NOORUL ISLAM CENTRE FOR HIGHER EDUCATION

(Deemed to be University Under Section 3 of the UGC Act, 1956)
Kumaracoil, Thuckalay

DEPARTMENT OF CHEMISTRY

M.Sc. CHEMISTRY

CURRICULUM AND SYLLABI

REGULATION 2021

NOORUL ISLAM CENTRE FOR HIGHER EDUCATION,
Kumaracoil
Regulation : 2021
Curriculum and Syllabi
M.Sc Programme
DEPARTMENT OF CHEMISTRY
M.Sc CHEMISTRY

Vision of the University

To be recognized by the Government and society at large as an institution able to deliver excellence with relevance in the field of higher education and research focusing on the needs of the nation in tune with the technological revolution to cope with the knowledge explosion and global competence.

Mission of the University

To develop the institution as a Centre of Excellence, keeping pace with the advances in the field, so as to provide quality higher education to the students and instill in them high standards of discipline and ethics so that they become enlightened individuals in the service of humanity and to carry out focused research in the frontier areas of science and technology.

Faculty of Chemistry

Department of Chemistry

Vision of the Department

To scientifically explore and emerging trends in new and chemical frontiers in the life sciences, physical sciences, medicine and material sciences through visionary research, innovations, scholarship and collaboration with industry professionals.

Mission of the Department

The Chemistry department provides rigorous preparations of students whose career path require expertise in chemistry. We are dedicated to produce and develop better attributes in terms of knowledge skill, communications, research performance and professional behavior. We offer effective training, educational and technological services to the society.

Description of the programme

Programme Educational Objectives - PEO	
PEO-01	Accelerate his/her thinking skills with the sound objective of problem solving at the forefront, on the basis of exposure to the curriculum based knowledge of chemical sciences.
PEO-02	Display greater respect to the cause –effect relationship which eventually creates new avenues and designs innovative pathways.
PEO-03	Integrate creative learning in his/her day-to-day activities with the needed confidence to embrace challenges.
PEO-04	Avail the opportunity to explore the knowledge of chemical sciences with related disciplines, in particular knowledge of synthetic methods, knowledge and application of analytical techniques with specific orientation towards industries.
PEO-05	Avail the benefit of enormous job avenues in different domains such as – academics, pharmaceutical industries, analytical laboratories, scientific organizations, entrepreneurship, administrative positions etc

Graduate attributes	
GA-1	Acquire in-depth knowledge and expertise in specific scientific disciplines, building upon foundational concepts to explore advanced theories, methodologies, and applications in the chosen field of study
GA-2	Demonstrate proficiency in designing, conducting, and interpreting complex research experiments, utilizing advanced research methodologies, tools, and technologies to contribute to scientific innovation and discovery
GA-3	Use sophisticated data analysis techniques, statistical tools, and computational models to solve complex scientific problems, make data-driven decisions, and predict outcomes in research and industry settings
GA-4	Develop advanced critical thinking and problem-solving skills, enabling the formulation of innovative solutions to theoretical and practical challenges in scientific research and application
GA-5	Work effectively in interdisciplinary teams, integrating knowledge from various scientific domains to tackle complex, real-world problems, and demonstrate leadership in collaborative research and professional projects

GA-6	Apply scientific principles to address environmental challenges, promote sustainability, and contribute to the development of environmentally responsible technologies and practices
GA-7	Uphold the highest standards of ethical conduct and professional integrity in scientific research, ensuring responsible data handling, experimentation, and reporting in accordance with global scientific standards
GA-8	Master cutting-edge laboratory techniques, instrumentation, and scientific tools, utilizing them to conduct sophisticated experiments and research that contribute to scientific progress and innovation
GA-9	Develop strong communication skills, capable of presenting complex scientific concepts, research findings, and technical information clearly and persuasively to both scientific and non-scientific audiences, including through publications and presentations
GA-10	Embrace a commitment to lifelong learning, staying updated with the latest scientific advances, technologies, and best practices, and continuously developing skills to remain at the forefront of the scientific community

Programme Outcome - PO	
PO-A	Students will have the ability to: Work effectively and safely in the chemical laboratory
PO-B	Think critically and analyzing chemical problems
PO-C	Use laboratory data and instrumentation values to analyze chemical molecules
P0-D	Apply modern methods of analysis to chemical systems in a laboratory
PO-E	Work in teams as well as individually

Mapping of Graduate Attributes and Programme Educational Objectives(PEO)

GAs / PEOs	GA-01	GA-02	GA-03	GA-04	GA-05	GA-06	GA-07	GA-08	GA-09	GA-10	GA-11	GA-12
PEO-01	H	A	A	A	H	A	A	H	H	A	H	A
PEO-02	A	A	H	A	A	A	H	H	A	H	H	H
PEO-03	H	A	A	A	A	H	H	H	A	H	A	A
PE0-04	H	H	A	A	A	A	H	H	A	A	H	H
PEO-05	A	A	H	H	H	A	A	H	A	H	A	A

H- Highly Associated A- Associated Not – Not Associated

Mapping of Graduate Attributes and Programme Outcomes (PO)

GAs / PEOs	GA-01	GA-02	GA-03	GA-04	GA-05	GA-06	GA-07	GA-08	GA-09	GA-10
PO-A	A	H	A	H	A	H	H	A	H	A
PO-B	A	A	A	A	H	A	A	H	A	A
PO-C	A	A	H	A	A	A	H	A	A	A
P0-D	A	A	H	A	A	A	A	A	A	A
PO-E	H	H	H	A	H	H	A	H	H	A

H- Highly Associated A- Associated Not – Not Associated

Mapping of Programme Educational Objective (PEOs) and Programme Outcomes (POs)

PEO / PO	PEO-01	PEO-02	PEO-03	PEO-04	PEO-05
PO-A	A	A	A	H	H
PO-B	A	A	A	A	H
PO-C	H	A	A	H	A
P0-D	A	H	A	A	H
PO-E	H	A	A	H	A

H- Highly Associated A- Associated Not – Not Associated

Duration of the programme: 2 Years/ IV Semesters

Total credit : 92

CURRICULUM & SYLLABI

SEMESTER I

Sl. No	Course Code	Course Title	L	T	P	C
THEORY						
1.	**CH3701**	**Organic Chemistry I**	4	1	0	5
2.	**CH3702**	**Inorganic Chemistry I**	4	1	0	5
3.	**CH3703**	**Physical Chemistry I**	4	1	0	5
4.	**CH3704**	**Basic Principles of Spectroscopic Techniques**	4	1	0	5
PRACTICAL						
5.	**CH3771**	**Organic Chemistry Lab**	0	0	6	6
TOTAL			16	4	6	26

SEMESTER II

Sl. No	Course Code	Course Title	L	T	P	C
THEORY						
1.	**CH3705**	**Organic Chemistry II**	4	1	0	5
2.	**CH3706**	**Inorganic Chemistry II**	4	1	0	5
3.	**CH3707**	**Physical Chemistry II**	4	1	0	5
4.	**CH37X1**	**Elective Paper**	3	1	0	4
PRACTICAL						
5	**CH3772**	**Inorganic Chemistry Lab**	0	0	6	6
TOTAL			15	4	6	25

SEMESTER III

Sl. No	Course Code	Course Title	L	T	P	C
THEORY						
1.	**CH3709**	**Organic Chemistry III**	4	1	0	5
2.	**CH3710**	**Inorganic Chemistry III**	4	1	0	5
3.	**CH3711**	**Physical Chemistry III**	4	1	0	5
4.	**C37X2**	**Elective Paper**	3	1	0	4
PRACTICAL						
5	**CH3773**	**Physical Chemistry Lab**	0	0	6	6
TOTAL			15	4	6	25

SEMESTER IV

Sl. No	Course Code	Course Title	L	T	P	C
THEORY						
1.	**CH37AX**	**Elective - I**	3	1	0	4
2.	**CH37AXX**	**Elective - II**	3	1	0	4
PRACTICAL						
3.	**CH37P1**	**Project and Viva - Voce**	0	0	6	6
TOTAL			6	2	6	14

SEMESTER I

Sl. No	Course Code	Course Title	L	T	P	C
THEORY						
1.	**CH3701**	**Organic Chemistry I**	4	1	0	5
2.	**CH3702**	**Inorganic Chemistry I**	4	1	0	5
3.	**CH3703**	**Physical Chemistry I**	4	1	0	5
4.	**CH3704**	**Basic Principles of Spectroscopic Techniques**	4	1	0	5
PRACTICAL						
5.	**CH3771**	**Organic Chemistry Lab**	0	0	6	6
TOTAL			16	4	6	26

CH3701	**Organic Chemistry I**	**L**	**T**	**P**	**C**
		4	**1**	**0**	**5**

OBJECTIVES

The Organic Chemistry-I paper was framed with different topics inclusive of reaction mechanism and stereochemistry. The students will be able to learn the following key aspects:

(i) Different effects (inductive, mesomericetc)

(ii) basics of reaction mechanism

(iii) naming reactions

(iv) aromatic character

(v) stereochemical aspects

Course Outcome		Cognitive Skill
CO-01	Students will be able tounderstand thechemical bonding of organic molecules and influence of different substituents	U,An,E
CO-02	Students will be able to learn the basics of reaction mechanism	S, A
CO-03	Students will be able to understand the different naming reactions and addition reactions	U, An
CO-04	Students will be able to study the aromaticity	R,E
CO-05	Students will be able to describe stereochemistry of organic molecules	R,U,An

R-Remember,U-Understand,A-Apply,An-Analyze,E-Evaluate, S-Synthesis

Mapping of Course Outcome with Programme Outcome

PO / CO	POA	POB	POC	PO-D	POE
CO-01	M	S	S	M	L
CO-02	S	M	S	S	M
CO-03	M	S	S	M	L
CO-04	M	S	M	S	S
CO-05	L	M	N	M	S

S-Strong, M-Medium,L-Low,N-Not relevant

Unit-I **9**

Polar effects in organic molecule:

Inductive effect –inductomeric effect-electromeric effect- mesomeric effect - steric inhibitionof resonance - 'p□-d□' bonding -hyperconjugation -cross-conjugation - hydrogen bonding - acidity, basicity, Dipole moment; Organic acids and bases; their relative strength, factors affecting the strength of acids and bases-Ionization constants, levelling effect-comparative strengths of acetic acid and its halogenated derivatives-Comparative strengths of aliphatic primary amines.

Unit -II: Reaction Mechanism: **9**

Kinetic and thermodynamic requirements. kinetic and thermodynamic control, Hammond Postulate, microscopic reversibility, Curtin-Hammet principle, energy profile diagram, intermediates *Vs* transition-states, The Hammett equation and linear free energy relati onships – substitution and reaction constants – Taft equation

Methods of determining reaction mechanism: Nonkinetic methods-Identification ofproducts, intermediates, stereochemistry, crossover experiments, nonkinetic isotopic labeling. Kinetic methods-order, molecularity, influence of ionic strength (salt effects), primary and secondary isotopic effects.

UNIT-III Addition Reactions **9**

Electrophilic, nucleophilic and free radical additions - Orientation and stereochemistry of addition of halogens and hydrogen halides to carbon-carbon multiple bonds - hydroboration, Sharpless asymmetric epoxidation and hydroxylation - Addition to □, □ - unsaturated carbonyl compounds - Michael reaction - condensation reactions - Perkin, Knoevenagel, Stobbe, Darzens, Sandmeyer, and Ullmann reactions.

Unit-IV Stereochemistry **9**

Optical isomerism: Symmetry elements and chirality, necessary and sufficient condition for chirality - concept of prochirality - enantiotropic and diasterotropic-Fischer, Sawhorse and Newmann projection formulae and their interconversions - calculations of number of stereoisomers - R, S noations- atropisomerism - molecular dissymmetry - optical activity of allenes and spiranes - Cram's rule, Prelog's rule- stereoselective and stereospecific syntheses.

Geometrical isomerism: E-Z nomenclature - stereoisomerism in monocyclic compoundsupto 6 membered rings - decalins and decalols, perhydrophenanthrenes and perhydroanthracenes. Conformation and reactivity of six membered ring systems.

