regio and stereoselective transformations.

Physical chemistry

1. Basic principles of quantum mechanics: Postulates; operator algebra; exactly-solvable systems: particle-in-a-box, harmonic oscillator and the hydrogen atom, including shapes of atomic orbitals; orbital and spin angular momenta; Tunnelling.
2. Approximate methods of quantum mechanics: Variational principle; perturbation theory up to second order in energy; applications.

3. Atomic structure and spectroscopy; term symbols; many-electron systems and antisymmetry principle.
4. Chemical bonding in diatomics; elementary concepts of MO and VB theories; Huckel theory for conjugated π-electron systems.
5. Chemical applications of group theory; symmetry elements; point groups; character tables; selection rules.
6. Chemical thermodynamics: Laws, state and path functions and their applications; thermodynamic description of various types of processes; 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.
7. Electrochemistry: Nernst equation, redox systems, electrochemical cells; Debye-Huckel theory; electrolytic conductance – Kohlrausch's law and its applications; ionic equilibria; conductometric and potentiometric titrations.
8. Polymer chemistry: Molar masses; kinetics of polymerization.
9. Data analysis: Mean and standard deviation; absolute and relative errors; linear regression; covariance and correlation coefficient.

Semester – IV			
Core XI	**Inorganic Chemistry - IV**		
Code : 19PCHC41	**Hrs / Week : 4**	**Hrs / Sem : 60**	**Credits : 4**

Vision:

To provide opportunity to get hands on experience in research oriented education.

Mission:

- To explain the various photophysical and photochemical processes involved in inorganic compounds.
- To understand the chemistry involved in energy sources of life and functions of enzymes.
- To discuss the theory of various types of nuclear reactions.
- To study in detail NMR, NQR and ESR spectroscopies.

Course Outcome:

CO No.	Upon completion of this course, students will be able to	PSO addressed	CL
CO - 1	develop the idea about the photo physical and photo chemical processes.	1,2	Ev
CO - 2	produce semiconductor electrodes and solar cells based on laws of photochemistry.	7	Cr
CO - 3	demonstrate the energy sources of life using photosynthetic and non-photosynthetic processes	4,5	Ap
CO - 4	illustrate the inhibition and poisoning of Xanthane oxidase and aldehyde oxidase.	5	Ap
CO - 5	explain the Iron transport and storage proteins.	3	Un
CO - 6	describe the tracer technique and counter technique in nuclear chemistry.	5,6	An
CO - 7	catagorise the principle and applications of NMR, NQR and EPR spectroscopy.	6,8	An
CO - 8	demonstrate the structural information from NMR and NQR spectra.	2,3	Ap

Semester – IV			
Core XI	**Inorganic Chemistry - IV**		
Code : 19PCHC41	**Hrs / Week : 4**	**Hrs / Sem : 60**	**Credits : 4**

Unit I Inorganic photochemistry

Photophysical processes - d-d and charge-transfer reactions, bimolecular deactivation and energy transfer - Photochemical processes: electron transfer reactions, isomerisation and substitution (Photoaquation , Photoanation Adamson's rules, Photorearrangement, Photo redox reations) - Photochemistry of Cr(III) and Co(III) complexes. Photochemistry of ruthenium polypyridyls - Applications of inorganic photochemistry: Photochemical conversion and storage of solar energy, semiconductor electrodes.

Unit II Bioinorganic chemistry I

Energy sources of life – Non photosynthetic process – Metalloporphyrins – Cytochromes A,B,C – Dioxygen binding – Interaction between Heme and Dioxygen, Binding of Dioxygen – Myoglobin – Structure and Functions of Hemoglobin – Electron transfer – Rubidoxins and Ferridoxins – Respiration – Bluecopper proteins – Photosynthesis-PS-I, PS-II - Photosynthesis with mechanism of Chlorophyll.

Unit III Bioinorganic chemistry II

Enzymes - Zinc enzymes : Carboxypeptidase A, Carbonic anhydrase, Inhibition and poisoning of enzymes illustrated by Xanthane oxidase, aldehyde oxidase - Copper enzyme : Superoxide dismutase - Toxicity of Metals and the role of Metallothionines - Vitamin B_{12} and coenzymes - Nitrogen fixation – Invitro and Invivo conditions - Iron storage and transport proteins – Transferrin and Ferritin.

