SHRI GUR RAM RAI UNIVERSITY

[Estd. by Govt. of Uttarakhand, vide Shri Guru Ram Rai University Act no. 03 of 2017 & recognized by UGC u/s (2f) of UGC Act 1956]

DEPARTMENT OF CHEMISTRY

SCHOOL OF BASIC & APPLIED SCIENCES
SHRI GURU RAM RAI UNIVERSITY

Bachelor of Science
OR
Bachelor of Science (Hons.) in Chemistry
OR
Bachelor of Science (Hons. with Research) in Chemistry

Based on NEP 2020

[Exit Options after completion of 01 Year, 02 Years, 03 Years, and 04 Years]

Effective from Academic Session 2023-2024
(Revised on 30th July 2024 & 12th August 2025)

Patel Nagar, Dehradun, Uttarakhand

Basic Structure of UG Multidisciplinary Programme (with Three Core disciplines)

B.Sc. (Chemistry, Botany and Zoology / Physics, Chemistry and Mathematics as core disciplines)

Basic Structure of UG Multidisciplinary Program (with Three Core Disciplines) –

Type of Course

Discipline Specific Core (DSC)
Discipline Specific Elective (DSE)
General Elective (GE)
Ability Enhancement Courses (AEC)
Skill Enhancement Course (SEC)
Internship/Apprenticeship / Project/ Community Outreach (IAPC)
Value Addition course (VAC)

Sem	**Core - Discipline Specific Core (DSC)**	**Elective-Discipline Specific Elective (DSE)**	**Elective-Generic Elective (GE)**	**Ability Enhancement Course (AEC)**	**Skill Enhancement Course (SEC)**	**(Internship/Apprenticeship / Project/ Community Outreach) (IAPC)**	**Value Addition Course (VAC)**	**Total credits**
	Course/credit distribution (Credits 4) Theory or Theory + Practicum (3T+1L)	**Course/ credit distribution** (Credits 4) Theory or Theory + Practicum/ Lab (3T+1L or 2T+2L)	**Course/ credit distribution** (Credits 4) Theory or Theory + Practicum/ Lab (Credits 4T or 3T+1L or 2T+2L)	**Course/ credit distribution** (Credits 2)	**Course/credit distribution** (Credits 2)	**Course/ credit distribution** (Credits 2)	**Course/ credit distribution** (Credits 2)	22
I	**DSC A(Botany/Physics) 1- (4) DSC B (Zoology/Maths) 1- (4) DSC C (Chemistry)1- (4)** (3T+1L) ***Either CBZ or PCM combination is allowed**		Choose one from a pool of courses **GE – 1 (4)**	**AEC – 1 (2)**	Choose one from a pool of courses **SEC – 1 (2)**		Choose one from a pool of courses **VAC – 1 (2)**	22

II	**DSC A(Botany/Physics) 2- (4)** **DSC B (Zoology/Maths) 2- (4)** **DSC C (Chemistry)2- (4)** (3T+1L) ***Either CBZ or PCM combination is allowed**		Choose one from a pool of courses **GE – 2 (4)**	**AEC – 2 (2)**	Choose one from a pool of courses **SEC – 2 (2)**		Choose one from a pool of courses **VAC – 2 (2)**	22
	Students on exit shall be awarded Undergraduate Certificate (in the field of Multidisciplinary study) after securing requisite 44 credits in semester I & II							**Total = 44**
III	**DSC A(Botany/Physics) 3- (4)** **DSC B (Zoology/Maths) 3- (4)** **DSC C (Chemistry)3- (4)** (3T+1L) ***Either CBZ or PCM combination is allowed**	Choose one from a pool of courses, **DSE A/B/C (4)** OR **GE - 3 (4)** (4 T/or 3T+1L/or 2T+2L) OR **MOOC**		**AEC – 3 (2)**	Choose one from **SEC 3 – (2)** OR **Internship/Apprenticeship / Project/ Community Outreach (IAPC) – (2)**		Choose one from a pool of courses **VAC – 3 (2)**	22
IV	**DSC A(Botany/Physics) 4- (4)** **DSC B (Zoology/Maths) 4- (4)** **DSC C (Chemistry)4- (4)** (3T+1L) ***Either CBZ or PCM combination is allowed**	Choose one from a pool of courses, **DSE A/B/C (4)** credits) OR **GE - 4 (4)** (4 T/or 3T+1L/or 2T+2L) OR **MOOC**		**AEC – 4 (2)**	Choose one from **SEC 4 – (2)** OR **Internship/Apprenticeship / Project/ Community Outreach (IAPC) – (2)**		Choose one from a pool of courses **VAC – 4 (2)**	22
Students on exit shall be awarded Undergraduate Diploma (in the field of Multidisciplinary study/Discipline) after securing requisite 88 credits in semester III & IV								**Total = 88**

V	**DSC A (Botany/Physics) 5- (4)** **DSC B (Zoology/Maths) 5- (4)** **DSC C (Chemistry)5- (4)** (3T+1L) ***Either CBZ or PCM combination is allowed**	Choose one from a pool of courses, **DSE A/B/C (4)** credits) (3T+1L/or 2T+2L) OR **MOOC**	Choose one from a pool of courses **GE – 5 (4)** OR **MOOC**		Choose one from **SEC 5 – (2)** OR **Internship/Apprenticeship / Project/ Community Outreach (IAPC) – (2)**		22
VI	**DSC A (Botany/Physics) 6- (4)** **DSC B (Zoology/Maths) 6- (4)** **DSC C (Chemistry)6- (4)** (3T+1L) ***Either CBZ or PCM combination is allowed**	Choose one from a pool of courses, **DSE A/B/C (4)** credits) (3T+1L/or 2T+2L) OR **MOOC**	Choose one from a pool of courses **GE – 6 (4)** OR **MOOC**		Choose one from **SEC 5 – (2)** OR **Internship/Apprenticeship / Project/ Community Outreach (IAPC) – (2)**		22
Students on exit shall be awarded Bachelor of Science (in the field of Multidisciplinary study/Discipline) after securing the requisite 132 credits on completion of semester VI							**Total= 132**
VII	**DSC A/B/C 7 - (4)** (3T+1L)	**Choose 3 DSE** (3x4) courses OR **Choose 2 DSE – (2x4) and one GE (4)** course OR **Choose 1 DSE (4) and 2 GE** (2x4) courses (Total= 12)			Dissertation on Major/Minor (4+2) OR Academic Project/ Entrepreneurship (4+2) **[B.Sc. Honours with Research]** **OR** One DSE (3T+1L) Seminar (2) **[B.Sc. Honours]**		22
VIII	**DSC A/B/C 8 - (4)** (3T+1L)	**Choose 3 DSE** (3x4) courses OR **Choose 2 DSE – (2x4) and one GE (4)** course OR **Choose 1 DSE (4) and 2 GE** (2x4) courses (Total= 12)			Dissertation on Major/Minor (4+2) OR Academic Project/ Entrepreneurship (4+2) **[B.Sc. Honours with Research]** **OR** One DSE (3T+1L)		22

				Seminar (2) **[B.Sc. Honours]**		
Students on exit shall be awarded Bachelor of Science (in the field of Multidisciplinary study/Discipline) (Honours with Research or Honours with Academic project/Entrepreneurship) after securing requisite 176 credits on completion of semester VIII						**Total = 176**

Exit Course is mandatory for exit after Ist and IInd year.
Rectification in 2023-24, 2024-25 with 2025-26 BOS

Course Introduction:

The modified curriculum of Bachelor of Science OR Bachelor of Science (Hons) with Research offers one year certificate, two-year diploma, three-year degree and four-year Degree in (Hons) with Research after securing required credits as per the Curriculum and credit framework for Undergraduate program guidelines by NEP2020 and UGC.

Eligibility Criteria for Admission: The candidate must have passed 10+2 with relevant field as a compulsory subject from a recognized board or its equivalent with minimum 45% marks.

Program Outcomes

PO 1	Bachelor of Science offers theoretical as well as practical knowledge about different subject areas.
PO2	Graduates will develop scientific temperament to solve scientific problems in emerging areas of science at National and International level.
PO3	Graduates will acquire coherent understanding of the academic field to pursue multi and interdisciplinary science careers in future.
PO4	Graduate will have clarity of thought and expression. Qualities like logical thinking and decision making will be enhanced
PO5	Graduates plan and execute experiments or investigations, analyze and interpret data information collected using appropriate methods
PO6	Graduates will be able to compete in various national and international competitive examinations.
PO7	Graduates will understand the principles of basic and applied sciences and apply them logically in environmental and socio-technological context with a systematic approach towards sustainable development.
PO8	Graduates will have critical thinking, follow innovations and developments in Science and technology
PO9	Graduates will acquire effective communication skills
PO10	Graduates will understand ethical principles and responsibilities for effective citizenship.
PO11	Graduates will develop new and enhancing conversational skills that lead to not only to good communication but also to the excellent drafting abilities linked with technical reports and presentations.

PO12	Graduates will become competent enough for doing jobs in Govt. and private sectors of academia, research and industry.

Program Specific Outcome (PSOs)

PSO 1	Chemistry graduates will become familiar with the fundamental concepts in organic, inorganic, physical and analytical chemistry.
PSO2	Chemistry graduates will develop analytical skills and acquire the ability to synthesize, separate and characterize compounds using laboratory techniques.
PSO3	Chemistry graduates will be able to understand the qualitative and quantitative chemical analysis of the compounds in the laboratory.
PSO4	Skill enhancement courses will equip students with the knowledge and skills which will help them to make a successful career in the respective industries.

Credit Requirements and Qualifications at different levels on the NHEQF:

Credit Requirements and Qualifications at different levels on the NHEQF: The level of the four years B.Sc. Programme shall be as per the Draft National Higher Educational Qualification Framework (NHEQF). As per the guidelines, the numbers of credits to be earned at each level are as under:

NHEQF Level	Nomenclature (qualifications within each level)	Credit earned without exit option	Credit earned with exit option
Level – 5	**Undergraduate Certificate** for those who exit after successful completion of first year (two semesters) of the undergraduate programme	***44***	***44***
Level – 6	**Undergraduate Diploma** for those who exit after successful completion of second year (four semesters) of the undergraduate programme	***88***	***88***
Level – 7	**Bachelor's Degree** for those who exit after successful completion of three years (six semesters) of the four-year undergraduate programme	***132***	***132***
Level – 8	**Bachelor's Degree with Honours** for those who have successfully completed four years (eight semesters) of the undergraduate programme	***176***	***176***
Level – 8	**Bachelor's Degree Honours with Research** for those who have successfully completed four years (eight semesters) of the undergraduate programme	***176***	***176***

Examination Scheme

Components	Ist Internal	IInd Internal	External (ESE)
Weightage (%)	15 Marks	15 Marks	70 Marks

Semester Wise Discipline Specific Core

Semester	Course Type	Course Code	Course Title	L	T	P	C
I	DSC-C (Chemistry)	CHEDC101	Fundamentals of Chemistry I	3	0	0	3
		CHEDL102	Lab course based on CHEDC101	0	0	2	1
II		CHEDC201	Fundamentals of Chemistry-II	3	0	0	3
		CHEDL202	Lab course based on CHEDC201	0	0	2	1
III		CHEDC301	General Chemistry-I	3	0	0	3
		CHEDL302	Lab course based on CHEDC301	0	0	2	1
IV		CHEDC401	General Chemistry-II	3	0	0	3
		CHEDL402	Lab course based on CHEDC401	0	0	2	1
V		CHEDC501	Organic Chemistry	3	0	0	3
		CHEDL502	Lab course based on CHEDC501	0	0	2	1
VI		CHEDC601	State of Matter and Chemical Kinetics	3	0	0	3
		CHEDL602	Lab course based on CHEDC601	0	0	2	1
VII		CHEDC701	Heterocyclic Chemistry	3	0	0	3
		CHEDL702	Lab course based on CHEDL701	0	0	2	1
VIII		CHEDC801	Spectroscopy and Chromatographic techniques	3	0	0	3
		CHEDL802	Lab course based on CHEDL802	0	0	2	1