Unit-V **9**

a) Aromaticity

Definitionm, Huckel's Rule, Characteristics of Aromatic compounds- alternant and nonalternant hydrocarbons - concept of aromaticity, homoaromaticity and antiaromaticity

- systems of 2, 4, 8 and 10-□ electrons and larger cyclic □ systems- aromaticity of azulenes, annulenes, fulvenes, tropolones, sydnones, and fullerenes(C_{60} only)

b) Reactive Intermediates: Formation, structure, and stabilization of carbocations,carbanions, free radicals, carbenes, and nitrenes.

TOTAL: 60 PERIODS

REFERENCES:

1. Peter Sykes, A Guidebook to Mechanism in Organic Chemistry, Orient Longman, New Delhi, 1989.
2. Jerry March, Advanced Organic Chemistry, 4th edition, John Wiley & Sons Inc., New York, 1992.
3. S. M. Mukherji and S.P Singh, Reaction Mechanisms in Organic Chemistry, Macmillan India Ltd., New Delhi, 1997.
4. G. M. Badger Aromatic Character and Aromaticity, Cambridge, 1969.
5. V. M. Potapov, Stereochemistry, MIR Publishers, Moscow, 1979.
6. E. L. Eliel and S. H Wilen, Stereochemistry of Organic Compounds, John Wiley & Sons, Inc. 1994.
7. D. Nasipuri, Stereochemistry of Organic Compounds, Principles and Applications, New Age International (P) Ltd., New Delhi 2000(Second Edition).
8. J. Clayden, N. Greeves, S. Warren and P. Wothers, Organic Chemistry, Oxford University Press Inc., New York, 2001.
9. V. K. Ahluwalia and R. K. Parashar, Organic Reaction Mechanisms, Narosa Publishing House, 2002.

CH3702	Inorganic Chemistry I	L	T	P	C
		4	1	0	5

Objective: To understand the basic concepts in inorganic chemistry.

To gain the knowledge about VSEPR theory.

To get an idea about solids.

To provide an information on nuclear chemistry.

Course Outcome - COs		Cognitive Skill
CO-01	To explain the concepts of VSEPR theory, multicenter bonding and BCS theory	U, A, An
CO-02	The students will be able to demonstrate a general understanding of lanthanide and actinide contraction	R,A,E

CO-03	Explain the electronic structure of solids and physical properties of nonstoichiometric effects.	U, A ,An, S
CO-04	Get an idea about spectral and magnetic characteristics of lanthanides.	R, A, An
CO-05	To understand the applications of redox potentials to inorganic reactions.	U, A, An, S

R- Remember, U-Understand, A-Apply, An-Analyze, E-Evaluate, S- Synthesis

Mapping of Course Outcome with Programme Outcome

PO / CO	PO-A	PO-B	PO-C	PO-D	PO-E
CO-01	S	L	M	S	S
CO-02	S	S	M	M	S
CO-03	S	S	S	M	L
CO-04	S	S	L	M	M
CO-05	S	S	S	S	S

S- Strong, M- Medium, L-Low, N- Not Relevant

Unit-I Solid State Chemistry **9**

Crystal defects: point, line and plane defects-intrinsic point defects: Schottky and Frenkel defects- extrinsic point defects: non-stoichiometric defect- preparation and physical properties of non–stoichiometric compounds, colour center.

Electronic structure of solids: free electron and band theories – types of solids: insulators, intrinsic and extrinsic semiconductors – optical and electrical properties of semiconductors: photovoltaic and Hall Effects-Superconductor, BCS Theory.

Unit II - Nuclear Chemistry **9**

Radioactive decay and equilibrium, Shell and liquid drop model of the nucleus; types of nuclear reactions- Meson theory of nuclear forces - fission and fusion; fission products and fission yields, nuclear reactors, nuclear power projects in India - radioactive techniques (isotope dilution method and neutron activation analysis), counting techniques (G.M., ionization, scintillation and proportional counters).

Unit III: Non aqueous solvents and electrode potentials **9**

General properties and classification of solvents. Self-ionizationand leveling effect. Liquid dinitrogen tetra oxide (N_2O_4), Liquid NH_3, Liquid SO_2, Liquid HF.
Electrochemical cell – Types of electrodes (metal-metal ion electrodes, gas -gas ion electrodes, metal-metal insoluble salt- anion electrodes).

Unit IV: Lanthanides and Actinides **9**

Unit IV: Lanthanides and Actinides Lanthanides: Characteristic properties. Electronic configuration, Occurrence and Separation techniques. Oxidation states. Spectral and magnetic properties.

Actinides: Occurrence and general properties. Electronic configuration, Oxidation states. Spectral and magnetic properties. Similarities between Lanthanides and Actinides. Lanthanide and Actinide Contraction-Applications of lanthanides, actinides and their compounds.

Unit V- Covalent and Ionic bonding **9**

VB approach to covalent bonding – Heitler-London, Pauling – Slater refinements, Hybridization and structure of molecule. VSEPR theory-Shape of molecules.MO approach to covalent bonding- Fajans rules- The concept of multi centre bonding. Structure and bonding in fluorine and oxygen compounds of xenon and krypton. Bonding in simple tri atomic molecules/ ions. Lattice energy and its calculations by Born-Lande and born-meyer equations-Determinations by Born-haber cycle-Kapustinski equation, energetic of dissolution of ionic compounds in polar solvents. Properties of ionc compounds-Hardness and electrical conductivity.

TOTAL: 60 PERIODS

REFERENCES

1. James E. Huheey, Ellen A. Keiter and Richard L. Keiter, Inorganic chemistry: principles Structure and Reactivity, 4th Ed., Harper College Publishers, 1993.
2. F. Albert Cotton, Geoffrey Wilkinson, Carlos A. Marilo and Manfred Bochman, Advanced Inorganic Chemistry, Wiley Interscience Publication, 6th Ed., 1999.
3. G.S. Manku, Theoretical Principles of Inorganic chemistry, Tata McGraw Hill, 12th reprint, 2004.
4. K.F. Purcell and J.C. Kotz, Advanced Inorganic Chemistry, Saunders Golden Publishers.
5. B.E. Douglas, D.H. McDaniel and J.J. Alexander, Concepts and Models of Inorganic Chemistry, John Wiley and Sons Ltd. 2nd Ed., 1983.
6. M.c. Day Jr and J. Selbin., Theoretical Inorganic Chemistry, 2nd Ed., East West Press, 2000.
7. J.D. Lee, Concise Inorganic Chemistry, ELBS, 2006.
8. A. R. West, Solid State Chemistry and its Application, John Wiley & Sons, (Asia), 1998.
9. T. Kutty, J. Tareen, Fundamentals of Crystal Chemistry, University Press, 1st Ed., 2001.
10. L.V. Azaroff, Introduction to Solids, Tata McGraw Hill Publishing Ltd., India, 1989.
11. C. Kittel, Introduction to Solid State Physics, Wiley Eastern Ltd., 5th Ed., 1993.
12. H.V. Keer, Principles of the Solid State, Wiley Eastern Ltd., 1993.
13. D.K. Chakrabarthy, Solid State Chemistry, New Age International.

14. A.F. Wells, Structural Inorganic Chemistry, Oxford Science Publication, London, 1979.
15. M.T. Weller, Inorganic Materials Chemistry, Oxford University Press, Reprint 1996.
16. B. Sahoo, N. C. Nayak, A. Samantaray, P.K. Pujapanda, Inorganic Chemistry, PHI Learning, New Delhi, 2012.
17. Structural Principles of Inorganic Chemistry-Addison
18. Inorganic Chemistry-Gilreath

CH3703	Physical Chemistry I	L	T	P	C
		4	1	0	5

Objectives: to get an idea about theory of unimolecular reactions to know the kinetics of thermal reactions to understand acid base catalysis

Course Outcome - COs		Cognitive Skill
CO-01	Students will be able to understand the theory of unimolecular and bimolecular reactions.	U
CO-02	Students will be able to impart knowledge in chemical kinetics and decomposition reactions	R
CO-03	Students will .be able to apply the kinetics in enzyme mechanisms and catalysis	E
CO-04	Students will be able to analyse the basics of electrochemistry and determination of thermodynamic parameters	An
CO-05	Students will be able to describe the applications of polarography, overvoltage, coulometry and recall batteries.	A

R- Remember, U-Understand, A-Apply, An-Analyze, E-Evaluate, S- Synthesis

Mapping of Course Outcome with Programme Outcome

PO / CO	PO-A	PO-B	PO-C	PO-D	PO-E
CO-01	S	S	M	M	L
CO-02	S	M	S	L	S
CO-03	M	S	S	M	L
CO-04	S	S	M	S	S
CO-05	L	M	S	M	S
CO-06					

S- Strong, M- Medium, L-Low, N- Not Relevant

Unit I: Chemical Kinetics-1 **9**

Theory of bimolecular reactions- collision, theory – Absolute reaction rate theory (ARRT) including Thermodynamic formulation of the reaction rates. Potential energy surfaces. kinetic isotope effect. Unimolecular reactions-Lindemann-Christiansen hypothesis, Hinshelwood, RRK, RRKM and Slater theories.

Unit II: Chemical Kinetics-II **9**

Kinetics of complex reactions- Parallel reactions, opposing reactions, consecutive reactions and chain reactions, steady state treatment, kinetics of H_2-$Cl_2$and H_2-Br_2reactions Rice-Herzfeld mechanism explosions-Hydrogen- Oxygen reaction.Factors affecting reaction rates in solutions, effect of dielectric constant, ionic strength and pressure.

Unit III: Chemical Kinetics-III **9**

Enzyme catalysis- effect of substrate concentration, pH and temperature - Kinetics of enzymatic reaction: Michaelis - Menton treatment, evaluation of Michaelis 's constant for enzyme - substrate binding by Lineweaver - Burk plot, by Dixon and by Eadie- Hofstae methods. Competitive and non-competitive inhibition. mechanisms of acid-base catalysis; salt effect, acidity functions and their importance; Bronsted catalysis law.

Unit-IV: Electrochemistry-I **9**

Debye-Huckel theory of strong electrolytes, Debye-Huckel-Onsager equation and its derivation, limitation of the model, conductance at high frequencies and high potentials – Wein effect and Debye - Falkenhagen effect. - Debye Huckel Limiting law- derivation and verification-Activity and activity coefficient of electrolytes, Types of electrodes. Electrochemical cells. Liquid junction potential. EMF-measurements- applications Evaluation of thermodynamics properties

UNIT – V: Electrochemistry II **9**

Electrode Kinetics - Butler volmer equation- Tafel equation-electrical double layer- zeta potential- stern theory-types of electrokinetic effects-; polarography- principle and applications; coulometric titration. over voltage- hydrogen over voltage, theories of over voltage, factors affecting over voltage Corrosion and its control. fuel cells

TOTAL: 60 PERIODS

REFERENCE

1. K. J. Laidler, Chemical kinetics, 2nd Edition, Tata McGRaw- Hill, New Delhi, 1991
2. K. J. Laidler, Theories of Chemical Reaction Rates, McGRaw- Hill, New Delhi, 1969.
3. D. V. Roberts , Enzyme kinetics, Cambridge Universty Press, Cambridge, 1977.
4. J. C. Kuriacose, Catalysis, Macmillan Indian Ltd., New Delhi 1991.
5. W. J. Moore, Basic physical chemistry, Prentice Hall, 1986.
6. S. Glasstone, An introduction to electrochemistry, Van Nostrand, New York 1965.
7. J. D. M. Bockris, A. K. N. Reddy, Modern Electrochemistry, Vol. I & II, Plenum Press, New York, 3rd Reprint, 1977.
8. J. Bard, L. R. Faulkner, Electrochemical Methods: Fundamentals and Application. John Willey and Sons, New York, 1980.
9. D. R. Crow, Principles and applications of Electrochemistry, Chapman and hall, London 1979.

CH3704	Basic Principles of Spectroscopic Techniques	L	T	P	C
		4	1	0	5

Objective:

To understand the basic concept in UV, IR, NMR and ESR spec spectroscopy.

To gains the knowledge about mass spectroscopy.