Unit IV Nuclear Chemistry

Nuclear Reactions - Types, Q value, Cross Section of reactions - Direct nuclear reaction - transmutation reactions: Stripping and pickup - high energy reactions : neutron evaporation and spallation - Nuclear Fission: mass and charge distribution of fission products - fission energy - Fission neutrons - Theory of nuclear fission - Nuclear Fusion and stellar energy - Nuclear waste disposal – Radioactive techniques: i) Countering Techniques such as G.M Ionization and Proportional counters. ii) Tracer techniques (Neutron activation analysis).

Unit V Spectroscopy III

NMR - Principle, ^{31}P, ^{19}F and ^{15}N NMR - Applications of spin-spin coupling to structure determination: P_4S_3, BrF_5, Pentacyanohydridorhodate(III) ion,SF_4, TiF_4 , H_3PO_3, H_3PO_2 – Comparison between ^{1}H and ^{15}N- NMR of $^{15}NH_3$ – Comparison between ^{1}H,^{31}P and ^{19}F- NMR

of H_2PF_3 and HPF_2 - Double resonance - NMR of fluxional molecules such as PF_5, $(ή^1\text{-}C_5H_5)_2$ $(ή^5\text{-}C_5H_5)_2Ti$, $(ή^5\text{-}C_5H_5)_2Fe_2(CO)_4$ and PCl_2F_3.

EPR – Principle **-** Interaction between nuclear spin and electron spin (hyperfine coupling) - Hyperfine splitting in isotropic systems - Zero field splitting - Kramer's degeneracy - Applications to transition metal complexes such as bis(salicylaldimine)copper(II),$Cu(bpy)_3]^{2+}$ $[(NH_3)_5Co\text{-}O\text{-}O\text{-}Co(NH_3)_5]^{5+}$ and $[Fe(CN)_5NO]^{2-}$- Jahn - Teller distortion in Cu(II) complexes.

Text Books:

1. James. E. Huheey, Ellen. A. Keiter and Richard. L. Keiter, Inorganic Chemistry: Principles of Structure and Reactivity, Harper Collins College Publishers, 4th Edition, 1993.
2. Rohatgi Mukherjee K.K., Fundamentals of Photochemistry, New age international limited, 2006.
3. Arnikar H.J, Essentials of Nuclear Chemistry, Wiley Eastern Ltd., 4th Edition, 2000.

Books for Reference:

1. Shriver D.F., Atkins P.W. and Langford C.H., inorganic chemistry, ELBS, Oxford university Press, 1994.
2. Gary L. Miessler, Donald A. Tarr, Inorganic chemistry. Pearson Publications, third edition, 2014.
3. Catherine Housecroft, Alan G. Sharpe, Inorganic Chemistry, 4th Edition, Prentice Hall, 2012.
4. Albert Cotton. F, Geoffrey Wilkinson, Carlos. A. Manic and Manfred Bochman, Advanced Inorganic Chemistry, Wiley Interscience Publication, 6th edition, 1999.
5. Purcell K.F. and Kotz J.C, Inorganic Chemistry, WB Saunders Company, 1977.
6. Robert H. Crabtree, The Organometallic Chemistry of the Transition Metals, John Wiley & Sons, Inc., Publication, 6th Edn, 2014.
7. Lee J.D., Concise Inorganic Chemistry, Blackwell Science Ltd., 5th Edition, Reprint 2003.
8. Samuel Glasstone, Source Book of Atomic Energy, East West Pvt. Ltd., 1969.

SEMESTER – IV			
Core XII	**Organic Chemistry - IV**		
Code : 19PCHC42	**Hrs / Week : 4**	**Hrs / Sem : 60**	**Credits : 4**

Vision:

To Chemists are driving a molecular revolution of unprecedented magnitude and impact that will transform all of science and the world as we know it.