Semester Wise Generic Elective Courses

Semester	Course Type	Course Code	Course Title	L	T	P	C
I	GE-C (Chemistry)	CHEGE103	s and p block elements and metallurgy	4	0	0	4
II		CHEGE203	Atomic Structure, Chemical Bonding and Volumetric Analysis	4	0	0	4
III		CHEGE303	General Organic Chemistry and Hydrocarbons	4	0	0	4
IV		CHEGE403	Chemical Energetics and Ionic Equilibria	4	0	0	4
V		CHEGE503	Molecules of Life	4	0	0	4
VI		CHEGE603	Carboxylic Acids, Amines and Derivatives	4	0	0	4

Semester Wise Ability Enhancement Course

Semester	Course Type	Course Code	Course Title	L	T	P	C
I	AEC	AEC-104	Environment Science-I	2	0	0	2
II		AEC-204	Environment Science-II	2	0	0	2
III		AEC-304	English Communication-I	2	0	0	2
IV		AEC-404	English Communication-II	2	0	0	2

Semester Wise Skill Enhancement Course/IAPC

Semester	Course Type	Course Code	Course Title	L	T	P	C
I	SEC/IAPC (Chemistry)	CHESC105	Basic Analytical chemistry-I **OR** Internship/Apprenticeship / Project/ Community Outreach/MOOC	2	0	0	2
II		CHESC205	Basics of Analytical Chemistry-II **OR** Internship/Apprenticeship / Project/ Community Outreach/MOOC	2	0	0	2
III		CHESC305	a)Chemistry of Soil and Water / b)Disaster Management **OR** Internship/Apprenticeship / Project/ Community Outreach/MOOC	2	0	0	2
IV		CHESC405	Pesticide Chemistry **OR** Internship/Apprenticeship / Project/ Community Outreach/MOOC	2	0	0	2
V		CHESC505	Fuel Chemistry **OR** Internship/Apprenticeship / Project/ Community Outreach/MOOC	2	0	0	2
VI		CHESC605	Business skills for chemist/ **OR** Internship/Apprenticeship / Project/ Community Outreach/MOOC	2	0	0	2

Semester Wise Discipline-Specific Elective

Semester	Course Type	Course Code	Course Title	L	T	P	C
III	DSE-C (Chemistry)	CHEDE306	Green Chemistry	3	0	0	3
		CHEDL307	Lab course based on CHEDE306	0	0	2	1
IV		CHEDE406	Polymer Chemistry	3	0	0	3
		CHEDL407	Lab course based on CHEDE406	0	0	2	1
V		CHEDE506	Environmental Chemistry	3	0	0	3
		CHEDL507	Lab course based on CHEDE506	0	0	2	1
VI		CHEDE606	Quantitative analytical Methods	3	0	0	3
		CHEDL607	Lab course based on CHEDE606	0	0	2	1
VII		CHEDE703	Biomolecules	3	0	0	3
		CHEDL704	Lab course based on CHEDE703	0	0	2	1
		CHEDE705	Coordination Chemistry and Bioinorganic Chemistry	3	0	0	3
		CHEDL706	Lab course based on CHEDE705	0	0	2	1
		CHEDE707	Electrochemistry	3	0	0	3
		CHEDL708	Lab course based on CHEDE707	0	0	2	1
		CHEDE709	Chemistry of Natural Products	3	0	0	3
		CHEDE710	Lab course based on CHEDE709	0	0	2	1
		CHEDE711	Research Methodology*	3	1	0	4
		CHEDE712	Industrial Chemicals and Environment	3	0	0	3
		CHEDL713	Lab course based on CHEDE712	0	0	2	1
		CHEDE714	Solid State Chemistry	3	1	0	4
VIII		CHEDE803	Structure and Properties of Metal Complexes	3	0	0	3
		CHEDL804	Lab course based on CHEDE803	0	0	2	1
		CHEDE805	Reagents and Reactions in Organic Chemistry	3	0	0	3
		CHEDL806	Lab course based on CHEDE805	0	0	2	1
		CHEDE807	Medicinal chemistry	3	0	0	3
		CHEDL808	Lab course based on CHEDE807	0	0	2	1
		CHEDE809	Applications of Computers in Chemistry	3	0	0	3
		CHEDL810	Lab course based on CHEDE809	0	0	2	1
		CHEDE811	Research Publications Ethics*	3	1	0	4
		CHEDE812	Pericyclic Reactions and Organic Photochemistry	3	1	0	4
		CHEDL813	Lab course based on CHEDE812	0	0	2	1
		CHEDE814	Quantum Chemistry	3	1	0	4

*Mandatory for the Hons. with research.

Semester Wise Dissertation

Semester	Course Type	Course Code	Course Title	L	T	P	C
VII	IAPC	CHEDT712	Dissertation (Discipline Specific) (Mandatory for Hons. With Research)	0	0	0	6
		CHEDS713	Seminar/ Academic Project/ Entrepreneurship (For Hons.)	0	0	0	2
VIII	IAPC	CHEDT812	Dissertation (Discipline Specific) (Mandatory for Hons. With Research)	0	0	0	6
		CHEDS813	Seminar/ Academic Project/ Entrepreneurship (For Hons.)	0	0	0	2

Semester Wise Value-Added Course

Semester	Course Type	Course Code	Course Title	L	T	P	C
I	VAC		Choose from the pool of courses offered by the University	0	0	0	2
II			Choose from the pool of courses offered by the University	0	0	0	2
III			Choose from the pool of courses offered by the University	0	0	0	2
IV			Choose from the pool of courses offered by the University	0	0	4	2

Discipline Specific Core

Semester I

Course code : CHEDC101				
Course Title : Fundamentals of Chemistry I				
Semester /Year : I				
	L	**T**	**P**	**C**
	3	**0**	**0**	**3**

Course outcomes (COs):
Upon successful completion of the course, student will be able to:

CO1	Outline key topics across inorganic, organic, and physical chemistry, including atomic structure, bonding, stereochemistry, and states of matter.
CO2	Discuss quantum theory (like Schrödinger equation and uncertainty principle) to explain atomic structure and orbitals.
CO3	Apply chemical bonding theories (VBT, hybridization, VSEPR) to predict molecular shapes, including xenon compounds.
CO4	Explain organic reaction mechanisms and stability of intermediates using electronic effects and reagent types.
CO5	Assess the stereoisomers using proper configuration rules (R/S, D/L, E/Z), and explain chirality and related terms.
CO6	Solve problems related to gas laws, surface tension, crystallography, and colloids using physical chemistry principles.

Unit	Content
1	**Atomic Structure:** Dual nature of matter; de Broglie concept. Heisenberg uncertainty principle; its significance. Atomic orbitals, Schrödinger wave equation; the significance of ψ and ψ^2. Quantum numbers, radial and angular wave functions and probability distribution curves, shapes of s, p, and d orbitals. Aufbau energy diagram, Pauli's exclusion principle. Hund's rule of maximum multiplicity.
2	**Chemical Bonding-I:** Ionic bond, covalent bond-Valence Bond Theory, and its limitations; various types of hybridization and shapes of different inorganic and organic molecules. Valence Shell Electron Pair Repulsion Theory (VSEPR) and shapes of NH3, H_2O, H_3O^+, SF_4, ClF_3, ICl_2^-, NH_4^+ and other simple molecules/ions (CO_2, SO_2, Cl_2O_7, SO_4^{2-}, NO_3^-, PO_3^-) including compounds of xenon.

3	**General Organic Chemistry and Mechanism of Organic Reactions:** Resonance, hyperconjugation, field effects- inductive, mesomeric, electromeric effect. Types of reagents- electrophiles and nucleophiles, Energy considerations. Reactive intermediates- carbocations, carbanions, free radicals.
4	**Stereochemistry of Organic Compounds:** Types of isomerism- optical isomerism- elements of symmetry, molecular chirality, enantiomers, stereogenic centers, optical activity, properties of enantiomers, chiral and achiral molecules diastereomers, threo and erythro diastereomers, meso compounds, inversion, retention, and racemization. Relative and absolute configuration, sequence rules, D & L and R & S systems of nomenclature. Geometrical isomerism: Determination of the configuration of geometrical isomers, E & Z system of nomenclature.
5	**States of Matter-I: Gaseous State-**Postulates of the kinetic theory of gases, deviation from ideal behavior, van der Waal's equation of states, Critical phenomena – PV isotherms of real gases. Molecular velocities: Root mean square, average, and most probable velocities. Numerical problems. **Liquid State-**Intermolecular forces, Structural differences between solids, liquids, and gases. Physical properties of liquids: surface tension and viscosity. Numerical problems.
6	**States of Matter-II: Solid State:** Introduction to crystalline materials, Definition of space lattice, unit cell, crystal planes, Miller indices, Laws of crystallography – (i) law of constancy of interfacial angles (ii) law of rationality of indices (iii) law of symmetry. Symmetry elements in crystals, X-ray diffraction by crystals. Bragg's equation, Numerical problems. **Colloidal State:** Definition of colloids, classification of colloids. Solids in liquids (sols): properties – kinetic, optical, and electrical; stability of colloids, protective action, Hardy-Schulze law, gold number.

Books Recommended:

i. Lee, J.D., "Concise, Inorganic Chemistry", Oxford University Press, 2008, India, 5th edition.
ii. Puri, B.R., Sharma, L.R., and Kalia, K.C., "Principles of Inorganic Chemistry", Vishal Publishing Co., India, 2020, 33rd edition.
iii. Madan, R.L., "Chemistry for Degree Students, B. Sc. First Year", S. Chand Publishing, New Delhi, India, 2011, 3rd edition.
iv. Madan, R.D., Malik, U.M. and Tuli, G.D., "Selected topics in Inorganic Chemistry", S. Chand Publishing, New Delhi, India, 2010.

CO-PO-PSO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4
CO1	3	3	3	2	2	3	3	3	1	1	1	3	3	2
CO2	3	2	2	2	1	2	2	3	1	1	1	2	3	2
CO3	3	3	3	2	2	1	1	2	1	1	1	2	3	3
CO4	3	2	3	3	1	1	1	3	2	1	1	2	3	2
CO5	3	2	2	2	3	3	3	3	1	1	1	2	3	3
CO6	3	3	3	3	3	3	3	3	1	1	1	3	3	3

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

Course code : CHEDL102				
Course Title : Lab course based on CHEDC101				
Semester /Year : I				
	L	**T**	**P**	**C**
	0	**0**	**2**	**1**

Course outcomes (COs):
Upon successful completion of the course, the student will be able to:

CO1	Define the essential laboratory safety rules, including hazard identification and safe handling of chemicals and equipment.
CO2	Describe the qualitative analysis of salt mixtures and identify acid radicals (anions) and basic radicals (cations) up to Group II using systematic procedures.
CO3	Interpret chemical reactions and confirmatory tests in inorganic analysis with accuracy, precision, and correct procedural steps.
CO4	Analyze the ball-and-stick models to determine the absolute configuration of organic molecules and represent them using Fischer projections.
CO5	Evaluate the stereochemical visualization skills by analyzing chirality and drawing stereoisomeric structures correctly.
CO6	Prepare detailed laboratory reports documenting objectives, procedures, observations, calculations, results, and environmental implications

Unit	Contents
1	Laboratory hazards and safety precautions

2	**Salt mixture analysis:** Identification of acid radicals (three to four) including anions in combination and basic radicals upto II Group in the given salt mixture.
3	**Organic exercise:** Determination of absolute configuration of organic molecules using ball and stick models. Students are supposed sketch the structure of simple organic compounds showing their stereochemistry using Fischer Projection.
4	**Physical exercise:** Determination of relative surface tension of the given liquid using Stalagmometer.

Books Recommended:

i. Mendham, J. Vogel's Quantitative Chemical Analysis, Pearson, 2009.
ii. Harris, D. C. Quantitative Chemical Analysis. 6th Ed., Freeman (2007) Chapters 3-5.
iii. Harris, D. C. Exploring Chemical Analysis, 9th Ed. New York, W.H. Freeman, 2016.
iv. Khopkar, S.M. Basic Concepts of Analytical Chemistry. New Age International Publisher, 2009.