To gets an idea about Raman and Mossbauer spectroscopy.

Course Outcome – Cos		Cognitive Skill
CO-01	The students will be able to demonstrate the basic knowledge of UV and IR spectroscopy.	U, An
CO-02	Understand the working principle of NMR and ESR spectroscopy.	An, S
CO-03	Get an idea about mass spectroscopy and also analyse the samples by thermal methods.	E,A
CO-04	Explain the working principle of Raman and mossbauer spectroscopy.	A, An, E

CO-05	Recognize the crystal structures by using XRD and neutron diffraction studies.	S,R,E

R- Remember, U-Understand, A-Apply, An-Analyze, E-Evaluate, S- Synthesis

Mapping of Course Outcome with Programme Outcome

PO / CO	PO-A	PO-B	PO-C	PO-D	PO-E
CO-01	S	L	M	S	S
CO-02	S	S	M	M	S
CO-03	S	S	S	M	L
CO-04	S	S	S	M	M
CO-05	M	M	S	S	S

S- Strong, M- Medium, L-Low, N- Not Relevant

Unit I Chromatography Techniques 9

Chromatography: Classification-Column-Paper and Thin Layer Chromatography. HPLC- outline study of Instrument modules. Ion-Exchange chromatography-Theory, Applications of chromatographic techniques. Gel Permeation chromatography.

Unit-II Electrogravimetry 9

Coulometry: Principle and Instrumentations (Constant current and constant voltage instruments, potentiostatic, coulometry), Coulometric titrations – Apparatus, Specific Applications of Coulometry., advantages and limitations, problems.

Cyclic Voltammetry and Amperometry: Principle, instrumentation, RandlesSevcik equation, Applications (cyclic voltamogram of $K_3[Fe(CN)_6]$), amperometric titrations.

Unit -III: UV - Visible and IR spectroscopy 9

Basic Instrumentation for UV-Vis., and IR spectrometry- Single beam and double beam instruments, FT-IR, Fundamental Laws of photometry- Deviations from Beers lawPhotometric accuracy –Relative photometric error- Nepholometry and turbidimetry. Applications of UV-Visible spectroscopy and IR spectroscopy.

Unit IV : NMR and ESR spectroscopy 9

Nuclear Magnetic Resonance spectroscopy: Origin - Shielding and deshielding mechanism -chemical shift - spin -spin interaction - coupling constant.

Electron Spin Resonance spectroscopy: Theory of ESR - comparison between ESR and NMR - hyperfine coupling.

Unit V : Mass Spectrometry and TGA/DTA 9

Mass Spectrometry: Ionization sources - simple instrumentation techniques - molecular ions -metastable ions.

TGA/DTA: Differential thermal analysis (DTA) - Differential scanning colorimetry (DSC) - Thermogravimetric analysis (TGA) - methodology of TGA/DTA.

TOTAL: 60 PERIODS

References

1. H. H. Willard, L. L. Merritt, J. A. Dean and F. A. Settle, Instrumental methods of Analysis, 7th EDN, CBS Publishers, 1986.
2. R. West, Solid state chemistry and its application, wiley, Reprint 2004.

CH3771	Organic Chemistry Lab	L	T	P	C
		0	0	6	6

Objectives

Gain an understanding of composition of matter and its properties.

Recognize the ways that elements are combined to form compounds (ionic, covalent, and dative bonding).

Be able to write and balance chemical equations and perform calculations involving equations.

Be able to draw structural formulas of organic molecules, recognize the classes of organic molecules, and learn about how the different classes react to various reagents.

Apply the principles organic chemistry to the molecules that form the basis of life.

Learn the characteristics of the four classes of biochemical molecules.

Apply the principles listed above to understand anabolism and catabolism.

Course Outcome - COs		Cognitive Skill
CO-01	Students will be able to understand the reactions such as bromination, oxidation, reduction, hydrolysis, acetylation etc.	A
CO-02	Students will be able to assign IR spectra of the synthesized components recorded	An
CO-03	Students will be able to explain the estimation of phenol, aniline, methyl ethyl ketone, glucose.	E
CO-04	Students will be able to analyze the separation of organic mixture into the components	S

CO-05	Be able to describe the estimation of amino acids, nitro group etc	U

R- Remember, U-Understand, A-Apply, An-Analyze, E-Evaluate, S- Synthesis

Mapping of Course Outcome with Programme Outcome

PO / CO	PO-A	PO-B	PO-C	PO-D
CO-01	M	S	S	L
CO-02	M	S	S	S
CO-03	S	S	M	M
CO-04	S	M	M	L
CO-05	S	S	M	M

S- Strong, M- Medium, L-Low, N- Not Relevant

1. Double stage preparations involving reactions such as bromination, nitration, oxidation, reduction, hydrolysis, diazotization, acetylation *etc*.
2. IR spectra of the synthesized components recorded (demonstration only).
3. Estimation of phenol, aniline, methyl ethyl ketone, glucose (both Bertrand's and Lane and Eynone methods).
4. Extraction of caffeine from tea leaves, piperine from black pepper, lycopene from tomatoes, limonene from orange peeels, ascorbic acid from lemon or gooseberry, eugenol from cloves (demonstration only).
5. Determination of Rf values by thin layer chromatography (TLC) (demonstration only).
6. Estimation of amino acids, nitro group, carboxylic acid, formalin, and acetyl group (for class work only)

Micro methods may be used wherever possible.

7. Separation of organic mixture into the components (demonstration only). 8. Virtual lab experiments <u>Books Suggested:</u>

1. Experimental Organic Chemistry – M. P. Doyle and W. S. Mungall.
2. A Text Book of Practical Organic Chemistry – A. I. Vogel.
3. Techniques and Experiments for Organic Chemistry – Addison Ault.
4. Advanced Practical Organic Chemistry – N. K. Vishnoi.

5. Laboratory Manual of Organic Chemistry – B. B. Dey and M. V. Sitaraman.

6. Laboratory Manual in Organic Chemistry – R. K. Bansal.

SEMESTER – II

Sl.No	**Subject code**	**Subject**	**L**	**T**	**P**	**C**
Theory						
1.	**CH3705**	**Organic Chemistry II**	4	1	0	5
2.	**CH3706**	**Inorganic Chemistry II**	4	1	0	5
3.	**CH3707**	**Physical Chemistry II**	4	1	0	5
4.	**CH37X1**	**Elective Paper**	3	1	0	4
Practical						
5.	**CH3772**	**Inorganic Chemistry Lab**	0	0	6	6
		TOTAL CREDITS	**15**	**4**	**6**	**25**

CH3705	Organic Chemistry-II	L	T	P	C
		4	1	0	5

Objectives

The following educational objectives are to be discussed in the paper: understand the nucleophilic substitution reactions learn the preparation of molecules based on electrophilic substitution reactions understand key aspects of elimination reaction explain the heterocycles, alkaloids and terpenoids

Course Outcome - COs		Cognitive Skill
CO-01	Students will be able tounderstand thenucleophilic substitution reactions	U,An,E
CO-02	Students will be able to learn the preparation of molecules based on electrophilic substitution reactions	S,A
CO-03	Students will be able to understand key aspects of elimination reaction	U, S
CO-04	Students will be able to explain the heterocycles	An,U
CO-05	Students will be able to describe some of the alkaloids and terpenoids	R,U

R- Remember, U-Understand, A-Apply, An-Analyze, E-Evaluate, S- Synthesis

Mapping of Course Outcome with Programme Outcome

PO / CO	PO-A	PO-B	PO-C	PO-D	PO-E
CO-01	M	S	S	M	L
CO-02	S	M	S	S	M
CO-03	M	S	S	M	L
CO-04	M	S	M	S	S
CO-05	L	M	N	M	S

S- Strong, M- Medium, L-Low, N- Not Relevant

Unit-I 9

Heterocyclics

General methods of synthesis and reactions of Quinolone, isoquinolone, carbazoles, acridines, imidazoles and pyrazoles, oxazoles and isoxazoles, thiazoles and isothiazoles, pyridazine, pyrimidine and pyrazines, □- and □-pyrones, benzotriazole. Synthesis and applications of polypyrrole and polythiophene.

UNIT-II

Alkaloids and Terpenoids: **9**

Alkaloids: Classification – General methods of determining the structure – structural elucidation, synthesis and stereochemistry of morphine, papaverine, and quinine – Biosynthesis of alkaloids.

Terpenoids: Classification, Structural elucidation, synthesis and stereochemistry of camphor, zingiberene, santonin, and abietic acid – Biosynthesis of terpenoids.

UNIT-III **9**

a) Aliphatic Nucleophilic Substitution

S_N1, S_N2, S_Ni, S_Ni' and tetrahedral mechanisms - ambident nucleophiles and ambident substrates - effect of substrate, attacking nucleophile, leaving group, and reaction medium -neighbouring group participation (NGP), anchimeric assistance.

b) Aromatic Nucleophilic Substitution:

S_NAr, S_N1, and benzyne mechanisms - structure-reactivity relationship-Ziegler alkylation and Chichibabin reaction, Rosenmund reaction, von Braun reaction.

Unit-IV **9**

a) Aliphatic Electrophilic Substitution:

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

b) Aromatic Electrophilic Substitution Reactions:

Arenium ion and S_E1 mechanisms. Orientation and reactivity of monosubstituted benzene rings - ortho/para ratio - Ipso attack. Quantitative treatment of reactivity in the substrates and electrophiles, diazonium couplingeffect of leaving group, formylation - Gattermann, Gattermann-Koch reactions - Reimer-Tiemann, Kolbes, Vilsmeier-Haak, Bischler-Napieralski, Hofmann - Martius and Jacobson's reactions, Friedel-Crafts alkylation and acylation

UNIT -V

Elimination Reactions **9**

The E1, E2, $E1_CB$ mechanisms - stereochemistry of eliminations - elimination versus substitution - orientation of double bond - Sayzteff and Hoffman rules - pyrolytic eliminations - mechanism of pyrolysis of esters of carboxylic acids -Chugaev reaction - Hofmann degradation - Cope elimination.

TOTAL: 60 PERIODS

References:

1. Peter Sykes, A Guidebook to Mechanism in Organic Chemistry, Orient Longman, New Delhi, 1989.
2. Jerry March, Advanced Organic Chemistry, 4th edition, John Wiley & Sons Inc., New York, 1992.
3. S. M. Mukherji and S.P Singh, Reaction Mechanisms in Organic Chemistry, Macmillan India Ltd., New Delhi, 1997.
4. R. K. Bansal, Heterocyclic Chemistry, Wiley Eastern Ltd., New Delhi, 1990.
5. R. M. Acheson, An Introduction to the Chemistry of Heterocyclic Compounds, Wiley Eastern Ltd., New Delhi.
6. I. L. Finar, Vols. I and II, ELBS with Longman.

CH3706	Inorganic Chemistry-II	L	T	P	C
		4	1	0	5

Objectives

To know the most common structures observed for metal complexes.
To predict the relative stabilities of metal complexes with different ligands. To be able to describe the shapes and structures of coordination complexes with coordination numbers ranging from 4 to 12.
To recognize the types of isomers in coordination compounds.
To be able to name coordination compounds and to be able to draw the structure based on it's name.
To become familiar with some applications of coordination compounds.
To be able to develop synthetic routes for organic molecules by means of integrated application of organometallic compounds.

Course Outcome - COs		Cognitive Skill
CO-01	Students will be able to understand the key features of coordination compounds including stability of complexes	U
CO-02	Students will be able to impart thorough knowledge in kinetic stability of complexes	R
CO-03	Students will be able to use CFT and analyze the magnetic properties of coordination compounds	An
CO-04	Students will be able to demonstrate the synthesis and structure of metal carbonyls	S
CO-05	Students will be able to describe the key mechanistic steps in reactions of organometallic compounds	U

R- Remember, U-Understand, A-Apply, An-Analyze, E-Evaluate, S- Synthesis

Mapping of Course Outcome with Programme Outcome

PO / CO	PO-A	PO-B	PO-C	PO-D	PO-E
CO-01	S	S	M	S	L
CO-02	S	M	S	L	S
CO-03	M	S	S	M	L
CO-04	S	S	M	S	M
CO-05	M	L	S	S	S

S- Strong, M- Medium, L-Low, N- Not Relevant

Unit-I Coordination Chemistry &Stability-I 9

Thermodynamic stability – stepwise and overall stability constants and their relationship– determination of stability constant by potentiometric and spectrophotometric methods-; continuous variation (Job's) method- factors affecting stability: chelate effect, kinetic and thermodynamic template effects and their application in the synthesis of macrocyclic ligands. HSAB Concept: applications and theoretical basis, characterization of stabilities of mixed ligand complexes.