Mission:

- To demonstrate the ability to analyze data, access information and integrate information from various sources in order to solve problems.
- To develope more-economic and greener strategies for chemical synthesis and production
- To design strategies and catalysts for making chemical bonds in new ways

Course Outcome:

CO No.	Upon completion of this course, students will be able to	PSO addressed	CL
CO - 1	study the synthesis and Elucidation of structure of steroids and terpenoids	6	Re
CO - 2	learn the conversion of cholesterol to progesterone, estrogen and testosterone	8	Un
CO - 3	study the outline of retrosynthetic analysis with some examples	7	An
CO - 4	appraise the different retrosynthetic compounds	5	Ev
CO - 5	learn the concept of cyclo addition, Electrocyclic and sigmatropic reaction mechanism	6	Cr
CO - 6	explain the nomenclature, reactivity and spectral properties of heterocyclic compounds	3	Un
CO - 7	demonstrate the synthesis and reactivity of heterocyclic compounds	2	Ap
CO - 8	outline the salient features of fragmentation pattern of organic compounds	8	Ev

SEMESTER – IV			
Core XII	**Organic Chemistry - IV**		
Code : 19PCHC42	**Hrs / Week : 4**	**Hrs / Sem : 60**	**Credits : 4**

Unit I Steroids and Terpinoids

Introduction, Classification, Nomenclature – Structural elucidation of cholesterol, ergosterol, androsterone, testosterone, progesterone and Oestrone - Conversion of Cholesterol into 5α- and 5β-Cholanic acid - Non Steroid Hormones

Terpenoids – Introduction - General properties of terpenoids - General methods to elucidate the structure of terepenes - Structural determination of camphor, zingiberine, α-pinene, Limonene and squalene.

Unit II Retrosynthetic Analysis

Synthon - Synthetic equivalent – Functional group interconversions - Use of protecting groups for alcohols, amines, acids, carbonyl compounds - Use of activating and blocking groups - Robinson annulations reaction - Carbon skeletal complexity - Role of key intermediates in organic synthesis - Reterosynthetic analysis of the following compounds - Twistane, cis-jasmone, Baclofan, Brufen, Trihexylphenydyl, Bisabolene, a-onocerin, isonootkatone, cascarillic acid, camphor.

Unit III Pericyclic Reactions

Atomic and molecular orbitals – Woodward-Hoffmann rules - the Mobius and Huckel concept, FMO and correlation diagrams - Electrocyclic reactions - con and dis rotatory motions for 4n and 4n+2 system (butadiene and 1,3,5-hexatriene) - Stereochemical course of electrocyclic reaction in terms of conservation of orbital symmetry - Cycloaddition - suprafacial and antarafacial additions, [2+2] and [2+4] reactions (ethylene and butadiene) – Sigmatropic rearrangements.

Unit IV Hetrocyclic Reactions

Nomenclature, reactivity, aromaticity, spectral properties, Synthesis and reactions of Indole, Isoindole, Oxazole, Imidazole, Thiazole, Osotriazole, Pyrimidine, Pyridazine, Pyrazine.

Unit V Mass Spectroscopy

Mass spectrometry - Basic principle - Instrumentation - Techniques of Ion production – EI, CI, FD, FAB, ESI- MS, MALDI-MS - Base peak - Molecular ion and parent ion - Metastable ion - Isotope ion - Daughter ion – Factors affecting fragmentation and governing reaction pathway - factors governing reaction pathway - Nitrogen rule - Fragmentation pattern of various

classes of organic compounds - Hydrocarbons, alcohols, amines, aldehyde, ketone, ether, ester, acids and phenols, amides - Mc-Lafferty rearrangement.

Text Books:

1. Ahluwalia V.K and Parshar R.K, Organic Reaction Mechanism Fourth Edition , Narosa Publishing House, 2013.
2. Mukherjee K.S, Mechanism of Organic reactions, Books and Allied Ltd, Kolkota, 2010.
3. Kalsi P S,Organic Reaction & Mechanism, 4th Edition,New-Age International Publishers, New Delhi, 2011.
4. Raj K Bansal, Organic reaction mechanism, 4^{th} edition, New Age international publishers, New Delhi, 2012.
5. Gurdeep Chatwal, Organic Chemistry of Natural Products, Vol II, Himalaya Publishing House, Bombay, 2003.
6. Sharma Y.R, Elementry Organic spectroscopy, S.Chand & Company, New Delhi, 2011.
7. Jag Mohan, Organic spectroscopy Principles and Applications, Narosa Publishing House, New Delhi. Second Edition, 2011.

Books for Reference:

1. Finar I L, Organic Chemistry Volume I and II, Sixth Edition, ELBS with Longmann, Singapore, 1997.
2. Warren S, A Programmed Synthon approach- John Wiley & Sons, 2013.
3. Clayden, Greeves, Warren and Wothers, Organic Chemistry, Oxford University Press, New York, 2006.
4. Finar I L, Organic Chemistry Volume I and II, Sixth Edition, ELBS with Longmann, Singapore, 1997.