CO-PO-PSO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4
CO1	3	2	2	3	2	1	2	2	2	3	2	2	2	3
CO2	3	3	2	2	3	2	2	2	2	2	2	3	3	3
CO3	3	3	3	2	3	2	2	2	2	2	2	3	3	3
CO4	3	2	2	3	2	1	1	3	2	2	3	2	3	2
CO5	3	2	2	3	2	2	2	3	2	2	3	2	3	2
CO6	3	3	3	2	3	3	2	3	2	2	2	3	3	3

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

Semester II

Course code : CHEDC201				
Course Title : Fundamentals of Chemistry-II				
Semester /Year : II				
	L	**T**	**P**	**C**
	3	**0**	**0**	**3**

Course outcomes (COs):

Upon successful completion of the course, student will be able to:

CO1	Recall Molecular Orbital Theory (MOT) and VBT
CO2	Describe the concepts of polarization in covalent molecules using Fajan's rule, polarizing power, and polarizability. Identify weak interactions like hydrogen bonding and van der Waals forces.
CO3	Illustrate the periodic trends and chemical properties of s- and p-block elements, including diagonal relationship, catenation, inert pair effect, and interhalogen compounds.
CO4	Analyze the reactivity and mechanisms of aliphatic and aromatic compounds, including free radical halogenation, addition reactions, aromaticity, and electrophilic substitution with directing effects.
CO5	Demonstrate the reaction kinetics, order, and rate laws.
CO6	Solve numerical problems related to thermodynamics and chemical kinetics.

Units	Content
1	**Chemical Bonding-II:** Molecular Orbital Theory (MOT) as applied to diatomic homonuclear/heteronuclear inorganic molecules. MO diagrams and bond order of H_2, He_2, Li_2, Be_2, B_2, C_2, N_2, O_2, F2, Ne2, CO, NO, HF difference between VB and MO theories. Polarization of covalent molecules, Polarizing power, and polarizability; Fajan's rule. Weak interactions-hydrogen bonding in inorganic and organic molecules and van der Waals interactions.

2	**Salient Features of s- and p-Block Elements:** General discussion with respect to all periodic (Occurrence, electronic configuration, atomic & ionic radii, density, ionization potential, metallic behaviour, electropositive nature, electronegativity, electron affinity, hydration energy, flame colouration, photoelectric effect, polarization power, boiling and melting point) and chemical properties (reactivity towards water, oxygen, air and moisture, hydrogen, halogens, ammonia). Diagonal relationship, catenation, inert pair effect and interhalogen compounds.
3	**Aliphatic Compounds:** Chemical reactions of alkanes. Mechanism of free radical halogenation of alkanes. Cycloalkanes- Baeyer's strain theory and its limitations. Chemical reactions of alkenes- mechanisms involved in hydrogenation, electrophilic and free radical additions, Markownikoff's Rule, hydroboration-oxidation, oxymercuration- reduction. Substitution at the allylic and vinylic positions of alkenes. Chemical reactions of alkynes, Mechanism of electrophilic and nucleophilic addition reactions, hydroboration- oxidation.
4	**Aromatic Compounds:** Aromaticity- the Hückel rule, aromatic ions. Aromatic electrophilic substitution- general pattern of the mechanism, role of σ and π complexes. Mechanism of nitration, halogenation, sulphonation, mercuration and Friedel- Crafts reaction. Energy profile diagrams. Activating and deactivating substituents, orientation and ortho/para ratio.
5	**Chemical Kinetics and Catalysis:** Chemical kinetics and its scope, rate of a reaction, factors influencing the rate of a reaction– concentration, temperature, pressure, solvent, light, catalyst; hetero and homocatalysis, significance. Molecularity, Order of reaction- zero order, first order, second order, pseudo-order, Radioactive decay a first order phenomenon, half-life period, Methods of determination of the order of reaction- differential method, method of integration, method of half-life period and isolation methods, Numerical problems.
6	**Thermodynamics I:** Definition of thermodynamic terms, system, surroundings, etc. Types of thermodynamic systems and thermodynamic processes. Intensive and extensive properties. Concept of heat and work, the first law of thermodynamics, and the definition of internal energy and enthalpy. Heat capacity – heat capacities at constant volume and at constant pressure and their relationship, calculation of w, q, dU & dH for the expansion of ideal gases under isothermal and reversible conditions. Thermochemistry, Standard enthalpy of formation – Hess's law of heat summation and its application. Temperature dependence of enthalpy, Kirchoff's equation, Numerical problems.

Books Recommended:

i. Lee, J.D., "Concise, Inorganic Chemistry", Oxford University Press, 2008, India, 5th edition.
ii. Puri, B.R., Sharma, L.R., and Kalia, K.C., "Principles of Inorganic Chemistry", Vishal Publishing Co., India, 2020, 33rd edition.
iii. Madan, R.L., "Chemistry for Degree Students, B. Sc. First Year", S. Chand Publishing, New Delhi, India, 2011, 3rd edition.
iv. Madan, R.D., Malik, U.M. and Tuli, G.D., "Selected topics in Inorganic Chemistry", S.Chand Publishing, New Delhi, India, 2010.

CO-PO-PSO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4
CO1	3	3	2	3	2	2	1	2	2	1	2	2	3	2
CO2	2	2	2	2	2	2	2	2	2	1	2	2	2	2
CO3	3	3	2	2	2	2	1	2	2	1	2	2	3	3
CO4	3	3	3	3	2	2	1	2	2	2	2	2	3	3
CO5	3	3	3	3	3	2	1	2	2	2	3	2	3	2
CO6	3	3	3	3	3	2	2	2	2	2	3	3	3	2

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

Course code : CHEDL202				
Course Title : Lab course based on CHEDC201				
Semester /Year : II				
	L	**T**	**P**	**C**
	0	**0**	**2**	**1**

Course outcomes (COs):

Upon successful completion of the course, student will be able to:

CO1	Describe the common laboratory hazards and implement proper safety measures and precautions to ensure safe handling of chemicals and equipment during experiments.
CO2	Compare molar and normal solutions accurately, and standardize secondary standard solutions using primary standards through acid-base titrations.
CO3	Demonstrate the acid-base titrations using appropriate indicators (like phenolphthalein) and calculate the strength of unknown acid or base solutions based on standardization.
CO4	Distinguish between alkanes, alkenes, and alkynes, and between aliphatic and aromatic compounds by conducting physical and chemical identification tests.
CO5	Evaluate fundamental principles to measure physical properties, such as relative viscosity of a liquid, using instruments like the Ostwald viscometer.

CO6	Develop experimental data, make accurate observations, perform related calculations, and draw logical conclusions from inorganic, organic, and physical chemistry experiments.

Unit	Contents
1	Laboratory hazards and safety precautions
2	**Inorganic exercise:** Acid-base titrations; preparation of a solution in normal/molar terms, its standardization using a primary standard solution, determination of the strength of unknown solution. For example: preparation of NaOH solution (secondary standard say N/10), preparation of (COOH)2 solution (primary standard say N/10), standardization of NaOH solution titrating it against (COOH)2 solution using phenolphthalein (indicator) and then the determination of the strength of given HCl solution.
3	**Organic exercise:** Differentiation between alkanes, alkenes, and alkynes. Differentiation between aliphatic and aromatic compounds using chemical and physical tests.
4	**Physical exercise:** Determining the given liquid's relative viscosity using Ostwald viscometer.

Books Recommended:

i. Mendham, J., A. I. Vogel's Quantitative Chemical Analysis 6th Ed., Pearson, 2009.
ii. Willard, H.H. et al.: Instrumental Methods of Analysis, 7th Ed.
iii. Wardsworth Publishing Company, Belmont, California, USA, 1988.
iv. Christian, G.D. Analytical Chemistry, 6th Ed. John Wiley & Sons, New York, 2004.
v. Harris, D. C. Exploring Chemical Analysis, 9th Ed. New York, W.H. Freeman, 2016.

CO-PO-PSO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4
CO1	2	2	1	2	1	3	2	3	2	1	2	1	2	2
CO2	3	3	2	3	2	2	1	2	2	1	2	1	3	2
CO3	3	3	2	3	2	2	1	2	2	2	2	2	3	2
CO4	2	2	2	2	1	1	1	2	2	2	2	2	2	3
CO5	3	2	2	3	2	2	1	2	2	1	2	2	3	2
CO6	3	3	3	2	2	2	2	2	2	2	3	2	3	2

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

Semester III

Course code : CHEDC301				
Course Title : General Chemistry-I				
Semester/Year : III				
	L	**T**	**P**	**C**
	3	**0**	**0**	**3**

Course outcomes (COs):
Upon successful completion of the course, student will be able to:

CO1	Recall and define transition elements, coordination chemistry, halides, alcohols, phenols, thermodynamics, chemical equilibria.
CO2	Explain the properties of transition elements, principles of coordination chemistry, and the fundamentals of thermodynamics and chemical equilibrium.
CO3	Apply the concepts of nucleophilic substitution in halides and chemical reactions of alcohols and phenols, including key named reactions and mechanisms.
CO4	Analyze the principles of coordination chemistry, properties of transition elements, and reaction mechanisms in halides, alcohols, and phenols.
CO5	Predict the geometry and magnetic nature of coordination compounds, mechanism of organic reactions and feasibility of reactions.
CO6	Solve numerical problems related to thermodynamics and chemical equilibria.

Unit	Contents
1	**Chemistry of Transition Elements (First, second and third Transition Series):** Characteristic properties of the elements; electronic configuration, atomic & ionic radii, oxidation states ionization energy, boiling & melting points, complex compound formation, colour, catalytic properties and magnetic properties. coordination number and geometry.
2	**Coordination Chemistry-I:** Definition, terminology (ligand, coordination number, coordination sphere, complex ion etc.), Nomenclature of coordination compounds (IUPAC system), Werner's theory for coordination compounds, effective atomic number (EAN) concept, 18-electron rule, Valence Bond Theory (VBT) for coordination compounds, geometry of complexes (tetrahedral, octahedral, square planar), Crystal Field Theory, Magnetic properties of complex compounds.
3.	**Halides:** Chemical reactions. Alkyl, aryl and vinyl halides. Mechanism of nucleophilic substitution reactions, SN2 and SN1 reactions with energy profile diagrams

4	**Alcohols and Phenols:** Alcohols: Preparation, Properties and Chemical reactions of alcohols. Dihydric alcohols-methods of preparation, chemical reactions of vicinal glycols, oxidative cleavage [$Pb(OAc)_4$ and HIO_4] Trihydric alcohols-methods of formation, chemical reactions of glycerol. **Phenols:** Physical properties and acidic character. Comparative acidic strengths of alcohols and phenols, resonance stabilization of phenoxide ion. Reactions of phenols-electrophilic aromatic substitution, acylation and carboxylation. Mechanism of Fries rearrangement, Claisen condensation, Gatterman synthesis, and Reimer-Tiemann reaction.
5	**Thermodynamics II:** Second law of thermodynamics, need of the law, different statements of the law. Carnot cycle and its efficiency, Carnot theorem. Concept of entropy: entropy as a state function, entropy as a function of V and T, entropy as a function of P and T. Clausius inequality, entropy as criteria of spontaneity and equilibrium. Entropy change in ideal gases. Gibbs free energy and Helmholtz work functions. Criteria for thermodynamic equilibrium and spontaneity, Variation of G and A with P, V and T, Gibbs- Helmholtz equation, Numerical problems.
6	**Chemical Equilibrium:** The law of mass action, free energy and equilibrium constant, factors influencing equilibrium constant, relationship between Kp and Kc. Le-Chatelier's principle, Numerical problems.

Books Recommended:

i. Lee, J.D., "Concise, Inorganic Chemistry", Oxford University Press, 2008, India, 5th edition.
ii. Puri, B.R., Sharma, L.R., and Kalia, K.C., "Principles of Inorganic Chemistry", Vishal Publishing Co., India, 2020, 33rd edition.
iii. Madan, R.L., "Chemistry for Degree Students, B. Sc. Second Year", S. Chand Publishing, New Delhi, India, 2011, 3rd edition.