Unit-II Coordination Chemistry &Stability-II 9

Kinetic stability, lability and inertness; ligand substitution reactions in octahedral and square planar complexes : acid hydrolysis, base hydrolysis and anation reactions; trans effect -theories- use of trans effect in synthesis of complexes; electron transfer reactions : complementary and non-complementary types; inner and outer-sphere processes – applications of electron transfer reactions in synthesis of coordination complexes – reactions of coordinated ligand : mechanism of ascorbic acid oxidation by free and chelate Cu(II) Complexes.

Unit-III Coordination Chemistry and bonding 9

VB, CF and MO theories of complexes with four and six coordination numbers-CFSEfactors affecting the magnitude of 10 Dq values –spectrochemical series-applications of CFT - site preferences in spinels- Site selection of the cations in spinel and inverse spinel– static and dynamic John-Teller behavior.

Unit – IV Organometallic Chemistry –I 9

Introduction-History-EAN and its correlation to stability-Synthesis and structures of metal carbonyls- carbonylate anions, -IR study of metal carbonyls- – identifications of bridging and terminal CO groups – Stretching mode analysis of metal carbonyls – evidence for MM bonds. Synthesis, properties and structural features of metal complexes with carbene, alkene, alkyne and arene. Hapticity-Metallocenes-synthesis, properties and bonding in ferrocene-covalent versus ionic bonding in beryllocene, clusters and catalysis, hydride and dihydrogen complexes, fluxionality.

Unit-V Organometallic Chemistry – II 9

Oxidative addition and reductive elimination - insertion and elimination reactions nucleophilic and electrophilic attack of coordinating ligands- Catalysis by organometallic compounds-Homogeneous catalysis- Wilkinson's catalyst and hydrogenation reactions, Tolman catalytic loop - synthesis gas and water-gas shift reaction- hydroformylation-carbonylation of alcohols and oxygenation of olefins-Heterogeneous catalysis-FischerTropsch process and Ziegler—Natta polymerization.

TOTAL: 60 PERIODS

REFERENCES

1. James E. Huheey, Ellen A. Keiter and Richard L. Keiter, Inorganic chemistry: Principles, Structure and Reactivity, 4th Ed., Harper Collins College Publishers, 1993.
2. F. Albert Cotton, Geoffrey Wilkinson, Carlos A. ManIc and Manfred Bochman, Advanced Inorganic Chemistry, Wiley lntersceince Publication, 6th Ed., 1999.
3. D. Bannerje, Coordination Chemistry, Tata McGraw Hill, 1993.
4. G.S. Manku, Theoretical Principles of Inorganic Chemistry Tata McGraw Hill, 12th reprint 2004.
5. K.F. Purcell and J.C. Kotz, Advanced Inorganic Chemistry, Saunders Golder Publishers.
6. B.E. Douglas, D.H. McDaniel and J.J. Alexander, Concepts and Models of Inorganic Chemistry, John Wiley and Sons Ltd., 2nd Ed., 1983.
7. M.C. Day Jr and J. Selbin, Theoretical Inorganic Chemistry, 2nd Ed., East West Press, 2000.
8. J.D. Lee, Concise Inorganic Chemistry, ELBS, 2006.
9. D.F. Shriver, P.W. Atkins and C.H. Langford, Inorganic Chemistry, ELBS, Oxford University Press, 1994.
10. W.L. Jolly, Modern Inorganic Chemistry, McGraw Hill Company, 2nd Ed., 1991.
11. R.S. Drago, Physical Methods in Inorganic Chemistry, Saunders College Publishers.
12. E.A.V. Ebsworth, D.W.H. Rankin and S. Cradock, Structural Methods in Inorganic Chemistry, ELBS, 1988.
13. D.A. Skoog, F. James Holler and J.A. Nieman, Principles of Instrumental Analysis, Saunders, 1992.
14. H.H. Willard, L.L. Merritt and J.A. Dean, Instrumental Methods of Analysis, CBS Publishers, 6th edition, 1986.
15. G.H. Jeffery et.aL, Vogel's Textbook of. Quantitative Chemical Analysis, Revised 5th edition, ELBS, 1989.
16. R.A. Day and A.L. Underwood, Quantitative Analysis, Prentice Hall, 1999.
17. Coordination Chemistry- Kettle.
18. Reaction mechanism- Basalo and Pearson
19. Coordination Chemistry- Basalo and Johnson
20. Inorganic Chemistry- P. B. Janadhanamand shivashankar.

CH3707	Physical Chemistry-II	L	T	P	C
		4	1	0	5

Objectives: to impart knowledge about various photophysical processes to analyse both the classical and quantum mechanics.

to understand the quantum statistics.

Course Outcome - COs		Cognitive Skill
CO-01	Students will be able to impart knowledge about various photophysical processes	R,A,U
CO-02	Students will be able to determine the partial molar quantities	R,U,E
CO-03	Students will .be able to Analyse both the classical and quantum mechanics	E,R,An
CO-04	Students will be able to Understand the postulates and derive the systems	R,U,A,An
CO-05	Students will be able to Apply different methods to He atom	R,U,A,An

R- Remember, U-Understand, A-Apply, An-Analyze, E-Evaluate, S- Synthesis

Mapping of Course Outcome with Programme Outcome

PO / CO	PO-A	PO-B	PO-C	PO-D	PO-E
CO-01	M	S	S	M	S
CO-02	M	S	S	L	M
CO-03	L	S	M	S	M
CO-04	M	S	M	S	L
CO-05	S	M	S	S	M

S- Strong, M- Medium, L-Low, N- Not Relevant

Unit I: Photochemistry **9**

Light absorption-The Jablonski diagram- fluorescence, phosphorescence delayed emission and other deactivation processes-Laws of photochemistry-quantum yielddetermination – Stern- Volmer equation and its application, photosensitization – chemiluminescence– flash photolysis; ewlementary aspects of photosynthesis; photochemical chain reactions H-Br reaction – ozone depletion – photochemical conversion and storage of solar energy.

Unit-II: Thermodynamics **9**

Thermodynamics of system of variable composition – partial molar properties – chemical potential – Gibbs Duhem equation – apparent molar properties – methods of determination

of partial molar quantities, partial molar thermal properties – differential and integral heats of solution.

Thermodynamic properties of real gases – fugacity concept – determination of fugacity – real and mixture of gases – Lewis – Randall rule. Nernst heat theorem –third law of thermodynamics-experimental verification– thermodynamic quantities at absolute zero.

Unit-III: Statistical thermodynamics **9**

Ensemble of systems – state of a system – microcanonical and grand canonical ensemble – micro and macro states; derivation of classical Boltzman distribution law; quantum statistics – Bose – Einstein, Fermi- Dirac and Maxwell-Boltzmann statistics – comparision of B.E and F.D statistics with Boltzmann statistics – photon gas and electron gas; Boltxmann-Planck equation; partition function – partition function and thermodynamics properties – partition function- Translational, rotational, vibrational, electronic and thermodynamic properties- equilibrium constant, heat capacity. concept of negative Kelvin tempertature.

Unit-IV :Quantum Chemistry-I **9**

Planck's Quantum theory- Wave particle duality – uncertainity principle, operators and commutation relation, postulates of quantum mechanics – simples' system – one dimensional box, three-dimensional box – rigid rotator – harmonic oscillator – hydrogen atom.

Unit –V- Quantum Chemistry-II **9**

Many electron system-Quantum numbers-significance – Paulisantisymmetry principle – Slater determinant – Approximation methods – variation and perturbation – application to heliun atom – Hartree Self Consistent field theory.

Born – oppenheimer approximation – LCAO –MO for H_2^+ ion – VB treatment of H_2 molecule. Hybridisation – sp, sp^2, sp^3, HMO theory – ethylene and butadiene.

TOTAL: 60 PERIODS

REFERENCES:

1. A.K. Chandra, Introduction to quantum Chemistry, Tata McGraw Hill, New Delhi, 1997.
2. L.N. Levine, Quantum Chemistry, Prentice Hall, New Delhi 1994.
3. R.K. Prasad Quantum Chemistry, Wiley Eastern, 1993.
4. F.E. Pilar, Elementary Quantum Chemistry, McGraw Hill, New Delhi, 1968.
5. S. Glasstone, Theoretical Chemistry, Van Nostrand, New York, 1944.
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7. M.C. Gupta, Statistical Thermodynamics, Wiley-Eastern, New Delhi, 1990
8. J.Rajaram, J.C. Kuriaacose, Thermodynamics for chemistry, Shoban Lal Nagain Chand, New Delhi, 1986.
9. K.K. Rohatgi- Mukerkkjee, Fundamentals of Photochemistry, Wiley-

Eastern, New Delhi, 1978.

10. J.R. Lakowicz, Princilpls of Fluoresence Spectroscopy, Plenum Press, New York, 1999.

11.N.J. Turro, Molecular Photochemistry, Benjamin, 1965.
12.J.G. Calvert, J.N. Pitts, Photochemistry, Wiley, New York, 1966.

CH3772	Inorganic Chemistry Lab	L	T	P	C
		0	0	6	6

Objectives

Apply the principles inorganic chemistry to the molecules that form the basis of life.

Learn the Semi micro qualitative analysis of inorganic mixture. Get an idea about the Complexometric titrations.

To understand the Preparation of coordination complexes.

Course Outcome – Cos		Cognitive Skill
CO-01	Students will be able to analyze semi micro qualitative analysis of inorganic mixture containing two less familiar cations W, Tl, Se, Mo, Ce, Th, Zr, Ti, V, U and Li	A,An
CO-02	Students will be able to understand the Complexometric titrations – Estimation of Cu, by EDTA.	R,,A,An,E
CO-03	Students will be able to explain the Complexometric titrations – Estimation of Zn, by EDTA titration.	R,,A,An,E
CO-04	Students will be able to analyze the Complexometric titrations – Estimation of Mg, by EDTA titration.	R,,A,An,E
CO-05	Be able to understand the Preparation of coordination complexes.	U,S

R- Remember, U-Understand, A-Apply, An-Analyze, E-Evaluate, S- Synthesis

Mapping of Course Outcome with Programme Outcome

PO / CO	PO-A	PO-B	PO-C	PO-D	PO-E
CO-01	M	S	S	L	S
CO-02	M	S	S	S	L
CO-03	S	S	M	M	M
CO-04	S	M	M	L	S
CO-05	S	S	M	M	S

S- Strong, M- Medium, L-Low, N- Not Relevant

1. Semi micro qualitative analysis of inorganic mixture containing two less familiar cations

   W, Tl, Se, Mo, Ce, Th, Zr, Ti, V, U and Li
2. Complexometric titrations – Estimation of Cu, Zn and Mg by EDTA titration in the presence of either Pb or Ba

3. Preparation of coordination complexes

4. Estimation of a cation in a mixture byvolumetry or gravimetry (demonstration only)
   i) Cu &Zn (ii) Ca and Ba (iii) Cu & Fe

Reference

1. V.V.Ramanujam, 'Inorganic semimicro Qualitative analysis, 3rd revised Edn, National Publishing Co., Chennai, 1988.

2. Vogel's Text book of Quantitative chemical analysis, Eds. G.H.Jeffrey, J.Banett, J.Mendham and R.C.Denney, ELBS, 5thEdn, 1991.