Semester – IV			
Core XIII	**Physical Chemistry - IV**		
Code : 19PCHC43	**Hrs / Week : 4**	**Hrs / Sem : 60**	**Credits : 4**

Vision

To understand the theories and applications of chemical kinetics.

Mission

- To elucidate the structure of chemical compounds by nuclear magnetic resonance spectroscopy.
- To gain knowledge about the principles of surface chemistry and catalysis.

Course Outcome:

CO No.	Upon completion of this course, students will be able to	PSO addressed	CL
CO - 1	explain the inter-linking of quantum chemistry and statistical thermodynamics that leads to classical thermodynamics.	1	Un
CO - 2	apply the concepts of statistical thermodynamics for the study of equilibrium reactions and reaction rates.	4	Ap
CO - 3	detect the use of chemical kinetics in understanding the reaction mechanisms.	2	Ev
CO - 4	apply the theories and concepts of chemical kinetics for homogeneous and heterogeneous catalysed reactions.	4	Ap
CO - 5	compare the different types of adsorption isotherm and improve the surface area in catalysis.	4	Ev, Cr
CO - 6	interpret nuclear quadrupole resonance and nuclear magnetic resonance.	3	Ev
CO - 7	examine the spin labeling studies of biomolecules using ESR spectroscopy.	7	An
CO - 8	judge the structure of molecules by applying various spectroscopic techniques.	5	Ev

Semester – IV			
Core XIII	**Physical Chemistry - IV**		
Code : 19PCHC43	**Hrs / Week : 4**	**Hrs / Sem : 60**	**Credits : 4**

Unit I Statistical Thermodynamics

Thermodynamic probability – Relation between entropy and probability (Boltzmann-Planck equation) – Ensembles - microstates and macrostates - Stirling's approximation - Maxwell-Boltzmann distribution law – Partition function - Translational, rotational, vibrational and electronic partition functions – Relationship between partition functions and thermodynamic properties – Evaluation of thermodynamic properties E, H, S, A, G, Cv and Cp for monoatomic and diatomic ideal gas molecule partition functions - Calculation of entropy of monatomic gases – Quantum statistics – Bose-Einstein (B.E.) and Fermi-Dirac (F.D.) distribution equations – Comparison of B.E. and F.D. statistics with Boltzmann statistics.

Unit II Chemical Kinetics

Theories of reaction rates - Arrhenius theory - Hard-sphere collision theory of gas phase reactions - Potential energy surfaces - Activated complex theory for ideal gas reactions (formation in terms of partition functions) - Relation between activated complex theory and hardsphere collision theory - Thermodynamic formulation - Activated complex theory (Enthalpies and entropies of activation) - Unimolecular reactions - Lindemann, Hinshelwood, RRK, RRKM and Slater theories - Kinetic isotopic effect.

Unit III Surface Chemistry & Catalysis

Surface phenomenon – Physical and chemical adsorptions - Adsorption and free energy relations at interface - Adsorption isotherms - Freundlich, Langmuir, Gibbs and BET adsorption isotherms - Measurement of surface area.

Catalysis - Homogeneous catalysis - Acid-base catalysis - Van't Hoff and Arrehenius complexes for Protropic and Protolytic mechanisms - Bronsted catalysis law - Hammett acidity function - Heterogeneous catalysis - Mechanism - Langmuir-Hinshelwood Mechanism - Langmuir- Rideal bimolecular mechanism - Role of surface in catalysis.

Unit IV Nuclear Magnetic Resonance Spectroscopy

Nuclear Magnetic Resonance Spectroscopy - Theory of PMR spectra - Chemical shift - Factors affecting chemical shift - Solvents used in NMR, solvents shift - Concentration and temperature effects - Hydrogen bonding - Relaxation times and spin-spin interactions - Theory of Spin - spin splitting - Magnitude of coupling - Coupling constant, J - Factors influencing coupling constant - First-order spectra of complex systems - NMR of simple AX and AMX type molecules - Calculation of coupling constants.