CO-PO-PSO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4
CO1	2	2	1	2	1	3	2	3	2	1	2	1	2	2
CO2	3	3	2	3	2	2	1	2	2	1	2	1	3	2
CO3	3	3	2	3	2	2	1	2	2	2	2	2	3	2
CO4	2	2	2	2	1	1	1	2	2	2	2	2	2	3
CO5	3	2	2	3	2	2	1	2	2	1	2	2	3	2
CO6	3	3	3	2	2	2	2	2	2	2	3	2	3	2

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

Course code : CHEDL302				
Course Title : Lab course based on CHEDC301				
Semester /Year : III				
	L	**T**	**P**	**C**
	0	**0**	**2**	**1**

Course outcomes (COs):
Upon successful completion of the course, student will be able to:

CO1	Define the procedures for systematic qualitative analysis of inorganic mixtures including acid and basic radicals.
CO2	Describe the role of solubility product and common ion effect in the separation of ions during inorganic analysis.
CO3	Perform functional group analysis to detect alcohols and phenols in organic compounds.
CO4	Differentiate between alcohols and phenols based on chemical reactions and physical properties.
CO5	Evaluate the critical solution temperature (CST) through experimental methods.
CO6	Prepare detailed laboratory reports documenting objectives, procedures, observations, calculations, results, and environmental implications.

Unit	Contents
1	Laboratory hazards and safety precautions
2	**Inorganic exercise:** Complete analysis of inorganic mixture including both acid and basic radicals with a special emphasis on the role of common ion effect and solubility product.
3	**Organic exercise:** Functional group tests for alcohols and phenols. Differentiation between alcohols and phenols using chemical and physical tests.
4	**Physical exercise:** Determination of critical solution temperature (CST)

Books Recommended:

i. Mendham, J., A. I. Vogel's Quantitative Chemical Analysis 6th Ed., Pearson, 2009.
ii. Willard, H.H. et al.: Instrumental Methods of Analysis, 7th Ed.
iii. Wordsworth PublishingCompany, Belmont, California, USA, 1988.
iv. Christian, G.D. Analytical Chemistry, 6th Ed. John Wiley & Sons, New York, 2004

CO-PO-PSO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4
CO1	3	2	3	2	2	2	2	2	1	1	2	2	3	3
CO2	3	3	2	2	2	2	2	2	1	1	1	2	3	3
CO3	3	3	2	2	3	2	2	2	1	1	1	2	3	3
CO4	3	2	2	3	2	2	2	3	1	1	1	2	3	2
CO5	3	2	2	2	3	2	2	3	1	1	1	2	2	3
CO6	3	2	3	3	3	2	3	2	3	3	3	2	3	3

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

Semester-IV

Course code : CHEDC401				
Course Title : General Chemistry-II				
Semester /Year : IV				
	L	**T**	**P**	**C**
	3	**0**	**0**	**3**

Course outcomes (COs):

Upon successful completion of the course, student will be able to:

CO1	Recall the basic concepts of acid and bases, inner transition elements, aldehydes, ketones, carboxylic acids and electrochemistry.
CO2	Describe the principles of acid-base theories, inner transition elements, and the structure–reactivity relationship in carboxylic acids, aldehydes, and ketones.
CO3	Apply the concepts of electrochemistry and the mechanisms of organic reactions such as nucleophilic addition, condensation, and reduction involving carbonyl and carboxylic compounds.
CO4	Analyze reaction mechanisms of carbonyl and carboxylic acid compounds, electrode processes, and trends in lanthanides and actinides.
CO5	Evaluate the suitability of different acid-base theories and electrochemical methods for interpreting chemical phenomena.
CO6	Solve numerical problems related to electrochemistry.

Unit	Contents

1	**Acids and Bases:** Arrhenius concept, Bronsted-Lowry concept, and Lewis concept of acids and bases; Hard and Soft Acid-Base Theory: Classification of acids and bases as hard and soft. Pearson's hard and soft acid base concept, acid base strength and hardness and softness.
2	**Chemistry of Inner Transition Elements:** Chemistry of Lanthanides: Electronic configuration, oxidation states, atomic & ionic radii, lanthanide contraction and its consequences, complex formation, colour; Methods of separation of lanthanides **Chemistry of Actinides:** General features of actinides-electronic configuration, atomic & ionic radii, ionization potential, oxidation states and complex formation.
3	**Aldehydes and Ketones:** Comparative account of properties of aliphatic and aromatic aldehydes and ketones. Mechanism of nucleophilic additions to carbonyl group with particular emphasis on benzoin, aldol, Perkin condensation. Condensation with ammonia and its derivatives; Wittig reaction, Oxidation of aldehydes, Baeyer- Villiger oxidation of ketones, Cannizzaro reaction, Clemmensen, Wolff-Kishner, LiAlH4 and NaBH4 reductions.
4	**Carboxylic Acids:** Reactions of carboxylic acids, Hell-Volhard- Zelinsky reaction. Synthesis of acid chlorides, esters and amides. Reduction of carboxylic acids, mechanism of decarboxylation. Methods of preparation and chemical reactions of unsaturated monocarboxylic acids.
5	**Electrochemistry I:** Electrical transport-conduction in metals and electrolytic solutions, specific conductance and equivalent conductance, measurement of equivalent conductance, variation of equivalent and specific conductance with dilution. Arrhenius theory of electrolytic dissociation and its limitations, weak and strong electrolytes, Ostwald's dilution law, its uses and limitations, Numerical Problems.
6	**Electrochemistry II:** Types of reversible electrodes-gas-metal ion, metal-metal ion, metal-insoluble salt anion and redox electrodes. Electrode reactions, Nernst equation, derivation of cell EMF and single electrode potential, standard hydrogen electrode-reference electrode, standard electrode potential, sign conventions, electrochemical series and its significance. Electrolytic and Galvanic cell, Reversible and irreversible cells, conventional representation of electrochemical cells. EMF of a cell and its measurements. Calculation of thermodynamic quantities of cell reactions (ΔG, ΔH and K), Numerical Problems.

Books Recommended:

i. Willard, H.H. et al.: Instrumental Methods of Analysis, 7th Ed.
ii. Wordsworth Publishing Company, Belmont, California, USA, 1988.
iii. Christian, G.D. Analytical Chemistry, 6th Ed. John Wiley & Sons, New York, 2004.
iv. Harris, D. C. Exploring Chemical Analysis, 9th Ed. New York, W.H. Freeman, 2016.

CO-PO-PSO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4
CO1	3	2	2	2	2	1	1	1	1	1	1	1	3	3
CO2	3	2	2	2	2	1	1	1	1	1	1	1	3	3
CO3	3	3	3	2	2	2	1	2	1	1	1	1	3	3
CO4	3	2	3	3	2	2	1	2	1	1	1	1	3	3
CO5	3	2	3	3	3	2	2	2	1	1	1	2	3	3
CO6	3	2	3	2	3	2	1	1	1	1	1	2	3	3

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

Course code : CHEDL402				
Course Title : Lab Course based on CHEDC401				
Semester /Year : IV				
	L	**T**	**P**	**C**
	0	**0**	**2**	**1**

Course outcomes (COs):

Upon successful completion of the course, student will be able to:

CO1	Identify basic laboratory techniques and safety protocols in inorganic, organic, and physical chemistry experiments.
CO2	Explain the principles behind redox titrations, solubility determination, and organic functional group analysis.
CO3	Perform volumetric analysis using internal and external indicators to determine concentrations of redox-active species.
CO4	Analyze experimental data to detect and differentiate functional groups in aldehydes, ketones, and carboxylic acids.
CO5	Assess accuracy and precision in solubility determination and volumetric titration methods.
CO6	Prepare detailed laboratory reports documenting objectives, procedures, observations, calculations, results, and environmental implications.

Unit	Contents
1	Laboratory hazards and safety precautions
2	**Inorganic exercise:** Volumetric exercises (double titration) based on redox reactions involving internal as well as external indicators.
3	**Organic exercise:** Preliminary and Functional group tests for aldehydes, ketones and carboxylic acids (both aliphatic and aromatic).

4	**Physical exercise:** Determination of solubility of salts.

Books Recommended:

i. Mendham, J., A. I. Vogel's Quantitative Chemical Analysis 6th Ed., Pearson, 2009.
ii. Willard, H.H. et al.: Instrumental Methods of Analysis, 7th Ed.
iii. Wordsworth PublishingCompany, Belmont, California, USA, 1988.
iv. Christian, G.D. Analytical Chemistry, 6th Ed. John Wiley & Sons, New York, 2002

CO-PO-PSO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4
CO1	3	2	2	1	2	3	1	2	1	1	1	1	3	2
CO2	3	3	2	2	2	2	1	2	1	1	1	1	3	3
CO3	3	3	3	3	2	2	1	2	1	1	1	2	3	3
CO4	3	2	3	3	2	2	1	2	1	1	1	2	3	3
CO5	3	3	3	3	3	2	1	2	1	1	1	2	3	3
CO6	3	2	2	3	2	2	2	3	2	2	2	3	3	3

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

Semester-V

Course code : CHEDC501				
Course Title : Organic Chemistry				
Semester /Year : V				
	L	**T**	**P**	**C**
	3	**0**	**0**	**3**

Course outcomes (COs):
Upon successful completion of the course student will be able to:

CO1	Define and identify the important reagents, dyes, carbohydrates and proteins.
CO2	Explain the organic reagents, nitrogen containing compounds, dyes, carbohydrates and proteins.
CO3	Identify different classes of dyes, relate their colour to chemical structure and constitution.
CO4	Describe the classification of carbohydrates proteins and dyes. Illustrate reactions, and stereochemical features of carbohydrates, including sugar configurations and mutarotation.
CO5	Analyze the structure, behaviour, and properties of amino acids and proteins, focusing on acid-base characteristics and electrophoresis.
CO6	Design organic chemistry concepts to predict reaction outcomes and solve problems related to synthesis and biomolecules.

Unit	Contents
1	**Reagents in Organic Synthesis:** Types of reagents, acetylene, ammonia, Bayer's reagent, chromic acid, DMSO, Fehling reagent, Grignard reagent, hydrogen peroxide, potassium dichromate, potassium permanganate, Raney Ni, silver nitrate, sodium borohydride, THF, TMS, Tollen's reagent.
2	**Nitrogen Containing Organic Compounds:** Chemical reactions of nitroalkanes. Mechanism of nucleophilic substitution in nitroarenes and their reduction in acidic, neutral and alkaline medium. Physical properties. Separation of mixture of primary, secondary and tertiary amines. Structural features affecting basicity of amines. Preparation of alkyl and aryl amines (reduction of nitro compounds, nitriles), reductive amination of aldehydic and ketonic compounds. Gabriel- phthalimide reaction, Hofmann bromamide reaction.

3	**Dyes:** Color and constitution, Classification of dyes by structure and methods of application. Synthesis and application of Alizarin, Indigo, Congo red, Malachite green, Methylene blue, Phenolphthalein, Methyl orange..
4	**Carbohydrates and Proteins:** Occurrence, classification and their biological importance. Reducing and nonreducing sugar, Epimers and anomers, Mutarotation, mechanism of osazone formation, Interconversions of aldoses and ketoses, Killiani-Fischer synthesis and Ruff degradation, Configuration of monosaccharides. Erythro and threo diastereomers. Formation of glycosides. Cyclic structure of D(+)-glucose.
5	**Amino Acids, Peptides and Proteins:** Preparation of Amino Acids: Strecker synthesis using Gabriel's phthalimide synthesis. Zwitterion, Isoelectric point and Electrophoresis. Reactions of Amino acids: ester of –COOH group, acetylation of –NH2 group, complexation with Cu2+ ions, ninhydrin test. Overview of Primary, Secondary, Tertiary and Quaternary Structure of proteins

Books Recommended:

i. Finar, I.L., "Organic Chemistry", Pearson Education India, 2002, 6th edition.

ii. Eliel, E.L. and Wilen, S.H., "Stereochemistry of Organic Compounds", Willey, 1994,1st edition.

iii. Boyd, Morrison and Bhattacharjee, "Organic Chemistry", Pearson Education India,2010, 7th edition.

iv. Mukerji, S.M., "Reaction mechanism in Organic Chemistry", Laxmi Publications,2007, 3rd edition.