SEMESTER – III

SL. NO.	SUBJECT CODE	SUBJECT	L	T	P	C
THEORY						
1.	**CH3709**	**Organic Chemistry III**	4	1	0	5
2.	**CH3710**	**Inorganic Chemistry III**	4	1	0	5

3.	**CH3711**	**Physical Chemistry III**	4	1	0	5
4.	**CH37X2**	**(Elective paper - II)**	3	1	0	4
PRACTICAL						
5.	**CH3773**	**Physical Chemistry Lab**	0	0	6	6
TOTAL CREDITS			**15**	**4**	**6**	**25**

CH3709	Organic Chemistry-III	L	T	P	C
		4	1	0	5

Objectives

Students will be able to understand the following aspects

- Different elucidation of organic molecules using different spectroscopic techniques
- Basics of carbohydrate and supramolecular aspects
- different strategy of construction molecules

Course Outcome - COs		Cognitive Skill
CO-01	Students will be able tounderstand thestructural elucidation of organic molecules using IR and UV	U, E
CO-02	Students will be able to understand thestructural elucidation of organic molecules using NMR and mass	S, A
CO-03	Students will be able to understand the basics of carbohydrate	E, An
CO-04	Students will be able to study the different strategy of construction molecules	A, U
CO-05	Students will be able to explain the supramolecular aspects	R,U

R- Remember, U-Understand, A-Apply, An-Analyze, E-Evaluate, S- Synthesis

Mapping of Course Outcome with Programme Outcome

PO / CO	PO-A	PO-B	PO-C	PO-D	PO-E
CO-01	M	S	S	M	L
CO-02	S	M	S	S	M
CO-03	M	S	S	M	L
CO-04	M	S	M	S	S
CO-05	L	M	N	M	S

S- Strong, M- Medium, L-Low, N- Not Relevant

Unit I: a) UV Spectroscopy

Ultraviolet bands for saturated and unsaturated carbonyl compounds, dienes, conjugated polyenes. Fischer–Woodward rules for conjugated dienes and carbonyl compounds, ultraviolet spectra of aromatic and heterocyclic compounds – Scott's rules – shift reagents – steric effect in biphenyls.

b) IR Spectroscopy

Detailed study of vibrational frequencies of carbonyl compounds (ketones, aldehydes, esters, amides, acids, anhydrides, lactones, lactams, and conjugated carbonyl compounds). Effect of hydrogen bonding and solvent effect on vibrational frequencies, overtones, combination bands and Fermi resonance, FT–IR.

c) ORD and CD

Principle and Applications of ORD and CD

Unit II: a) ^{1}H–NMR Spectroscopy **9**

Stereochemistry, hindered rotation, Karplus curve – variation of coupling constant with dihedral angle. Simplification of complex spectra – double resonance, shift reagents, NOE, FT–technique – Spin Relaxation.

b) C–NMR Spectroscopy

2-D NMR–COSY, DEPT, Magnetic Resonance Imaging (MRI)

c) Mass spectrometry

Mass spectral fragmentation of organic compounds, common functional groups, molecular ion peak, nitrogen rule, metastable peak, McLafferty rearrangement – Isotopic peaks, CI, FAB, MALDI.

d) Combined spectral problems

Spectral problems involving UV, IR, NMR and Mass spectral data.

Unit-III: Carbohydrate chemistry **9**

Carbohydrate – classification, monosaccharides- physical and chemical properties, structure elucidation of glucose, configuration of C_1 in glucose, stereoisomers of glucose- name & structure only, Hudsons rule, glycosides, isopropyledine derivatives of monosaccharides, oligo and polysaccharides – maltose & trehalose – starch.

Sugar derivatives – glycals, glycosamines&glycosans, ascorbic acid.

Unit IV: a) Selected Name Reactions: **9**

Aldol, Dieckmann condensations–Reformatsky, Grignard, Wittig and Mannich reactions-Robinson annulation-Oppenauer oxidation – Clemmenson, Wolff-Kishner, Meerwin-PondorfVerley (MPV) and Birch reductions-Nef reaction, McMurry reaction, Japp-Klingemann reaction, Polonovski reaction.

b) Retro-Synthetic Analysis:
Strategy and planning-starting material-Linear and Convergent approach, protecting groups and activating groups. regio-selectivity, chemoselectivity. diastereoselectivity. Target molecule containing one functional group requiring a single disconnection-Synthons and synthetic equivalents. Latent polarity. Target molecules with two functional groups– 1, 2-, 1, 3- 1, 4-, 1, 5-, and 1, 6-dicarbonyl compounds, Umpolung. Functional group interconversions (FGI).

9

Unit V: Supra molecular Chemistry:
Defnition – host-guest chemistry – classification of supramolecular host-guest compounds – coordination and the lock and key analysis – the chelate, macrocyclic and template effects – nature of supramolecular interactions – spherands, lariat ethers, podants, cryptands – molecular recognition, chiral recognition, molecular sieves, molecular wires, molecular switches.

TOTAL: 60 PERIODS

REFERENCES
1.R.M. Silverstein, G.C. Bassler, T.C. Morril, Spectrometric Identification of Organic Compounds, John Wiley & Sons, New York, 1991.
2. W. Kemp, Organic Spectroscopy, Macmillan Press Ltd. 1996.
3.D.H. Williams and I. Fleming, Spectroscopic Methods in Organic Chemistry, Tata McGraw Hill, New Delhi, 1988(Fourth Edition)
4.Jag Mohan, Organic Spectroscopy, Principles and Applications, Narosa publishing House, New Delhi, 2001.
5. P.Y. Bruice, Organic Chemistry, Pearson Education, Inc., Delhi, 2002.
6.P.R.Young, Practical Spectroscopy, The Rapid Interpretation of Spectral Data Brooks/Cole, California, 2000.
7. R. Davis, M. Frearson, Mass Spectrometry, John Wiley & Sons, New York, 1991 8.S. Warren, Designing Organic Syntheses: A Programmed Introduction to the Syntheses Approach, John Wiley & Sons, 1978.

CH3710	Inorganic Chemistry-III	L	T	P	C
		4	1	0	5

Objectives

To decide whether a given group is cyclic, and given a finite cyclic group, find a generator for a subgroup of a given order.
To recognize the dihedral and dicyclic groups when described using a standard form. Be able to predict the number of proton and carbon NMR signals expected from a compound given its structure.
To calculate the relative energies of electrons in atoms and molecules.
Be able to determine the compound structure based on information generated from Mossbauer spectrometry, NMR and photoelectron spectroscopy.

Ability to comprehend the current problems in bioinorganic chemistry and answer specific scientific questions using the knowledge provided during the course.

Course Outcome - COs		Cognitive Skill
CO-01	Students will be able to explain the concepts of symmetry elements in group theory by solving chemical structural problems and construct a character table	U
CO-02	Students will be able to know the importance of molecular structure by using character tables, projection operators and spectroscopic techniques	An
CO-03	Students will be able to interpret the chemical molecules and confirmed the structure by spectroscopic techniques like NMR and ESR	A, An
CO-04	Students will be able to find out the oxidation state and spin states of metal ion by Mossbauer spectroscopy and apply the principle of PES for chemical analysis	A, An
CO-05	Students will be able to impart thorough knowledge about the importance of metals in biological systems that will promote their activity.	E

R- Remember, U-Understand, A-Apply, An-Analyze, E-Evaluate, S- Synthesis

Mapping of Course Outcome with Programme Outcome

PO / CO	PO-A	PO-B	PO-C	PO-D	PO-E
CO-01	S	S	M	M	L
CO-02	S	M	S	L	S
CO-03	M	S	S	M	L
CO-04	S	S	M	S	S
CO-05	L	M	S	M	S

S- Strong, M- Medium, L-Low, N- Not Relevant

9

Unit I: Group Theory-I

Symmetry properties of molecules and group theory

Symmetry elements, symmetry operations and point groups, properties of groups, symmetry operations as a group, group multiplication table. Classes of symmetry operations- Reducible and irreducible representation, The great orthogonality theorem. Properties of irreducible representations. Construction of character table for point groups (C_{2v}, C_{3V}). Explanations for the complete table for a point group-term symbols and splitting of terms.

Unit II: Group Theory-II **9**

Application of group theory:

Symmetry selection rules for IR, Raman and electronic spectraSymmetry reduction formula. Determination of representations of vibrationalmodes in non-linear molecules (H_2O, NH_3 and Trans N_2F_2). Infra red and Raman activities of normal modes of vibrations. Rule of mutual exclusion. Electronic spectra of ethylene and formaldehyde molecules. Hybrid orbital in non-linear molecules (CH_4, XeF_4, BF_3 and PF_3). Calculation of delocalization energy for ethylene, trans-1,3 –butadiene, and benzene systems.

Unit-III : Application of spectroscopy to the study of Inorganic compounds – I **9**

NMR spectroscopy: ^{31}P,^{19}F and^{15}N-NMR–Introduction, Chemical shift and its measurement, Factors influencing chemical shift, applications to structuralproblemsevaluation of rate constants-monitoring the course of reaction-NMR of fluxional molecules – NMR of paramagnetic molecules-contact shifts and shift reagents.

ESR spectroscopy: Principles–preparation of the spectrum–hyperfine splitting– factors affecting the magnitude of g-values-zero field splitting and Kramer's degeneracy-anisotropy in the hyperfine coupling constant. Application of ESR in the study of transition metal complexes – J-T-distortion: studies of Cu(II) complexes.

Unit-IV: Application of spectroscopy to the study of Inorganic compounds - II **9**

Mossbauer spectroscopy: Principle – application of isomer shift, quadrupole interactions and magnetic splitting in the study of iron and tin compounds-structural elucidation of inorganic complexes.

Photoelectron spectroscopy: Koopman's theorem. PES – PE spectra of homonuclear diatomic molecules (CO, H_2O, NH_3 and CH_4) - UVPES of O_2 and N_2 - XPES (ESCA)-chemical shifts in XPS- application of ESCA to inorganic systems- Auger electron spectroscopy.

Unit-V: Bioinorganic chemistry **9**

Non-metals and metals in biological systems, essential and trace elements. Porphyrin-metal complex systems, chlorophyll and photosynthesis (PS I and PS II), cytochromes, haemoglobin, myoglobin and oxygen binding. Vitamin B_{12} and coenzymes, in vivo and invitro nitrogen fixation. Iron storage and transport: ferritin, transferrins and siderophores, hemerythrin, cytochrome P_{450}, ferredoxin and rubredoxin.

TOTAL: 60 PERIODS

REFERENCES

1, F.A. Cotton, Chemical Applications of Group Theory, Wiley-Eastern, New Delhi, 1971.

2 G. Davidson, Introductory Group Theory for Chemists, Applied Science Publishers, London, 1971.
3. V. Ramakrishnan and M.S. Gopinathan, Group theory and Chemistry, Vishal Publications, Delhi, 1991.
4. K.V. Raman, Group theory and its Applications to Chemistry, Tata McGraw-Hill, New Delhi, 1990.
5. D.C. Harris, M.D. Bertolucci, Symmetry and Spectroscopy, Oxford University Press, New York, 1978.
6 . R.S. Drago, Physical Methods in Chemistry, Saunders, London, 1977.
7.C.N. Banwell, Fundamentals of Molecular Spectroscopy, Tata McGraw-Hill, New Delhi, 1990.

CH3711	Physical Chemistry-III	L	T	P	C
		4	1	0	5

Objectives:

To understand the basic idea about the mechanism of polymers.

To provide a valuable understanding about molecular spectroscopy.

To understand the basic idea about adsorption and surface activities.

.To acquire knowledge about Nanomaterial's and its applications.

Course Outcome – Cos		Cognitive Skill
CO-01	The students will be able to To know about the different types of polymer, mechanism of radical and ionic polymerization	U,An,E
CO-02	To understand the basic of microwave and Raman spectroscopy.	An,S,E
CO-03	Get an idea about Molecular spectroscopy used in research works.	E,A,U
CO-04	To know about Langmuir, B.E.T equation and identify the significance in surface area.	A,E,R
CO-05	To understand the nanomaterials and nano structures.	S

R- Remember, U-Understand, A-Apply, An-Analyze, E-Evaluate, S- Synthesis

Mapping of Course Outcome with Programme Outcome

PO / CO	PO-A	PO-B	PO-C	PO-D	PO-E
CO-01	S	L	M	S	S
CO-02	S	S	M	M	S
CO-03	S	S	S	M	L
CO-04	S	S	S	M	M
CO-05	M	M	S	S	S

S- Strong, M- Medium, L-Low, N- Not Relevant

Unit-I: Polymer Chemistry **9**

Natural and synthetic polymers - general concept – chemical heterogenitypolymolecularity – radical, ionic and coordination chain polymerization; stereospecific polymerization and the utility of Ziegler-Natta catalyst; copolymerization – synthesis of graft and block copolymers; polystyrene, acrylic polymers and polyesters, cellulosic polymers, phenol resins, amino resins and epoxy resins – mechanism of radical and ionic polymerization. Conducting polymers – chemical structure and electronic behavior of polymers – doping of conducting polymers – such as polyaniline, polypyrrole and polythiophene.