Unit V EPR and NQR spectroscopy

Electron Spin Resonance Spectroscopy - Basic principles - Factors affecting "g" value - Hyperfine splitting - Deuterium, methyl, benzene, naphthalene, anthracene, o-, p- and m-xylene, p-benzosemiquinone radicals - Calculation of electron density - McConnel equation - Fine structure in ESR - Zero field shifting and Kramer`s degeneracy - Double resonance – ELDOR and ENDOR.

Theory and Principle of NQR spectroscopy - Nature of electric field gradient - Energy levels and selection rules - Interaction of electric quadrupole with electromagnetic radiation - Nuclear orientations - The asymmetry parameter - Quadrupole transitions in spherical - Axially symmetric fields and not axially symmetric fields - Applications of NQR spectra.

Text Books:

1. Gupta.M.C, Statistical Thermodynamics, Wiley Easter Ltd., 1990.
2. Kuriacose and Rajaram, Kinetics and Mechanism of Chemical Transformation, Macmillan & Co, Delhi, 1993.
3. Banwell C N, Molecular spectroscopy, New Delhi, TATA McGraw Hill Co., 1997.

Books for Reference:

1. Lee.J.F, Sears.F.W and Turcottee.D.L, Statistical Thermodynamics, 1972.
2. Donald McQuarrie, Stastistical Thermodynamics, Indian Edition, Viva Books Private Ltd., New Delhi, 2003.
3. Ferrell L Hill, Introduction to Statistical Thermodynamics, Addison-Wesley Publishing Company, INC, London, 1962.
4. Frost A.A and Pearson R.G, Kinetics and Mechanism, Wiley Eastern, Pvt. Ltd, 1970.
5. Laidler.K.J, Chemical Kinetics, Third edition, New Delhi TATA McGraw Hill Co. 1984.
6. Drago R S, Physical Methods in Inorganic Chemistry, New Delhi, East West Press Ltd, 1971.
7. Chang R, Basic Principles of Spectroscopy, New Jersy, Englewood Cliffs, 1978.
8. Straughan B P and Walker S, Spectroscopy Volume 1,2,3, New York, London Chapman and Hall, A Halstet Press Book, John Wiley & Sons Ins. 1975.
9. Barrow G M, Introduction to Molecular Spectroscopy, Tata McGraw Hill Edition, 1993.
10. Gurdeep R Chatwal and Sham K Anand, Spectroscopy, Himalaya Publishing House, 2009.

Semester – III & IV			
Core Practical IV	**Inorganic Chemistry Practicals – II**		
Code : 19PCHCR4	**Hrs / Week : 4**	**Hrs / Sem : 60**	**Credits : 4**

1. Preparation of inorganic complexes (a minimum of 6 complexes)

    1. cis potassiumdiaquadioxalatochromate(II) dihydrate
    2. trans potassiumdiaquadioxalatochromate(II) dihydrate
    3. tristhioureacopper(I)chloride dihydrate
    4. hexathiourealead(II)nitrate
    5. pentaamminenitritocobalt(III) nitrate
    6. aquapentamminecobalt(III)chloride
    7. pentakisthioureadicopper(I) nitrate trihydrate
    8. Potassium triooxalatoferrate(III)nonahydrate
    9. pentaamminechlorocobalt(III) chloride
    10. tristhioureacopper(I)sulphate dihydrate

2. Quantitative estimation of a mixture containing two metal ions (Volumetric and Gravimetric estimations).
    1. Estimation of Cu^{2+} and Ni^{2+} ions.
    2. Estimation of Cu^{2+} and Zn^{2+} ions.
    3. Estimation of Fe^{2+} and Cu^{2+} ions.
    4. Estimation of Fe^{2+} and Ni^{2+} ions.
    5. Estimation of Ca^{2+} and Mg^{2+} ions.
    6. Estimation of Ca^{2+} and Ba^{2+} ions.

3. Analysis of ores and alloys (Course work only).

Note: For examination, a mixture may be given from which one cation is to be estimated volumetrically and the other gravimetrically.

Books for Reference:

1. Mendtam. J et. al., Vogel's Text book of Quantitative Chemical Analysis, Pearson Education, 6th Edition, 2009.

SEMESTER – III & IV			
Core Practical V	**Organic Chemistry Practicals – II**		
Code : 19PCHCR5	**Hrs / Week : 4**	**Hrs / Sem : 60**	**Credits : 4**

1. Quantitative Analysis

i) Estimation of ethyl methyl ketone

ii) Estimation of glucose - Lane Eynon method

iii) Estimation of glucose - Bertrand's method

iv) Determination of saponification value of oil.

v) Estimation of iodine value of oil.

vi) Estimation of Acetone by Messinger's method.

vii) Estimation of phenol

viii) Estimation of aniline.