CO-PO-PSO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4
CO1	3	3	2	2	2	2	1	2	2	1	2	2	3	3
CO2	3	3	3	2	2	2	1	2	2	2	2	2	3	3
CO3	2	2	2	2	2	2	1	2	1	1	2	2	2	2
CO4	3	3	2	3	2	2	1	2	2	2	2	2	3	2
CO5	3	3	3	3	2	2	1	2	2	2	2	2	3	2
CO6	3	3	3	3	3	2	2	2	2	2	3	3	3	3

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

Course code : CHEDL502				
Course Title : Lab course based on CHEDC501				
Semester /Year : V				
	L	**T**	**P**	**C**
	0	**0**	**2**	**1**

Course outcomes (COs):
Upon successful completion of the course, student will be able to:

CO1	Identify common laboratory hazards and follow essential safety precautions during practical work.
CO2	Discuss qualitative analysis of nitrogen-containing organic compounds by detecting elements and functional groups like amines, nitro, amides, and anilides.
CO3	Use binary organic mixtures using techniques like water solubility-based separation.
CO4	Design simple organic compounds using standard reactions such as nitration, halogenation, acetylation, sulphonation, and oxidation.
CO5	Analyze carbohydrates and proteins qualitatively through specific biochemical tests.
CO6	Create experimental results accurately and develop basic skills in organic qualitative analysis and synthesis techniques.

Unit	Contents
1	Laboratory hazards and safety precautions
2	**Organic qualitative analysis:** Analysis of Nitrogen containing organic compounds (detection of elements, amines, nitro, amides and anilides) Binary mixture of organic compounds separable by water **Organic synthesis:** through nitration, halogenation, acetylation, sulphonation and simple oxidation
3	Qualitative analysis of carbohydrate and protein

CO-PO-PSO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4
CO1	3	2	2	2	2	1	1	1	1	1	1	1	3	3
CO2	3	2	2	2	2	1	1	1	1	1	1	1	3	3
CO3	3	3	3	2	2	2	1	2	1	1	1	1	3	3
CO4	3	2	3	3	2	2	1	2	1	1	1	1	3	3
CO5	3	2	3	3	3	2	2	2	1	1	1	2	3	3
CO6	3	2	3	2	3	2	1	1	1	1	1	2	3	3

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

Course code : CHEDC601				
Course Title : States of Matter and Chemical Kinetics				
Semester /Year : VI				
	L	**T**	**P**	**C**
	3	**0**	**0**	**3**

Course outcomes (COs):

Upon successful completion of the course student will be able to:

CO1	Recall the postulates of kinetic theory of gases, types of solids, crystal structures, and basic principles of chemical kinetics.
CO2	Explain the basic concepts of the kinetic theory of gases, intermolecular forces in solids and liquids, and the mechanisms of chemical kinetics.
CO3	Apply kinetic theory, crystallography, and chemical kinetics to analyze gas behavior, crystal structures, and reaction parameters using experimental and theoretical approaches.
CO4	Compare the crystal field splitting in octahedral and tetrahedral complexes, and the kinetics of reactions with different orders based on rate constants and half-lives.
CO5	Evaluate surface tension and viscosity of liquids using stalagmometer and Ostwald's viscometer through experimental techniques.
CO6	Solve numerical problems based on chemical kinetics, solids, liquids, and kinetic theory of gases.

Unit	**Contents**
1	**Kinetic Theory of Gases:** Postulates of Kinetic Theory of Gases and derivation of the kinetic gas equation. Deviation of real gases from ideal behaviour, compressibility factor, causes of deviation. van der Waals equation of state for real gases. Boyle temperature (derivation not required). Maxwell Boltzmann distribution laws of molecular velocities and molecular energies (graphic representation – derivation not required) and their importance. Temperature dependence of these distributions. Most probable, average and root mean square velocities (no derivation).
2	**Liquids:** Surface tension and its determination using stalagmometer. Viscosity of a liquid and determination of coefficient of viscosity using Ostwald viscometer. Effect of temperature on surface tension and coefficient of viscosity of a liquid (qualitative treatment only).
3	**Solid:** Forms of solids. Symmetry elements, unit cells, crystal systems, Bravais lattice types and identification of lattice planes. Laws of Crystallography -Law of constancy of interfacial angle Law of rational indices. Miller indices. X–Ray

	diffraction by crystals, Bragg's law. Structures of NaCl, KCl and CsCl (qualitative treatment only). Defects in crystals. Glasses and liquid crystals.
4	**Chemical Kinetics:** The concept of reaction rates. Effect of temperature, pressure, catalyst and other factors on reaction rates. Order and molecularity of a reaction. Derivation of integrated rate equations for zero, first and second order reactions. Half–life of a reaction. General methods for determination of order of a reaction. Concept of activation energy and its calculation from Arrhenius equation. Theories of Reaction Rates: Collision theory and Activated Complex theory of bimolecular reactions.

Books Recommended:

i. R L Madan, Chemistry For Degree Students, S. Chand.
ii. Barrow, G.M. Physical Chemistry Tata McGraw-Hill (2007).
iii. Atkins, P. W. & Paula, J. de Atkin's Physical Chemistry Ed., Oxford University Press 13 (2006).
iv. Ball, D. W. Physical Chemistry Thomson Press, India (2007).
v. Castellan, G. W. Physical Chemistry 4th Ed. Narosa (2004).
vi. Mortimer, R. G. Physical Chemistry 3rd Ed. Elsevier: Noida, UP (2009)

CO-PO-PSO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4
CO1	3	2	2	2	2	1	1	1	1	1	1	1	3	3
CO2	3	2	2	2	2	1	1	1	1	1	1	1	3	3
CO3	3	3	3	2	2	2	1	2	1	1	1	1	3	3
CO4	3	2	3	3	2	2	1	2	1	1	1	1	3	3
CO5	3	2	3	3	3	2	2	2	1	1	1	2	3	3
CO6	3	2	3	2	3	2	1	1	1	1	1	2	3	3

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

Course code : CHEDL602				
Course Title : States of Matter and Chemical Kinetics				
Semester /Year : VI				
	L	**T**	**P**	**C**
	0	**0**	**2**	**1**

Course outcomes (COs):

Upon successful completion of the course student will be able to:

CO1	List the basic principles and apparatus involved in surface tension, viscosity, and chemical kinetics experiments.

CO2	Explain the methods for measuring surface tension (drop number and drop weight) and viscosity (relative and absolute) using stalagmometer and Ostwald's viscometer.
CO3	Apply experimental techniques to determine surface tension and viscosity of liquids and dilute solutions.
CO4	Analyze the effect of solute concentration on the viscosity of sucrose solution.
CO5	Evaluate the rate constant of acid hydrolysis of methyl acetate
CO6	Prepare detailed laboratory reports documenting objectives, procedures, observations, calculations, results, and environmental implications.

Unit	Contents
1	Surface tension measurements: To determine the surface tension of a liquid or a dilute solution using a stalagmometer. To determine the surface tension by (i) drop number (ii) drop weight method.
2	Viscosity measurements: To determine the relative and absolute viscosity of a liquid or dilute solution using an Ostwald's viscometer. To study the variation of viscosity of sucrose solution with the concentration of solute.
3	Chemical kinetics: To study the kinetics of acid hydrolysis of methyl acetate (with hydrochloric acid) using the integrated rate method.

Books Recommended:

i. Khosla, B. D.; Garg, V. C. & Gulati, A. Senior Practical Physical Chemistry, R. Chand & Co.: New Delhi (2011).
ii. Garland, C. W.; Nibler, J. W. & Shoemaker, D. P. Experiments in Physical Chemistry 8th Ed.; McGraw-Hill: New York (2003).
iii. Halpern, A. M. & McBane, G. C. Experimental Physical Chemistry 3rd Ed.; W.H. Freeman & Co.: New York (2003).

CO-PO-PSO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4
CO1	3	2	2	2	2	1	1	1	1	1	1	1	3	3
CO2	3	2	2	2	2	1	1	1	1	1	1	1	3	3
CO3	3	3	3	2	2	2	1	2	1	1	1	1	3	3
CO4	3	2	3	3	2	2	1	2	1	1	1	1	3	3
CO5	3	2	3	3	3	2	2	2	1	1	1	2	3	3
CO6	3	2	3	2	3	2	1	1	1	1	1	2	3	3

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

Semester-VII

Course code : CHEDC701				
Course Title : Heterocyclic Chemistry				
Semester /Year : VII				
	L	**T**	**P**	**C**
	3	**0**	**0**	**3**

Course outcomes (COs):

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

CO1	Recall the basic concepts, classification, and nomenclature (trivial and systematic) of heterocyclic compounds, including key examples like pyrrole, furan, thiophene, pyridine, indole, quinoline, and isoquinoline.
CO2	Explain the molecular orbital picture, structure, aromaticity and mechanisms of substitution reactions of pyrrole, furan, thiophene, and pyridine.
CO3	Apply the principles of nomenclature to name heterocyclic compounds.
CO4	Compare and contrast the aromaticity and reactivity of pyrrole, furan, thiophene, and pyridine.
CO5	Assess the role of aromaticity and molecular orbital interactions in determining the chemical behaviour and substitution patterns of furan, pyrrole, thiophene, pyridine, indole, quinoline, and isoquinoline.
CO6	Design synthetic routes for the preparation of heterocyclic compounds like pyrrole, furan, thiophene, pyridine, indole, quinoline, and isoquinoline using appropriate synthesis methods.

Unit	Contents
1	Introduction, classification and nomenclature of heterocyclic compounds (Trivial and Systematic).
2	Molecular orbital picture of pyrrole and pyridine, structure and aromaticity of pyrrole, furan, thiophene and pyridine. Synthesis, reactions and mechanism of substitution reactions of: Furan, Pyrrole (Paal-Knorr synthesis, Knorr pyrrole synthesis, Hantzsch synthesis), Thiophene, Pyridine (Hantzsch synthesis).
3	Structure elucidation of indole (Fischer indole synthesis and Madelung synthesis), Structure elucidation of quinoline and isoquinoline, Skraup synthesis, Friedlander's synthesis, Knorr quinoline synthesis, Doebner-Miller synthesis, Bischler-Napieralski reaction, Pictet-Spengler reaction.

4.	Derivatives of furan: Furfural and furoic acid

Books Recommended

i. "Heterocyclic Chemistry" by Raj K. Bansal 5th Edn, New Age International Publisher, ISBN 978-81-224-3143-8. 7.
ii. "Heterocyclic Chemistry" 5th Edn. by J. A. Joule, K. Mills and G. F. Smith, Wiley International Publications, ISBN: 978-1-4051-3300-5. 8.
iii. "Heterocyclic Chemistry" (3rd Edition) by Thomas. L. Gilchrist, Prentice Hall Publication, ISBN 978-0-5822-7843-1. 9.
iv. "Organic Chemistry" Vol. 1 by I L Finar, Published by Pearson Education; ISBN 10: 8177585428.

CO-PO-PSO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4
CO1	3	1	2	1	1	1	1	2	1	1	1	1	3	1
CO2	3	2	2	2	1	1	1	3	3	1	3	2	3	2
CO3	3	2	2	2	3	1	2	3	2	1	2	3	3	3
CO4	3	2	2	3	2	2	1	3	2	1	2	2	3	2
CO5	3	2	3	3	2	2	2	3	2	1	2	3	3	2
CO6	3	3	3	3	3	2	2	3	2	1	3	3	3	3

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

Course code : CHEDL702				
Course Title : Lab based on CHEDC701				
Semester /Year : VII				
	L	**T**	**P**	**C**
	3	**0**	**0**	3

Course outcomes (COs):

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

CO1	Recall the fundamental concepts, reaction conditions, and reagents involved in the multi-step synthesis of organic compound.
CO2	Explain the reaction mechanisms, structural changes, and chemical principles underlying the multi-step syntheses of Benzpinacolone, Benzanilide, and Benzilic acid.
CO3	Apply appropriate synthetic methods and reagents to perform the multi-step syntheses of Benzpinacolone, Benzanilide, and Benzilic acid in a laboratory setting.
CO4	Analyze the reaction pathways, intermediates, and yields in the multi-step syntheses of Benzpinacolone, Benzanilide, and Benzilic acid, identifying factors affecting reaction efficiency.