Unit II: Molecular Spectroscopy-I **9**

Characterization of electromagnetic radiation - signal to noise ratio – the width and intensity of spectral transitions; microwave spectroscopy – rotational spectra of diatomic and simple polyatomic molecules; infrared spectroscopy – harmonic and anharmonic oscillator – vibration – rotation spectra of diatomic and polyatomic molecules- influence of rotation on the spectra of polyatomic molecules – parallel and perpendicular vibrations.

Raman spectroscopy – theory of Raman effect – pure rotational Raman spectra - vibrational Raman spectra –mutual exclusion principle

Unit III: Molecular spectroscopy-II **9**

Electronic spectroscopy – Born- Oppenheimer approximation – vibrational coarse structure – Franck-Condon principle – dissociation energy – rotational fine structure of electronic – vibration transitions- Fortrat diagram – predissociation.

NMR Spectroscopy – spin and an applied field – nature of spinning particles – interaction of spin magnetic field – population of energy levels; chemical shift and coupling constant NQR

spectroscopy – principles- experimental set up- nuclear quadrupole coupling in atoms and molecules – applications; ESR spectroscopy – basis principles – hyperfine splitting – origin of hyperfine interaction – the g value – Mc Connel relationship – applications of ESR.

Unit IV: Adsorption and surface phenomenon

Physisorption and Chemisorption-adsorption, sorption- adsorption isotherms – Langmuir and B.E.T. equation and significance in surface area determination, surface films, adsorption from solution, Gibb's adsorption equation: derivation, significance. Kinetics of unimolecular and bimolecular surface reactions. Principle & applications of photoelectron spectroscopy, ESCA and Auger spectroscopy to the study of surfaces.

Surface activity, surface active agents and their classification, micellisation, critical micelle concentration (cmc), thermodynamics of micellisation, factors affecting cmc, methods of determination of cmc, use of surfactants in oil recovery.

UNIT-V: Nanomaterials **9**

Nanoscience: Introduction, classification of nanomaterials: definition and examples of zero, 1D, 2D and 3D Nanostructures- Properties of nanomaterials – physical properties – finite size effects – optical, magnetic and electronic properties-Turbevitch and Brust method of preparation of nanogold and other noble metals- surface plasma resonance of nanogold and its applications in sensors.

TOTAL: 60 PERIODS

REFERENCES

1. F. A. Cotton, Chemical Applications of Group Theory, Wiley-Eastern, New Delhi, 1971.
2.G. Davidson, Introductory Group Theory for Chemists, Applied Science Publishers, London, 1971.
3.V. Ramakrishnan and M. S. Gopinathan, Group theory and Chemistry, Vishal Publications, Delhi, 1991.
4.K.V. Raman, Group theory and its Applications to Chemistry, Tata McGraw-Hill, New Delhi, 1990.
5.D. C. Harris, M.D. Bertolucci, Symmetry and Spectroscopy, Oxford University Press, New York, 1978.
6. R. S. Drago, Physical Methods in Chemistry, Saunders, London, 1977.

CH3773	Physical Chemistry Lab	L	T	P	C
		0	0	6	6

Objectives

Understand laboratory and chemical safety

Comprehend concept and perform chemical measurement calibration

Relate the microscopic and macroscopic properties of matter to each other •Use statistical methods for evaluating and interpreting data

Assess sources of error in chemical and instrumental analysis and account for errors in data analysis

Demonstrate competency in written and oral communication using mathematics if needed

Course Outcome - COs		Cognitive Skill
CO-01	To develop skill for handling the potentiometer	,A,U
CO-02	To know about the estimation of Fe2+ by redox titration	,U,A,An
CO-03	To understand the techniques in determining the strength of acids	An,U,A,E
CO-04	To impart knowledge about the adsorption process	A,An,E
CO-05	To analyse the adsorption both by oxalic acid and acetic acid in charcoal	E,,U, An, A

R- Remember, U-Understand, A-Apply, An-Analyze, E-Evaluate, S- Synthesis

Mapping of Course Outcome with Programme Outcome

PO / CO	PO-A	PO-B	PO-C	PO-D	PO-E
CO-01	S	S	S	S	S
CO-02	S	S	M	S	S
CO-03	S	S	S	S	M
CO-04	S	S	S	M	S
CO-05	S	S	S	S	S

S- Strong, M- Medium, L-Low, N- Not Relevant

1. **Adsorption**

Adsorption of acetic acid/ oxalic acid on activated charcoal- Verification of Frendulich isotherm - determination of unknown concentration

2.**Precipitation KCl –**

$AgNO_3$KCl + KI – $AgNO_3$

3.**Potentiometric titration**

1.Redox

FAS vs Ce^{4+} Fe^{2+} -

4. **$KMnO_4$ KI - $KMnO_4$**

5.**Determination of solubility product of a sparingly soluble salt**

6. **Conductivity**

Titrations (mixture of acids vs NaOH)

7.**Thermometry**

Determination of solution enthalpy

Oxalic acid – water

Ammonium oxalate – water

8.**Distribution**

Distribution of benzoic acid between benzene /toluene & water

SEMESTER – IV

Sl.No	Course code	Course Title	L	T	P	C
Theory						
1	**CH37AX**	**Elective - I**	3	1	0	4
2	**CH37AXX**	**Elective - II**	3	1	0	4
Project						
4	**CH37P1**	**Project and Viva - Voce**	0	0	6	6
		Total Credits	**6**	**2**	**6**	**14**

ELECTIVE PAPER I

CH37A1	Green Chemistry	L	T	P	C
		3	1	0	4

Objectives

To understanding the fundamental principles of Chemistry and Applied Chemistry.

To provide interdisciplinary orientations and approach to solving life challenging problems.

To undertake general supervisory and managerial functions in chemical and allied industries.

To collect samples and carry out chemical analysis on them.

To ability to organize, supervise production and quality control of chemical and allied industries.

Course Outcome - COs		Cognitive Skill
CO-01	Students will be able to understand the petroleum distillation and its applications.	A
CO-02	Students will be able to assign the basics of polymers and their applications.	An
CO-03	Students will be able to explain the manufacture of soap and its types.	E
CO-04	Students will be able to analyze the requirements of fertilizers and its utilization.	S
CO-05	Be able to describe the manufacture of cement and its processes.	U

R- Remember, U-Understand, A-Apply, An-Analyze, E-Evaluate, S- Synthesis

Mapping of Course Outcome with Programme Outcome

PO / CO	PO-A	PO-B	PO-C	PO-D
CO-01	M	S	S	L
CO-02	M	S	S	S
CO-03	S	S	M	M
CO-04	S	M	M	L
CO-05	S	S	M	M

S- Strong, M- Medium, L-Low, N- Not Relevant

Unit I: Introduction **9**

Introduction-Current status of chemistry and the Environment-Evolution of the Environmental movement: Public awareness - Dilution is the solution to pollution. Pollution prevention.

Unit II : Principles **9**

Green Chemistry – Definition – Principles of Green Chemistry - Why is this new area of Chemistry getting to much attention - Why should chemist pursue the Goals of Green Chemistry - The roots of innovation – Limitations

Unit III: Bio Catalytic Reactions **9**

Green Chemistry Using Bio Catalytic Reactions – Introduction - Fermentation and Bio transformations - Production of Bulk and fine chemicals by microbial fermentationAntibiotics – Vitamins - Bio catalyses synthesis of industrial chemicals by bacterial constructs - Future Tends.

Unit IV: Green House Effect **9**

Green house effect and Global Warming – Introduction - How the green house effect is produced - Major sources of green house gases - Emissions of CO2 - Impact of green house effect on global climate - Control and remedial measures of green house effect - Global warming a serious threat - Important points.

Unit V: Green Analytical Methods **9**

Future trends in Green Chemistry - Green analytical methods, Redox reagents, Green catalysts; Green nano-synthesis, Green polymer chemistry, Exploring nature, Biomimetic, Proliferation of solvent-less reactions; Non-covalent derivatization, Biomass conversion, emission control

TOTAL: 60 PERIODS

Reference Books

1. V. Kumar, “An Introduction to Green Chemistry” Vishal publishing Co. Reprint Edition 2010

2. Rashmi Sanghi, M.M Srivastava “Green Chemistry” Fourth Reprint - 2009

3. Anastas & Warner, Green Chemistry: Theory & Practice ,Oxford Univ. Press,New York,1998

ELECTIVE PAPER II

CH37A2	Waste management & hazard analysis	L	T	P	C
		3	1	0	4

Objective:

i)To understand the basic idea about the nature cycles of environment
ii) To provide a valuable understanding about pollutions. iii) To understand the basic idea about environmental restoration

Course Outcome - COs		Cognitive Skill
CO-01	Describe the components, structure, progresses and functions of ecological systems including the relationship between biotic and abiotic factor.	U, A, An
CO-02	Explain the effects of air, water, soil, noise, and thermal pollution and suggest ways to reduce them.	R, A, E
CO-03	The student will be able to demonstrate a general understanding of interdisciplinary nature of environmental uses and able to characterize natural resources.	R,U,A
CO-04	Apply systems, concept and methodologies to analyze and understand interaction between social and environmental process.	R,A,E
CO-05	Explain the effects of hospital and industrial wastes in environment and suggest to reduce them.	R, A, An

R- Remember, U-Understand, A-Apply, An-Analyze, E-Evaluate, S- Synthesis

Mapping of Course Outcome with Programme Outcome

PO / CO	PO-A	PO-B	PO-C	PO-D
CO-01	S	M	M	M
CO-02	M	M	M	M
CO-03	M	M	S	S
CO-04	M	M	L	S
CO-05	M	M	S	L

S- Strong, M- Medium, L-Low, N- Not Relevant

Unit I :Treatment Processes **9**

Waste water, toxicity, Treatment Processes – Sedimentation - Coagulation and Flocculation - Activated Sludge - Sand Filters - Membrane Separation, advanced oxidation process, adsorption, fenton oxidation.

Unit II: Waste Electrical and Electronic Equipment **9**

Waste Electrical and Electronic Equipment (WEEE), The scale of problem, restriction of hazardous substances, material composition of WEEE, anticipated hazards to ecosystems, WEEE health and safety implications.

Unit III: E-Waste Recycling **9**

Integrated approach to E-Waste Recycling, recycling and recovery technologies, automated disassembly, thermal treatment, separation, comminution, capture technologies, design for recycling.

Unit IV: Context for Technological Risk **9**

Context for Technological Risk, Origins and Development of Risk Assessment, Societal Dimensions of Risk - Frameworks Addressing the Social Dimensions of Risk - How Risk Assessment Is Used in Environmental Decision Making.

Unit V: Risk Assessment **9**

The Four Steps of Risk Assessment - Issues in Applying the Four Steps of Risk Assessment to Nanotechnology - Hazard Assessment - Exposure Assessment - Dose-Response Evaluation - Risk Characterization.

TOTAL: 60 PERIODS

References

1. Nanotechnology and the Environment, Kathleen Sellers, Christopher Mackay, Lynn L. Bergeson, Stephen R. Clough, Marilyn Hoyt, Julie Chen, Kim Henry, Jane Hamblen, CRC Press (2009).
2. Nanotechnologies in Food, Edited by Qasim Chaudry, Laurence Castle and Richard Watkins, RSC Publications (2010).
3. Nanotechnology: Health and Environmental Risks, Jo Anne Shatkin, CRC Press, (2008).