2. Preparation of Organic compounds (Double stage)

i) Preparation of p-bromoaniline from acetanilide

ii) Preparation of m-nitrobenzoic acid from ethyl benzoate

iii) Preparation of p-nitro aniline from acetanilide

iv) Preparation of 1, 3, 5-tribromobenzene from aniline

v) Preparation of benzpinacolone from benzophenone

vi) Preparation Benzilic acid from Benzoin

3. Course work

i) Estimation of Ascorbic acid

Books for Reference:

1. Vogel's Textbook of Practical Organic Chemistry, B.S. Furniss, A.J. Hannaford, P.W.G.Smith, and A.R. Tatchell, V Edition, Pearson Education Ltd., 1997.
2. Gnanapragasam and Ramamurthy, Organic Chemistry Lab Manual, Second Edition, S.Vishwanathan Printers and Publishers (P) Ltd., Chennai, 2000.
3. Ragupathi Mukhopadhyay, Pratul Chatterjee, Advanced Practical Chemistry, Books and Allied (p) Ltd., Third edition, 2007
4. Bidhan Chandra Ray, Satyanarayan Das, A textbook on Chemistry Practical, New Central Book Agency Ltd, London, 2014.

Semester – III & IV			
Core Practical VI Physical Chemistry Practicals – II			
Code : 19PCHCR6	Hrs / Week : 4	Hrs / Sem : 60	Credits : 4

1. Potentiometry

1. Determination of solubility product of sparingly soluble salts.
2. Determination of dissociation constant of a weak acid.

2. Potentiometric titrations

a) Redox titrations	**b) Precipitation titrations**
i) Fe^{2+} Vs $Cr_2O_7^{2-}$	i) Cl^- Vs $AgNO_3$
ii) I^- Vs MnO_4^-	ii) I^- Vs $AgNO_3$
iii) Fe^{2+} Vs Ce^{2+}	iii) Mixture of Cl^- and I^- Vs $AgNO_3$

3. Adsorption:

Adsorption of acetic acid / oxalic acid on activated charcoal - Verification of Freundlich isotherm - Determination of unknown concentration.

4. Conductivity method

Study of kinetics of ester hydrolysis and comparison of acid strength by conductivity method.

5. Spectroscopy

Verification of Beer-Lambert's law. Determination of $[Mn^{2+}]$ and $[Cr^{3+}]$ by using UV-Visible spectrophotometer.

Books for Reference:

1. Viswanathan.B and Raghavan.P.S, Practical Physical Chemistry, Viva Books Pvt.LTD., 2005.
2. Michell.J.Sienko, Robert.A, Plane, Stanley.T. Martu, Experimental Chemistry, International Student Edition, 1984.
3. Athawale V D, Parul Mathur, Experimental Physical Chemistry Practicals, New Age International Publishers, 1st Edition, 2017.
4. Peter Mathews.G , Experimental Physical Chemistry, Clarendan Press Oxford, 1985.

Semester – IV			
Project			
Code : 19PCHP41	**Hrs / Week : 6**	**Hrs / Sem : 90**	**Credits : 6**

Format for preparation of project report

1. Identification of the problem

Students are given the freedom of choosing the topic of the project. It may be theoretical or practical.

2. Arrangement of contents

The sequence in which the project report material should be arranged and bound should be as follows:

- Cover page and Title page
- Bonafide Certificate
- Abstract
- Table of contents
- List of Tables
- List of Figures
- List of Symbols, Abbreviations & Nomenclature
- Chapters
- Appendices
- Books for Reference

3. Page dimension and binding specifications

- The dimension of the project report should be in A4 size. The project report should be bound using flexible cover of the thick white art paper. The cover should be printed in black letters and the text for printing should be identical.
- Total number of pages should not exceed 70.

4. Typing instructions

- The impression on the typed copies should be black in colour.
- One and a half spacing should be used for typing the general text. The general text shall be typed in the Font style “Times New Roman” & Font size 12.