CO5	Evaluate the suitability of different synthetic routes and reagents for the preparation of Benzpinacolone, Benzanilide, and Benzilic acid, considering factors like yield, safety, and environmental impact.
CO6	Design optimized synthetic routes for the multi-step preparation of Benzpinacolone, Benzanilide, and Benzilic acid, integrating alternative reagents or conditions to improve efficiency or sustainability.

Unit	**Contents**
1	**Multi-step Synthesis of Organic Compounds** Benzophenone ⟶ Benzpinacol ⟶ Benzpinacolone Beckmann rearrangement: Benzanilide from benzene Benzene ⟶ Benzophenone ⟶ Benzophenone oxime ⟶ Benzanilide Benzilic acid rearrangement: Benzilic acid from benzoin Benzoin ⟶ Benzil ⟶ Benzilic acid

Books Recommended

i. "Heterocyclic Chemistry" by Raj K. Bansal 5th Edn, New Age International Publisher, ISBN 978-81-224-3143-8. 7.
ii. Laboratory Manual of Organic Chemistry, RK Bansal, New Age International, Delh
iii. Operational Organic Chemistry, A Laboratory Course, Second Edition, JW Lehman, Allyn & Bacon, Inc. Boston
iv. "Organic Chemistry" Vol. 1 by I L Finar, Published by Pearson Education; ISBN 10: 8177585428.

CO-PO-PSO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4
CO1	3	1	2	1	1	1	1	2	1	1	1	1	3	1
CO2	3	2	2	2	1	1	2	3	3	1	3	2	3	2
CO3	3	2	2	2	3	1	2	3	2	1	2	3	3	3
CO4	3	2	2	3	3	2	2	3	2	1	2	3	3	3
CO5	3	3	3	3	2	2	3	3	2	2	2	3	3	2
CO6	3	3	3	3	3	2	3	3	2	2	3	3	3	3

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

Semester-VIII

Course code : CHEDC801				
Course Title : Spectroscopy and Chromatography				
Semester /Year : VIII				
	L	**T**	**P**	**C**
	3	**0**	**0**	**3**

Course outcomes (COs):

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

CO1	Outline the concept of spectroscopy and chromatography.
CO2	Describe the principle, instrumentation and applications associated with spectroscopy and chromatographic techniques.
CO3	Interpret the data of spectroscopy and chromatography.
CO4	Explain the concept of UV, IR NMR spectroscopic techniques and chromatography.
CO5	Summarize the factors associated with band position in IR, UV and NMR.
CO6	Solve the numerical based on theory.

Unit	Content
1	**General principles Introduction to absorption and emission spectroscopy** **UV Spectroscopy**: Types of electronic transitions, λmax, Beer- Lambert Law, Chromophores and Auxochromes, Effect of solvent on electronic transitions, Absorption and Intensity shifts, Application of Fieser- Woodward rules for conjugated dienes and carbonyl compounds; distinction between cis and trans isomers.
2	**IR Spectroscopy**: Fundamental and non-fundamental molecular vibrations; IR absorption positions of O, N and S containing functional groups; factors affecting the band positions and intensities; Fingerprint region and its significance; application in functional group analysis.
3	**NMR Spectroscopy**: Basic principles of Proton Magnetic Resonance, chemical shift and factors influencing it; Spin – Spin coupling and coupling constant; Anisotropic effects in alkene, alkyne, aldehydes and aromatics, Interpretation of NMR spectra of simple compounds.
4	**Applications** of IR, UV and NMR for identification of simple organic molecules.
5	**Chromatographic Methods:** Principle, instrumentation and applications of gas liquid chromatography and HPLC. Ion exchange chromatography: cationic and anionic exchanges and their applications. Van-Deemter equation (no derivation), concept about HEPT-plate theory and rate theory. Applications.

Books Recommended

i. Instrumental Methods of Chemical Analysis, Willard, Meritt, Dean & Settle (Wiley Eastern).
ii. Modern Spectroscopy, J.M. Hollas, John Wiley.
iii. High Performance Liquid Chromatography, Heinz Engelhardt.
iv. Theory and Applications of UV Spectroscopy, H.H. Jaffe and M. Orchin, IBH-Oxford.
v. Introduction of Molecular Spectroscopy, G.M. Barrow, McGraw Hill.

CO-PO-PSO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4
CO1	3	1	2	1	1	1	1	2	1	1	1	1	3	1
CO2	3	2	2	2	2	1	2	3	3	1	3	2	3	2
CO3	3	2	2	3	3	2	2	3	2	1	2	3	3	3
CO4	3	2	2	2	1	1	2	3	3	1	3	2	3	2
CO5	3	2	3	2	2	2	2	3	3	1	3	3	3	2
CO6	3	3	3	3	3	3	2	3	2	1	2	3	3	3

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

Course code : CHEDL802				
Course Title : Lab course based on CHEDC801				
Semester /Year : VIII				
	L	**T**	**P**	**C**
	0	**0**	**2**	1

Course outcomes (COs):

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

CO1	Recall the fundamental principles, terminologies, and techniques of UV-Vis spectroscopy, IR spectroscopy, and paper chromatography.
CO2	Explain the theoretical basis and operational principles of UV-Vis spectroscopy, IR spectroscopy, and paper chromatography.
CO3	Apply UV-Vis, IR spectroscopy, and paper chromatography techniques to perform experiments, such as determining λ_max and concentration of an unknown compound, identifying functional groups in organic compounds, and separating mixtures of amino acids, chlorophyll, dyes, or inorganic cations.
CO4	Analyze experimental data from UV-Vis, IR spectroscopy, and paper chromatography to interpret results.
CO5	Evaluate the accuracy, precision, and limitations of experimental results obtained from UV-Vis spectroscopy, IR spectroscopy, and paper chromatography, considering factors like instrument calibration, sample preparation, spectral resolution, and separation efficiency.

CO6	Design comprehensive experimental protocols for UV-Vis, IR spectroscopy, and paper chromatography.

Unit	Contents
1	Laboratory hazards and safety precautions
2	**Spectroscopic exercise:** Determination of lambda max for unknown compound by UV-Vis Determination of concenteration of unknown compound UV-Vis Functional Group determination by by IR i.e alcohols, phenols, carboxylic acids, carbonyl compounds, nitrogen containing compounds.
3	**Chromatographic technique:** Demonstrative Chromatography-paper chromatography (Analytical separation of organic compounds- Amino acids/ chlorophyll/ dyes and Inorganic cations)

Books Recommended

i. Instrumental Methods of Chemical Analysis, Willard, Meritt, Dean & Settle (Wiley Eastern).
ii. Modern Spectroscopy, J.M. Hollas, John Wiley.
iii. High Performance Liquid Chromatography, Heinz Engelhardt.
iv. Theory and Applications of UV Spectroscopy, H.H. Jaffe and M. Orchin, IBH-Oxford.
v. Introduction of Molecular Spectroscopy, G.M. Barrow, McGraw Hill.

CO-PO-PSO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4
CO1	3	1	2	1	1	1	1	2	1	1	1	1	3	1
CO2	3	2	2	2	1	1	2	3	3	1	3	2	3	2
CO3	3	2	2	2	3	1	2	3	2	1	2	3	3	3
CO4	3	2	2	3	3	2	2	3	2	1	2	3	3	3
CO5	3	3	3	3	3	2	3	3	2	2	2	3	3	3
CO6	3	3	3	3	3	2	3	3	2	2	3	3	3	3

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

Generic Elective Courses

SEMESTER I

Course code : CHEGE103				
Course Title : s and p block elements and Metallurgy				
Semester/Year : I				
	L	**T**	**P**	**C**
	4	**0**	**0**	**4**

Course outcomes (COs):
Upon successful completion of the course, student will be able to:

CO1	Define chemistry of s and p block elements and metallurgy
CO2	Describe concepts of s and p block elements and metallurgy
CO3	Apply general principles of metallurgy and chemistry of s and p block elements
CO4	Analyse the structure, bonding, properties and uses of compounds of p block elements.
CO5	Predict shape of noble gas compounds on the basis of VSEPR Theory
CO6	Solve problems related to coordination chemistry

Unit	Contents
1	**General Principles of Metallurgy:** Chief modes of occurrence of metals based on standard electrode potentials. Ellingham diagrams for reduction of metal oxides using carbon and carbon monoxide as reducing agent. Electrolytic Reduction, Hydrometallurgy. Methods of purification of metals: Electrolytic Kroll process, van Arkel-de Boer process and Mond's process, Zone refining.
2	**Chemistry of s and p Block Elements:** Inert pair effect, Relative stability of different oxidation states, diagonal relationship and anomalous behaviour of first member of each group. Allotropy and catenation. Complex formation tendency of s and p block elements. Hydrides and their classification ionic, covalent and interstitial. Study of the following compounds with emphasis on structure, bonding, preparation, properties and uses. Boric acid and borates, boron nitrides, borohydrides (diborane) carboranes and silanes, Oxides and oxoacids of nitrogen, Phosphorus and chlorine. interhalogen compounds, and basic properties of halogens.

3	**Noble Gases:** Occurrence and uses, rationalization of inertness of noble gases, Clathrates; preparation and properties of XeF2, XeF4 and XeF6; Nature of bonding in noble gas compounds (Valence bond treatment and MO treatment for XeF2). Molecular shapes of noble gas compounds (VSEPR theory).
4	**Inorganic Polymers:** Types of inorganic polymers, comparison with organic polymers, synthesis, structural aspects and applications of silicones and siloxanes. Borazines, silicates and phosphazenes

Books Recommended:

i Lee, J.D. Concise Inorganic Chemistry, ELBS, 1991.
ii Douglas, B.E; Mc Daniel, D.H. & Alexander, J.J. Concepts & Models of Inorganic Chemistry 3rd Ed., John Wiley Sons, N.Y. 1994.
iii Greenwood, N.N. & Earnshaw. Chemistry of the Elements, Butterworth-Heinemann. 1997.
iv Cotton, F.A. & Wilkinson, G. Advanced Inorganic Chemistry, Wiley, VCH, 1999.
v Miessler, G. L. & Donald, A. Tarr. Inorganic Chemistry 4th Ed., Pearson, 2010.
vi Shriver & Atkins, Inorganic Chemistry 5th Ed.

CO-PO-PSO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4
CO1	3	2	3	1	0	2	2	2	1	1	0	1	3	2
CO2	3	3	2	2	1	2	2	2	0	0	0	1	3	3
CO3	3	2	3	2	2	2	2	2	2	1	1	2	3	3
CO4	3	3	3	3	2	2	2	3	2	0	1	2	3	3
CO5	3	2	3	2	1	2	2	3	0	1	1	2	3	2
CO6	3	2	2	2	3	3	2	2	1	0	1	2	2	3

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

SEMESTER II

Course code : CHEGE203				
Course Title : Atomic Structure and Chemical Bonding				
Semester /Year : II				
	L	**T**	**P**	**C**
	4	**0**	**0**	**4**

Course outcomes (COs):

Upon successful completion of the course, student will be able to:

CO1	Recall the knowledge of atomic structure and chemical bonding
CO2	Describe the concepts of atomic structure and chemical bonding
CO3	Explain quantum mechanics, Schrodinger equation, various related principles and rules, periodic properties of elements, different types of chemical bonds including ionic bond, covalent bond, VSEPR theory, hybridization, molecular orbital theory, metallic bond and weak chemical forces
CO4	Illustrate MO diagrams of homonuclear and heteronuclear molecules, Born Haber's cycle and atomic structure
CO5	Justify the structure of molecules on the basis of VSEPR theory and hybridization
CO6	Predict the magnetic nature of homonuclear and heteronuclear molecules on the basis of MO diagram

Unit	Contents
1	**Atomic Structure:** Review of Bohr's theory and its limitations, dual behaviour of matter and radiation, de-Broglie's relation, Heisenberg Uncertainty principle. Hydrogen atom spectra. Need of a new approach to Atomic structure. What is Quantum mechanics? Time independent Schrodinger equation and meaning of various terms in it. Significance of ψ and ψ2 , Schrödinger equation for hydrogen atom. Radial and angular parts of the hydogenic wavefunctions (atomic orbitals) and their variations for 1s, 2s, 2p, 3s, 3p and 3d orbitals (Only graphical representation). Radial and angular nodes and their significance. Significance of quantum numbers, orbital angular momentum and quantum numbers ml and ms. Shapes of s, p and d atomic orbitals, nodal planes. Discovery of spin, spin quantum number (s) and magnetic spin quantum number (ms). Rules for filling electrons in various orbitals, electronic configurations of the atoms. Stability of half filled and completely filled orbitals, concept of exchange energy. Relative energies of atomic orbitals, Anomalous electronic configurations.