LIST OF ELECTIVES-2021

LIST OF ELECTIVE COURSES						
1.	**CH37A1**	**Chemistry and Industry**	3	1	0	4
2.	**CH37A2**	**Chemistry and Environment**	3	1	0	4
3.	**CH37A3**	**Advanced Organic Chemistry**	3	1	0	4
4.	**CH37A4**	**Inorganic Materials and Bioinorganic Chemistry**	3	1	0	4
5.	**CH37A5**	**Physical Chemistry – Catalysis**	3	1	0	4
6	**CH37A6**	**Chemistry of nanomaterials**	3	1	0	4
7	**CH37A7**	**Environmental Chemistry**	3	1	0	4

Note:-

A student has to choose four electives-one in II semester, one in III semester and two in IV semester. A student can opt for either Chemistry & environment (CH37A2) or Environmental chemistry (CH37A7) only & not both during the course of study.

CH37A3	**Advanced Organic Chemistry**	**L**	**T**	**P**	**C**
		3	**1**	**0**	**4**

Objectives

The following key aspects will learn by the students are

Photochemical reactions
Molecular rearrangements
Basics and structural aspects of vitamins, steroids, antibiotics
Green chemistry
Molecular methodologies

Course Outcome – Cos		Cognitive Skill
CO-01	Students will be able to understand the photochemical aspects on organic molecules	U, A
CO-02	Students will be able to explain the different molecular rearrangement reactions	E, An
CO-03	Students will be able to describe the vitamins, steroids and antibiotics	U, A
CO-04	Students will be able to understand the different green chemistry aspects	R,E
CO-05	Students will be able to study the advanced synthetic methodologies	R,U, S

R- Remember, U-Understand, A-Apply, An-Analyze, E-Evaluate, S- Synthesis

Mapping of Course Outcome with Programme Outcome

PO / CO	PO-A	PO-B	PO-C	PO-D	PO-E
CO-01	M	L	S	M	N
CO-02	S	M	M	S	M
CO-03	S	S	S	M	L
CO-04	M	S	L	S	S
CO-05	M	M	N	M	S

S- Strong, M- Medium, L-Low, N- Not Relevant

Unit I: Photochemistry **9**

Photophysical processes - Jablonski diagram - Photochemical intramolecular reactions of the olefinic bond, geometrical isomerism, cyclization reactions, rearrangement of 1,3- and 1,5dienes.

Intramolecular reactions of carbonyl compounds: Structural, cyclic and acyclic, Norrish type I and II, □, □-unsaturated and □, □-unsaturated compounds – cyclohexadienones.

Intermolecular reactions of carbonyl compounds-cycloaddition reaction, dimerizations, Paterno -Buchi reaction.

Photosensitization, photo-oxidation, auto-oxidation, photo-reduction, Barton reaction, photoFries rearrangement, di -□-methane rearrangement. Photo chemistry of vision.

Pericyclic reactions - conservation of molecular orbital symmetry - electrocyclic and cycloaddition reactions - Sigmatropic rearrangements - applications of correlation diagram - Applications of Frontier Molecular Orbital (FMO) theory. Perturbation Molecular Orbital (PMO) theory and Huckel-Mobius approach to the above reactions – Hofmann-LofflerFreytag reactions, Ene synthesis, cheletropic reactions.

Unit II: Molecular Rearrangements **9**

1. General mechanistic consideration: Nature of migration, migratory aptitudes, memory effects.
2. Rearrangement to electron-deficient carbon: Wagner-Meerwein, pinacolpinacolone, benzil-benzilic acid, Wolff (Arndt-Eistert Synthesis) Demyanov, dienone-phenol.
3. Rearrangement to electron-deficient nitrogen: Hofmann, Curtius, Schmidt, Lossen Beckmann, Neber
4. Rearrangement to electron-deficient oxygen: Baeyer-Villiger, Dakin reaction.
5. Rearrangement proceeding through electron-rich carbon: Stevens, Sommelet-Hauser, Wittig, Favorskii,
6. Aromatic rearrangements: N-haloanilides, hydroxylamine-aminophenol, von Richter.
7. Miscellaneous: Bamford-Stevens, Shapiro, Pummerer.

Unit III: Antibiotics, Vitamins and Steroids **9**

Antibiotics: Penicillin, chloramphenicol, viruses-SARS, Corona-Elementary ideas only.
Vitamins: A_1, A_2, B_1, B_2, H.
Steroids: Androsterone, testosterone, estrone, progesterone.

Unit IV: Green Chemistry **9**

Definition – necessity for green chemistry – green chemistry and sustainable environment – principles of green chemistry – atom economy – atom economy vs yield in assessing greenness of organic reactions – example for green chemistry in organic synthesis – methods of greening organic reactions: solvent free reactions, green solvent reactions, green catalysis, microwave assisted reactions – application of ultrasound in organic synthesis - reactions in supracritical fluids – reactions in ionic solvents.

Unit V: Advanced Organic Synthesis **9**

Asymmetric synthesis-Definition of enantiomeric and diastercotopic excess- analytical methods to determine ee and de – classification of methods of asymmetric synthesis chiral auxillaires chiral reagents chiral catalysis. A systematic analysis of the total synthesis of longifolene, isonootkatone, alphaonocerin, and Z-jasmone.

TOTAL: 60 PERIODS

REFERENCES

1. VertosChemis, The Conservation of Orbital Symmetry, Gmbh and Asadan Press, 1971.
2. J.M. Coxon and B.Halton, Organic Photochemistry, Cambridge University Press, 1974.
3. Jagdamba Singh and Jaya Singh, Photochemistry and Pericyclic Reaction, New Age International (P) Ltd., New Delhi, 2003.
4. R. Sanghi and M.M. Srivastava – Green Chemistry (Environment Friendly Alternatives), Alpha Science Internaional Ltd, Pangbourne England, 2003.
5. V.K. Ahluwalia – Green Chemistry (Environmentally Beingn Reactions), Ane Books India, New Delhi, 2006.

6. Rashmi Sanshi, M.M. Srivastra – Green Chemistry – Alpha Sciences, 2003.
7. Organic Chemistry, I L Finar, Vol.I& II, ELBS.

CH37A4	Inorganic Materials and Bioinorganic Chemistry	L	T	P	C
		3	1	0	4

Objectives

Provide professional opportunities, such as internships and employment, for ceramic artists of various levels.
To impart thorough knowledge with the chemistry of silicones.
To be able to develop their attitude for preparing pigments.
To be able to discuss the tunable versatility of the Fe-heme system in biology from O_2 binding and transport in hemoglobin (myoglobin) to electron transfer (cytochromes).
Ability to comprehend the current problems in bioinorganic chemistry and answer specific scientific questions using the knowledge provided during the course.

Course Outcome - COs		Cognitive Skill
CO-01	Students will be able to know about the preparation and properties of ceramics, fibre and get an idea to use ceramics in daily life.	U
CO-02	Students will be able to understand the basics of inorganic pigments and analyse the various methods for synthesizing pigments.	An
CO-03	Students will be able to learn the important aspects of inorganic chains, rings, cages and metal clusters and also aware on the preparation of polymers.	E
CO-04	Students will be able to provide an insight into the manufactur and applications of elemental silicon, silicones.	A
CO-05	Students will be able to impart thorough knowledge in the importance of metals in biological systems at a molecular level that promote their activity	U

R- Remember, U-Understand, A-Apply, An-Analyze, E-Evaluate, S- Synthesis

Mapping of Course Outcome with Programme Outcome

PO / CO	PO-A	PO-B	PO-C	PO-D	PO-E
CO-01	S	M	S	M	S
CO-02	S	S	M	S	S
CO-03	M	S	S	L	M
CO-04	S	M	S	M	S
CO-05	S	S	S	M	S

S- Strong, M- Medium, L-Low, N- Not Relevant

Unit I: Ceramics **9**

Ceramics – classification, optical waveguides (optical fiber), sol-gel formation for low temperature ceramic formation. Non-oxide ceramics – general aspects, silicon carbide, silicon nitride and boron nitride ceramics. Fabrication of ceramic materials and its challenges. Textile glass fiber (E-glass fiber) and optical fiber manufacture, fabrication and applications.

Unit II: Metal oxide pigments **9**

Inorganic pigments: white pigments: TiO_2 pigment, its manufacture and applications; ZnO white, lithopone and ZnS pigments. Coloured pigments: iron oxide pigments – manufacture, oxidation processes and applications; chromate, molybdate and ferrocyanide pigments; lustrous, luminescent, magnetic and corrosion protection pigments-paint and its constituents.

Unit III: Inorganic Polymers and metal clusters **9**

General characteristics, degree of polymerization, S-N chain one dimensional conductor, phosphazene polymers, homocyclic and heterocyclic inorganic ring systems; Boranes and carboranes - Structure and bonding in boranes - Molecular frame work of hydrides of boron skeletal electron pair counting and Wade's rule. Metal clusters: dinuclear, trinuclear, tetranuclear and hexanuclear clusters and their synthesis and properties, polyatomic Zintl anions and cations, infinite metal chains.

Unit IV: Elemental Silicon & silicones **9**

Silicon: metallurgical grade, manufacture and applications. Silicones and Polysiloxanes. Structure and Allotropy of elements - Carbon, Oxygen and Sulphur-silicone oil, emulsion, rubbers and resins.

Unit V **9**

Copper proteins and Enzymes: plastocyanin, azurin, hemocyanin and ascorbic oxidase - different types of Cu present in proteins and enzymes. Zinc enzymes: carboxypeptidase A, carbonic anhydrase and superoxide dismutase. Inhibition and poisoning of enzymes illustrated by xanthine oxidase and aldehyde oxidase. Toxicity of metals and the role of metallothionins - excess and deficient levels of Cu,and Fe and the consequent diseases - chelate therapy – metal complexes as drugs, anticancer and antiarthritic agents. Metal complexes as probes of nucleic acids.

TOTAL: 60 PERIODS

References

1. H.R. Allcock, Introduction to Materials Chemistry, Wiley, 2008.
2. S.K. Agarwala, Keemti Lal, Advanced Inorganic Chemistry, Pragati Prakashan, 10thedn., 2011.
3. A.R. West, Solid State Chemistry and its applications, Wiley, 2004.
4. M.G. Arora, M. Singh, Industrial Chemistry, Anmol Publications, Reprint 2004.
5. Harish Kumar, Industrial Chemistry, Sarup& Sons Reprint 2002.
6. J.E. Huheey, E.A. Keiter, R.L. Keiter, Inorganic Chemistry, Pearson Education Asia, Reprint 2001.
7. F.A. Cotton and G. Wilkinson, Advanced Inorganic Chemistry, John Wiley & Sons, 5thEdn., 1988.
8. B.E. Douglas, D.H. McDaniel and J.J. Alexander, Concepts and Models of Inorganic Chemistry, John Wiley & Sons, 2 Edn. 1983.

9. I. V. Kozhevnikov, Catalysis by Heteropoly Acids and Multicomponent Polyoxometalates in Liquid-Phase Reactions, *Chem. Rev.* **1998,** *98,* 171-198.
10. D. E. Katsoulis, A Survey of Applications of Polyoxometalates, *Chem. Rev.* **1998,** *98,* 359387.
11. R.S.Drago, Physical methods in inorganic Chemistry, Saunders college publishers. 12 .J. D. Lee, Concise Inorganic Chemistry, Blackwell Science, Ltd5thEdn., **2008.**

CH37A5	Physical Chemistry-catalysis	L	T	P	C
		3	1	0	4

Objectives

i)Accurately describe and compare energy efficiencies of the materials and systems in photocatalysis and electrocatalysis ii) able to Choose appropriate catalyst for industrial purposes iii) to Apply the mechanisms of surface reactions

Course Outcome - COs		Cognitive Skill
CO-01	Students will be able to define and derive different catalysis	R,A,U
CO-02	Students will be able to Choose appropriate catalyst for industrial purposes	R,U,E,An
CO-03	Students will be able to describe micellar catalysis, inhibition in micellar solutions	R,U,A,E
CO-04	Students will be able to explain petroleum refining, ethylene based processes.	R,U,A
CO-05	Students will be able to Apply the mechanisms of surface reactions	R,U,An,A

R- Remember, U-Understand, A-Apply, An-Analyze, E-Evaluate, S- Synthesis

Mapping of Course Outcome with Programme Outcome

PO / CO	PO-A	PO-B	PO-C	PO-D	PO-E
CO-01	M	S	L	M	S
CO-02	S	S	M	S	S
CO-03	M	S	S	L	M
CO-04	S	S	S	M	S
CO-05	S	M	S	L	M

S- Strong, M- Medium, L-Low, N- Not Relevant

Unit I: Biocatalysis **9**

Biocatalysis -characteristics of Enzyme catalysis–Hypothesis for enzyme catalyzed reactions – strategies of enzyme catalysis- mechanisms of acid-base catalysis effect of substrate concentration, pH and temperature -Kinetics of Enzyme Catalysis-: Michaelis - Menton treatment, evaluation of Michaelis 's constant for enzyme - substrate binding by Lineweaver - Burk plot, and by Eadie-Hofstae methods..–,Enzyme Inhibition and types Competitive, uncompetitive and noncompetitive inhibition- salt effect, acidity functions and their importance; Bronsted catalysis law.

Unit II: Industrial catalysis **9**

Zeolites – synthesis, properties, applications-factors influencing zeolite synthesis; adsorption and diffusion in zeolites –shape selectivity-variants- molecular sieves – classificationcharacterization Phase transfer Catalysis –mechanism and benefits of PTC – types of PTC reactions –industrial processes -Solid catalysts - Catalyst components-Preparation of solid catalystPrecipitation and co-precipitation -Parameters affecting the properties of the precipitatePreparation of dual oxides catalysts by coprecipitation

Unit III: Micellar catalysis **9**

Micellar catalysis:-kinetics of micellar catalysis-reactions assisted by micelle formationQuantitative treatment of kinetic rate effects-surfactants-types-CMC-factors influencing CMCthermodynamics of micellazion-methods involved in CMC- inhibition in micellar solutions; reverse micelles and micro emulsions

Unit IV:Electro catalysis **9**

Introduction to electro catalysis -fuel cells –types- industrial applications of catalysis – petroleum refining–distillation, cracking-types-knocking-octanenumber-reforming,isomerization Alkylation, hydro treating, Hydrocarbon Steam Cracking for Petrochemicals , ethylene-based processes – Ethylene dichloride ,vinyl chloride Ethanolamine ethylene oxide, Propylene-based processes – Cumene and acrylonitrile

Unit V: Surface catalysis **9**

Introduction – mechanism of surface reactions: Langmuir-Hinshelwood &Rideal mechanisms; high-surface area amorphous solids;Supported catalysts-Preparation, Impregnation- Mechanism of impregnation- Drying -Mechanism-Parameters affecting the impregnation -Ion exchange - Mechanism of single ion exchange

TOTAL: 60 PERIODS

REFERENCES:

1.B. C. Gates, Catalytic Chemistry, John Wiley & Sons, Inc., 1992.

2.J. C. Kuriacose, Catalysis, Macmillan India Ltd., New Delhi, 1991.

3.M. Gratzel, K. Kalyanasundaram, Eds., Kinetics and Catalysis in Micro heterogeneous Systems, Marcel Dekker, New York, 1991.

4.K. Kalyanasundaram, Photochemistry in Microheterogeneous Systems, Academic Press, Orlando, 1987.

5.K. J. Laidler, Chemical Kinetics, 3rd Edition, Pearson Education Pte., Ltd., 2005.

6.P. H. Emmett, Catalysis, Vol. I and II, Reinhold Corp., New York, 1954.

7.J. M. Smith, Chemical Engineering Kinetics, McGraw Hill, 1971.

8.J. Hagen, Industrial Catalysis: A Practical Approach, 2nd Edition, Wiley-VCH, 2006.

CH37A6	CHEMISTRY OF NANOMATERIALS	L	T	P	C
		3	1	0	4

Objectives:

1.explain the effects of quantum confinement onthe electronic structure and corresponding physical and chemical properties of materials at nanoscale.

2.choose appropriate synthesis technique to synthesize quantum nanostructures of desired size, shape and surface properties.

3.correlate properties of nanostructures with their size, shape and surface characteristics.

4.appreciate enhanced sensitivity of nanomaterial-based sensors and their novel applications in industry.

Course Outcome - COs		Cognitive Skill
CO-01	Students will be able to know about the properties of nanomaterials	U
CO-02	Students will be able to understand the basics of interactions in nanoscale.	An
CO-03	Students will be able to learn theNanostructured Molecular Architectures	E
CO-04	Students will be able to provide an insight into the Synthesis of Nanomaterials	A
CO-05	Students will be able to impart thorough knowledge in Characterization and Applications of Nanomaterials	U

R- Remember, U-Understand, A-Apply, An-Analyze, E-Evaluate, S- Synthesis

Mapping of Course Outcome with Programme Outcome

PO / CO	PO-A	PO-B	PO-C	PO-D	PO-E
CO-01	M	S	L	M	S
CO-02	S	S	M	S	S
CO-03	M	S	S	L	M
CO-04	S	S	S	M	S
CO-05	S	M	S	L	M

S- Strong, M- Medium, L-Low, N- Not Relevant

Unit 1: Properties of Nanomaterials **9**

Difference in behavior between bulk and nanomaterial's, Size and dimensionality effects, Quantum size effect. Nanoscale confinement of electronic interactions, Quantum confined materials, Novel optical and magnetic properties of nanomaterials. Quantum dots and its fluorescence, Up conversion and down conversion, Metal nanoparticles, Surface Plasmon

Resonance, Magnetic nanoparticles, Superparamagnetism in nanoparticles. Environmental Issues of nanomaterials

Unit II: Chemical Interaction at Nanoscale **9**

Interparticle interactions in nanoscale, Types of intermolecular bonding, Electrostatic interactions,- Ionpairintractions, solvent effects, ion dipole and dipole dipole interactions, Dative bond, π interactions hydrogen bonding, Vander waals attractions and its physical property dependence, hydrophobic effect, Ostwald ripening. Reverse micelle as Spherical nanoreactors.

Unit III :Nanostructured Molecular Architectures **9**

Carbon fullerenes, its structure and applications, Superconductivity in C**60**. Carbon nanotubes, its structure electrical and mechanical properties and its applications. Semiconductor nanomaterials, Graphenes, Carbon dots, Dendrimers. Biological nanomaterials, biomimetics, Self assembly of proteins, micelles and vesicles. Liposomes Core shell structures, Ferrofluids.

Unit IV: Synthesis of Nanomaterials **9**

Solution based synthesis of nanoparticles, synthesis of quantum dots, silver & Gold nano particles using aqueous chemical method, Brief introduction to vapour phase synthesis of nanoparticles. Synthesis using frame work, support and substrates, Introduction to Physical vapour deposition, Molecular beam epitaxy, Chemical vapour deposition, Chemical beam Epitaxy, LAVD, Atomic layer deposition, Electrospinning and Lithographic techniques

Unit V: Characterization and Applications of Nanomaterials **9**

Optical Characterization, UV Visible Spectroscopy, Spectrofluorometry, Dynamic light scattering method, Surface Plasmon resonance spectroscopy. Structural Characterization. Using AFM,STM, SEM, HRTEM ,SERS Nanophotonic devices, Nanophotonics for biotechnology and nanomedicine Magnetic nanoparicles as MRI Contrast agents, Drug delivery, Nanoparticle for optical diagnosis and targeted therapy, Bio-imaging with quantum dots, FRET, Nanosensors,

TOTAL: 60 PERIODS

References

1, G. L. Hornyak, Harry F. Tibbals, Joydeep Dutta, John J. Moore, Introduction to Nanoscience andnanotechnology, CRC Press, London 2009.

2, Paras M Prasad - Nanophotonics.John Wiley and Sons,New Jersey,2004

3, Geoffrey A. Ozin& Andre C. Arsenault , Nanochemistry, A chemical approach to nonmaterial's;RSC Publishing 2005

4, Charles P. Poole Jr & Frank J Owens; Introduction to Nanotechnology, Wiley, India , 2008

5, Richard Booker, Earl Boysen, Nanotechnology, Wiley, India 2005.

6, Pradeep T. Nano the essentials, Understanding Nanoscience and Technology, McGraw – HillEducation, NewDelhi 2007.

CH37A7	Environmental Chemistry	L	T	P	C
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Objective:

i)To understand the basic idea about the nature cycles of environment.
ii) To provide a valuable understanding about pollutions iii) To understand the basic idea about environmental restoration.

Course Outcome - COs		Cognitive Skill
CO-01	Describe the components, structure, progresses and functions of ecological systems including the relationship between biotic and abiotic factor.	U, A, An
CO-02	Explain the effects of air, water, soil, noise, and thermal pollution and suggest ways to reduce them.	R, A, E
CO-03	The student will be able to demonstrate a general understanding of interdisciplinary nature of environmental uses and able to characterize natural resources.	R,U,A
CO-04	Apply systems, concept and methodologies to analyze and understand interaction between social and environmental process.	R,A,E
CO-05	Explain the effects of hospital and industrial wastes in environment and suggest to reduce them.	R, A, An

R- Remember, U-Understand, A-Apply, An-Analyze, E-Evaluate, S- Synthesis

Mapping of Course Outcome with Programme Outcome

PO / CO	PO-A	PO-B	PO-C	PO-D
CO-01	S	M	M	M
CO-02	M	M	M	M
CO-03	M	M	S	S
CO-04	M	M	L	S
CO-05	M	M	S	L

S- Strong, M- Medium, L-Low, N- Not Relevant

Unit-I: Scope: **9**

Environmental pollution - structure of atmosphere - biogeological cycles - oxygen -nitrogen – carbon – phosphorous – sulphur - biodistribution of elements - air pollutions - reactions in atmosphere - primary pollutants - air quality standards - analysis of CO, nitrogen oxides, sulphur oxides, hydrocarbons and particulate matter - particulate pollution - control methods - vechicular pollution –greenhouse effect and global warming - climatic changes – ozone - photochemical smog - acid rain - sampling - monitoring – control.

Unit-II: Hydrosphere: **9**

Water pollution - hyrological cycle - chemical composition - sea watercomposition - water quality criteria for domestic and industrial uses - BIS and WHO standards - ground water pollution -

surface water pollution - lake and river water - eutrophication - marine pollution - water pollutants - biodgradeability of detergents – pestisides - endosulfan and related case studies.

Unit-III: Classification of industrial waste waters: 9

Principles of water and waste water treatment -aerobic and anaerobic treatment - industrial waste water treatment - heavy metal pollution - hard water - softening - purification of water for drinking purposes - water treatment for industrial use - electrodialysis - reverse osmosis - other purification methods - chemical speciation of elements.

Unit-IV: Water analysis: 9

Color - odor - conductivity - TDS - pH - acidity - alkalinity - chloride -residual chlorine - hardness - trace metal analysis - elemental analysis - ammonia - nitrite - nitrate - fluoride - sulphide - phosphate - phenols - surfactants - BOD - COD - DO - TOC - nondispersive IR spectroscopy - anode stripping - ICP - AES - Chromatography - ion selective electrodes - neutron activation analysis.

Unit-V: Soil pollution: 9

Soil humus - soil fertility - inorganic and organic components in soil - acid -base and ion exchange reactions in soils - micro and macro nutrients - wastes and pollutants in soil - introduction to geochemistry - solid waste management - treatment and recycling-soil analysis - radioactive pollution - disposal of radioactive waste.

TOTAL: 60 PERIODS

References:

1. H. Kaur, Environmental Chemistry, 6thEdn, PragathiPrakashan, Meerut, 2011.
2. K.H.Mancy and W,.J.Weber Jr. Wiley, Analysis of Industrial Waste Water, Interescience New York, 1971.
3. L.W. Moore and E. A. Moore, Environmental Chemistry, McGraw Hill Publication, New York, 2002.
4. S. M. Khopkar, Environmental Pollution Analysis, New Age International (P) Ltd, 1993.
5. Colid Baird. Environmental Chemistry, W. H. Freemand and Company, 1995.