2	**Chemical Bonding and Molecular Structure:** Ionic Bonding: General characteristics of ionic bonding. Energy considerations in ionic bonding, lattice energy and solvation energy and their importance in the context of stability and solubility of ionic compounds. Statement of Born-Landé equation for calculation of lattice energy, Born-Haber cycle and its applications, polarizing power and polarizability. Fajan's rules, ionic character in covalent compounds, bond moment, dipole moment and percentage ionic character. Covalent bonding: VB Approach: Shapes of some inorganic molecules and ions on the basis of VSEPR and hybridization with suitable examples of linear, trigonal planar, square planar, tetrahedral, trigonal bipyramidal and octahedral arrangements. MO Approach: Rules for the LCAO method, bonding and antibonding MOs and their characteristics for s-s, s-p and pp combinations of atomic orbitals, nonbonding combination of orbitals, MO treatment of homonuclear diatomic molecules of 1st and 2nd periods and heteronuclear diatomic molecules such as CO, NO and NO^+. Comparison of VB and MO approaches.

Books Recommended:

i J. D. Lee: A new Concise Inorganic Chemistry, E L. B. S.
ii F. A. Cotton & G. Wilkinson: Basic Inorganic Chemistry, John Wiley.
iii James E. Huheey, Ellen Keiter and Richard Keiter: Inorganic Chemistry: Principles of Structure and Reactivity, Pearson Publication.
iv Vogel's Qualitative Inorganic Analysis, A.I. Vogel, Prentice Hall, 7th Edition. Vogel's Quantitative Chemical Analysis, A.I. Vogel, Prentice Hall, 6th Edition.

CO-PO-PSO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4
CO1	2	1	2	1	1	3	2	2	1	2	2	1	3	2
CO2	2	2	2	1	1	2	1	1	1	2	2	2	3	2
CO3	3	2	3	2	2	1	1	1	1	2	2	2	2	2
CO4	3	2	3	2	3	1	1	1	1	2	2	1	2	2
CO5	3	2	3	2	2	1	1	1	1	2	2	2	2	2
CO6	2	3	2	3	2	2	1	2	1	3	3	2	3	3

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

SEMESTER III

Course code : CHEGE303				
Course Title : General Organic Chemistry and Hydrocarbons				
Semester : III				
	L	**T**	**P**	**C**
	4	**0**	**0**	**4**

Course outcomes (COs):

Upon successful completion of the course, student will be able to:

CO1	Recall the basics of organic chemistry, stereochemistry, aliphatic and aromatic hydrocarbons.
CO2	Explain electronic effect, reactive intermediates, nucleophiles and electrophiles, stereochemistry, and reactions of alkanes, alkenes, alkynes.
CO3	Apply basics of organic chemistry in different topics related to stereochemistry and reactions involved in aliphatic hydrocarbons.
CO4	Illustrate the reactions involved in aliphatic hydrocarbons and conformers, isomers & different projections in stereochemistry.
CO5	Explain the different nomenclature in stereochemistry, term used in organic chemistry.
CO6	Summarize the concepts of organic chemistry, stereochemistry, aliphatic and aromatic hydrocarbons.

Unit	Contents
1	**Fundamentals of Organic Chemistry:** Physical Effects, Electronic Displacements: Inductive Effect, Electromeric Effect, Resonance and Hyperconjugation. Cleavage of Bonds: Homolysis and Heterolysis. Structure, shape and reactivity of organic molecules: Nucleophiles and electrophiles. Reactive Intermediates: Carbocations, Carbanions and free radicals. Strength of organic acids and bases: Comparative study with emphasis on factors affecting pK values. Aromaticity: Benzenoids and Hückel's rule.
2	**Stereochemistry :** Conformations with respect to ethane, butane and cyclohexane. Interconversion of Wedge Formula, Newmann, Sawhorse and Fischer representations. Concept of chirality (upto two carbon atoms). Configuration: Geometrical and Optical isomerism; Enantiomerism, Diastereomerism and Meso compounds). Threo and erythro; D and L; cis - trans nomenclature; CIP Rules: R/ S (for upto 2 chiral carbon atoms) and E / Z Nomenclature (for upto two C=C systems)

3	**Aliphatic Hydrocarbons:** Functional group approach for the following reactions (preparations & reactions) to be studied in context to their structure. *Alkanes*: (Upto 5 Carbons). Preparation: Catalytic hydrogenation, Wurtz reaction, Kolbe's synthesis, from Grignard reagent. Reactions: Free radical Substitution: Halogenation. *Alkenes*: (Upto 5 Carbons) Preparation: Elimination reactions: Dehydration of alkenes and dehydrohalogenation of alkyl halides (Saytzeff's rule); cis alkenes (Partial catalytic hydrogenation) and trans alkenes (Birch reduction). Reactions: cis-addition (alk. KMnO4) and trans-addition (bromine), Addition of HX (Markownikoff's and anti Markownikoff's addition), Hydration, Ozonolysis, oxymecuration-demercuration, Hydroboration-oxidation. *Alkynes*: (Upto 5 Carbons) Preparation: Acetylene from CaC2 and conversion into higher alkynes; by dehalogenation of tetra halides and dehydrohalogenation of vicinal dihalides. Reactions: formation of metal acetylides, addition of bromine and alkaline KMnO4, ozonolysis and oxidation with hot alk. KMnO4.

Books Recommended:

i. Douglas, McDaniel and Alexader: *Concepts and Models in Inorganic Chemistry*, John Wiley.
ii. T. W. Graham Solomon: *Organic Chemistry*, John Wiley and Sons.

CO-PO-PSO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4
CO1	3	1	3	1	1	2	1	1	1	1	1	1	3	1
CO2	3	2	3	2	1	2	2	2	2	1	2	1	3	1
CO3	3	3	3	2	2	2	2	3	1	1	1	2	3	2
CO4	3	2	3	2	1	2	2	2	2	1	2	2	3	1
CO5	3	1	3	2	1	2	1	1	2	1	2	1	3	1
CO6	3	2	3	2	1	2	2	2	2	1	2	1	3	1

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

SEMESTER IV

Course code : CHEGE403				
Course Title : Chemical Energetics and Ionic Equilibria				
Semester /Year : IV				
	L	**T**	**P**	**C**
	4	**0**	**0**	**4**

Course outcomes (COs):

Upon successful completion of the course, student will be able to:

CO1	Define the fundamentals of thermochemistry
CO2	Outline the concept of thermodynamics and its laws, important principles and definitions of thermochemistry.
CO3	Identify the concepts of chemical equilibrium and ionic equilibrium
CO4	Illustrate the concepts of Le Chatelier's principle.
CO5	Explain the buffer solution and solubility products.
CO6	Discuss the numerical related to thermochemistry

Unit	Content
1.	**Chemical Energetics:** Laws of Thermodynamics. Principles of thermochemistry. Concept of standard state and standard enthalpies of formations. Variation of enthalpy of a reaction with temperature – Kirchhoff's equation. Statement of Third Law of thermodynamics and calculation of absolute entropies of substances.
2.	**Chemical Equilibrium:** Free energy change in a chemical reaction. Thermodynamic derivation of the law of chemical equilibrium. Distinction between ΔG and ΔG^{o}, Le Chatelier's principle.
3.	**Ionic Equilibria:** Strong, moderate and weak electrolytes, degree of ionization, factors affecting degree of ionization, ionization constant and ionic product of water. Ionization of weak acids and bases, pH scale, common ion effect.
4.	**Salt hydrolysis:** Calculation of hydrolysis constant, degree of hydrolysis and pH for different salts. Buffer solutions. Solubility and solubility product of sparingly soluble salts – applications of solubility product principle.

Books Recommended:

i G. M. Barrow: Physical Chemistry Tata McGraw-Hill (2007)

ii G. W. Castellan: Physical Chemistry 4th Edn. Narosa (2004).

iii R. H. Petrucci: General Chemistry 5th Ed. Macmillan Publishing Co.: New York (1985)

CO-PO-PSO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4
CO1	3	2	3	1	1	2	1	2	1	1	0	2	3	1
CO2	3	2	3	1	2	2	2	2	1	1	0	2	3	2
CO3	3	2	2	2	2	2	2	3	1	1	0	2	3	2
CO4	3	2	3	2	1	2	2	3	1	1	0	2	3	2
CO5	3	3	3	2	2	2	2	3	1	1	0	2	3	2
CO6	3	2	2	2	1	2	2	3	1	1	1	2	3	1

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

SEMESTER V

Course code : CHEGE503				
Course Title : Molecules of Life				
Semester /Year : V				
	L	**T**	**P**	**C**
	4	**0**	**0**	**4**

Course outcomes (COs):
Upon successful completion of the course, student will be able to:

CO1	Outline the concepts of chemistry of s and p block elements and metallurgy
CO2	Describe concepts of s and p block elements and metallurgy
CO3	Differentiate the general principles of metallurgy and chemistry of s and p block elements
CO4	Distinguish the structure, bonding, properties and uses of compounds of p block elements.
CO5	Predict the shape of noble gas compounds on the basis of VSEPR Theory
CO6	Solve the problems related to coordination chemistry

Unit	Contents
1	**General Principles of Metallurgy:** Chief modes of occurrence of metals based on standard electrode potentials. Ellingham diagrams for reduction of metal oxides using carbon and carbon monoxide as reducing agent. Electrolytic Reduction, Hydrometallurgy. Methods of purification of metals: Electrolytic Kroll process, van Arkel-de Boer process and Mond's process, Zone refining.
2	**Chemistry of s and p Block Elements:** Inert pair effect, Relative stability of different oxidation states, diagonal relationship and anomalous behaviour of first member of each group. Allotropy and catenation. Complex formation tendency of s and p block elements. Hydrides and their classification ionic, covalent and interstitial. Study of the following compounds with emphasis on structure, bonding, preparation, properties and uses. Boric acid and borates, boron nitrides, borohydrides (diborane) carboranes and silanes, Oxides and oxoacids of nitrogen, Phosphorus and chlorine. interhalogen compounds, and basic properties of halogens.
3	**Noble Gases:** Occurrence and uses, rationalization of inertness of noble gases, Clathrates; preparation and properties of XeF_2, XeF_4 and XeF_6; Nature of bonding in noble gas compounds (Valence bond treatment and MO treatment for XeF2). Molecular shapes of noble gas compounds (VSEPR theory).

4	**Inorganic Polymers:** Types of inorganic polymers, comparison with organic polymers, synthesis, structural aspects and applications of silicones and siloxanes. Borazines, silicates and phosphazenes

Books Recommended:

i Lee, J.D. Concise Inorganic Chemistry, ELBS, 1991.
ii Douglas, B.E; Mc Daniel, D.H. & Alexander, J.J. Concepts & Models of Inorganic Chemistry 3rd Ed., John Wiley Sons, N.Y. 1994.
iii Greenwood, N.N. & Earnshaw. Chemistry of the Elements, Butterworth-Heinemann.

CO-PO-PSO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4
CO1	3	3	2	2	2	2	2	2	2	1	2	2	3	2
CO2	3	3	3	2	2	2	1	2	2	2	3	2	3	3
CO3	3	3	3	2	2	2	2	2	2	2	2	2	3	2
CO4	3	3	2	3	2	2	1	2	2	2	2	2	3	3
CO5	3	3	3	2	2	2	1	2	2	2	3	2	3	3
CO6	3	3	3	2	2	2	1	2	2	2	3	3	3	3

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

SEMESTER VI

Course code : CHEGE603				
Course Title : Carboxylic Acids, Amines and Derivatives				
Semester /Year : VI				
	L	**T**	**P**	**C**
	4	**0**	**0**	**4**

Course outcomes (COs):

Upon successful completion of the course, student will be able to:

CO1	Recall the preparation and chemical properties of carboxylic acids, derivatives of carboxylic acids, amines, diazonium salts, amino acids, peptides and proteins.
CO2	Generalize the concept behind preparation and chemical properties of carboxylic acids and its derivatives, amines, diazonium salts, amino acids, peptides and proteins.
CO3	Explain various preparation and chemical properties of carboxylic acids, amines, diazonium salts, and proteins.
CO4	Illustrate the reaction mechanism for different reactions.
CO5	Compare the different type of preparation and chemical properties.
CO6	Solve the questions based on reaction pathways.

Unit	Contents
1	**Carboxylic acids and their derivatives:** Carboxylic acids (aliphatic and aromatic): Preparation: Acidic and Alkaline hydrolysis of esters. Reactions: Hell – Vohlard - Zelinsky Reaction.
2	**Carboxylic acid derivatives (aliphatic): (Upto 5 carbons):** Preparation: Acid chlorides, Anhydrides, Esters and Amides from acids and their interconversion. Reactions: Comparative study of nucleophilicity of acyl derivatives. Reformatsky Reaction, Perkin condensation.
3	**Amines and Diazonium Salts:** Amines (Aliphatic and Aromatic): (Upto 5 carbons) Preparation: from alkyl halides, Gabriel's Phthalimide synthesis, Hofmann Bromamide reaction. Reactions: Hofmann vs. Saytzeff elimination, Carbylamine test, Hinsberg test, with HNO2, Schotten – Baumann Reaction. Electrophilic substitution (case aniline): nitration, bromination, sulphonation. Diazonium salts: Preparation: from aromatic amines. Reactions: conversion to benzene, phenol, dyes.

4	**Amino Acids, Peptides and Proteins** Preparation of Amino Acids: Strecker synthesis using Gabriel's phthalimide synthesis. Zwitterion, Isoelectric point and Electrophoresis. Reactions of Amino acids: ester of –COOH group, acetylation of –NH2 group, complexation with Cu2+ ions, ninhydrin test. Overview of Primary, Secondary, Tertiary and Quaternary Structure of proteins

Books Recommended:

i J. C. Kotz, P. M. Treichel, J. R. Townsend, *General Chemistry*, Cengage Learning India Pvt. Ltd.: New Delhi (2009).

ii B. H. Mahan: *University Chemistry*, 3rd Edn. Narosa (1998).

CO-PO-PSO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4
CO1	3	1	2	1	1	1	1	2	1	1	1	1	3	1
CO2	3	1	3	2	1	1	1	3	1	1	1	1	3	2
CO3	3	1	2	1	1	1	1	2	3	1	3	1	3	2
CO4	3	1	2	1	3	1	1	3	1	1	2	1	3	3
CO5	3	1	2	3	2	1	1	3	1	1	1	1	3	2
CO6	3	1	2	1	3	2	1	3	1	1	1	3	3	3

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

Skill Enhancement Courses

SEMESTER I

Course code : CHESC105				
Course Title : Basic Analytical chemistry-I				
Semester/Year : I				
	L	**T**	**P**	**C**
	2	**0**	**0**	**2**

Course outcomes (COs):
Upon successful completion of the course, student will be able to:

CO1	Recall about the basic concepts of analytical chemistry.
CO2	Outline the analytical approaches, lab equipment and concentrations of solutions.
CO3	Identify the lab equipment, concentrations of solutions and various types of titrations.
CO4	Explain errors, precision, accuracy, sampling, measuring equipment and strength of solutions.
CO5	Determine the concepts of analytical chemistry.
CO6	Solve numerical problems based on analytical chemistry

Unit	Contents
1	**Analytical approaches:** Types of errors, precision & accuracy, absolute and relative uncertainty. Significant figures; significant figures in Arithmetic's addition, subtraction, multiplication and division. Mean and standard deviation.
2	**Laboratory Apparatus:** Laboratory burner; Bunsen burner, air flow regulation, obtaining warm gentle flame with the burner, Hottest flame of the burner. Cutting and bending of glass tubing/glass rod, fine polishing of glass tubing or rod.
3	**Steps in Chemical Analysis:** Sampling, sample preparation, analysis, interpretation and preparation of report.
4	**Use of Measuring Equipment's:** Pipette, burette, chemical balance, least count.
5	**Chemical Concentration:** Normality, morality, preparation of solution of defined normality/molarity of a given compound and from a given solution of different strength, percent composition, part per million(ppm), part per billion(ppb), calculations.
6	**Titration: Types** of titrations, end point, equivalence point, Indicators-types and theory.

Books recommended

i Nivaldo, J. and Tro, Ho Yu Au- Yeung, Introductory Chemistry, Pearson India Education,2017,5th edition.

ii Timberlake, K. C., and Timberlake, W., Basic Chemistry, Pearson India Education,2017,4 th edition.

iii Pavia, D.L., Lampman, G.M., Kriz, G.S, and Engel, R.G., Micro scale and Macro scale Techniques in the Organic Laboratory, Harcourt College Publishers,2001,1stedition.

iv Harris, D. C., Exploring Chemical Analysis, W. H. Freeman and Company, NewYork,1993,4thedition.

CO-PO-PSO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4
CO1	3	3	2	2	2	1	1	1	2	2	1	2	3	2
CO2	3	2	2	2	2	1	1	1	2	2	1	2	3	2
CO3	3	2	3	2	2	1	2	1	2	2	1	2	3	2
CO4	3	2	3	2	2	1	2	1	2	2	1	2	3	2
CO5	3	3	3	2	2	1	2	1	2	2	2	2	3	2
CO6	3	3	3	3	3	1	2	1	2	2	2	3	3	3

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

SEMESTER II

Course code : CHESC205				
Course Title : Basic Analytical chemistry-II				
Semester /Year : II				
	L	**T**	**P**	**C**
	2	**0**	**0**	**2**

Course outcomes (COs):

Upon successful completion of the course, student will be able to:

CO1	Recall the basic concepts of analytical chemistry.
CO2	Summarize the concepts of physical constants, polarimeter, and electromagnetic radiation.
CO3	Explain distillation, crystallization, filtration, solubility and extraction.
CO4	Illustrate instrumentation of polarimeter, spectrophotometer and distillation assemblies.
CO5	Simplify the concepts of analytical chemistry.
CO6	Solve numerical problems related to polarimeter, electromagnetic radiation and solubility.

Unit	Contents
1	**Physical Constants:** Melting points, melting point theory, mixture melting point, packing of melting point tube, Determination of me melting point; decomposition, discoloration, softening, shrinking and sublimation. Boiling point, determination of boiling point, use of boiling chips, calibration of thermometer.
2	**Polarimeter:** Polarimetry: Nature of polarized light, polarimeter, sample cells, operation of the polarimeter, optical purity.
3	**Electromagnetic Radiation:** Properties, absorption of light, transmittance, absorbance and Beer's Law. Spectrophotometer- Single beam and double beam instruments.
4	**Distillation:** Simple distillation, distillation theory, fractional distillation, difference between simple and fractional distillation, vapour- liquid composition diagram, Raoult's Law.
5	**Crystallization filtration:** Filtration- Selection of suitable solvent/purification of compounds. Filtration- Gravity filtration, Filter papers, vacuum filtration, aspirator.
6	**Solubility and Extraction:** Solubility-Definition, predicting solubility behaviour, water as a solvent, organics solvents. Extraction Theory, distribution coefficient, separation and drying agents.

Books Recommended

i Nivaldo, J. and Tro, Ho Yu Au- Yeung, Introductory Chemistry, Pearson India Education,2017,5th edition.
ii Timberlake, K. C., and Timberlake, W., Basic Chemistry, Pearson India Education,2017,4 th edition.
iii Pavia, D.L., Lampman, G.M., Kriz, G.S, and Engel, R.G., Micro scale and Macro scale Techniques in the Organic Laboratory, Harcourt College Publishers,2001,1stedition.
iv Harris, D. C., Exploring Chemical Analysis, W. H. Freeman and Company, NewYork,1993,4thedition.

CO-PO-PSO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4
CO1	2	1	2	2	2	2	1	1	2	2	2	1	1	2
CO2	1	2	2	2	3	1	1	2	2	3	2	2	2	2
CO3	3	2	2	2	2	2	1	2	2	2	2	1	3	3
CO4	2	2	2	2	3	2	1	1	2	2	2	1	2	2
CO5	2	2	2	2	2	1	1	1	2	3	2	2	2	2
CO6	2	2	2	2	2	1	1	1	2	2	2	1	2	2

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

SEMESTER III

Course code : CHESC305				
Course Title : Chemistry of Soil and Water				
Semester /Year : III				
	L	**T**	**P**	**C**
	2	**0**	**0**	**2**

Course outcomes (COs):
Upon successful completion of the course, students will be able to

CO1	Define the basic composition of soil and water.
CO2	Describe about the chemistry of soil and water
CO3	Explain physical, chemical and biological parameters of soil.
CO4	Examine physical, chemical and biological parameters of water
CO5	Evaluate pH of soil and water samples
CO6	Test the quality of soil and water samples

Unit	Contents
1	**Analysis of soil:** Composition of soil, Concept of pH and pH measurement, Complexometric titrations, Chelation, Chelating agents, use of indicators. Determination of pH of soil samples. Estimation of Calcium and Magnesium ions as Calcium carbonate by complexometric titration.
2	**Analysis of water:** Definition of pure water, sources responsible for contaminating water, water sampling methods, water purification methods. Determination of pH, acidity and alkalinity of a water sample. Determination of dissolved oxygen (DO) of a water sample.

Books recommended

i. Srilakshmi, B., Food Science, 7th Ed., New Age International, New Delhi (2018)
ii. Biswas, T. D.; Mukherjee, S. K., Text Book of Soil Science, 2nd Ed., McGraw Hill Publishing Company, New Delhi (2017).

CO-PO-PSO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4
CO1	3	2	2	2	2	1	1	1	1	1	1	1	3	3
CO2	3	2	2	2	2	1	1	1	1	1	1	1	3	3
CO3	3	3	3	2	2	2	1	2	1	1	1	1	3	3
CO4	3	2	3	3	2	2	1	2	1	1	1	1	3	3
CO5	3	2	3	3	3	2	2	2	1	1	1	2	3	3
CO6	3	2	3	2	3	2	1	1	1	1	1	2	3	3

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

SEMESTER IV

Course code : CHESC405				
Course Title : Pesticide Chemistry				
Semester /Year : IV				
	L	**T**	**P**	**C**
	2	**0**	**0**	**2**

Course outcomes (COs):

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

CO1	Define pesticides.
CO2	Develop understanding of various types of pesticides.
CO3	Explain the applications of various synthetic classes of pesticides.
CO4	Analyse the benefits, adverse effects and types of pesticides.
CO5	Evaluate the various types of pesticides.
CO6	Predict the synthesis and properties of pesticides.

Unit	Contents
1	General introduction to pesticides (natural and synthetic), benefits and adverse effects, changing concepts of pesticides
2	Structure activity relationship, synthesis and technical manufacture and uses of representative pesticides in the following classes: Organochlorines (DDT, Gammexene,); Organophosphates (Malathion, Parathion); Carbamates (Carbofuran and carbaryl); Quinones (Chloranil), Anilides (Alachlor and Butachlor).

Books recommended

i Handa S.K., Principles of Pesticide Chemistry, Agrobios India (1 January 2004).

ii Saha C., Chakraborty B., Chakraborty S., Basu k., Lectures on Pharamaceutical Chemistry and Pesticide Chemistry, Techno world.

CO-PO-PSO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4
CO1	3	3	2	2	2	1	1	1	2	2	1	2	3	2
CO2	3	2	2	2	2	1	1	1	2	2	1	2	3	2
CO3	3	2	3	2	2	1	2	1	2	2	1	2	3	2
CO4	3	2	3	2	2	1	2	1	2	2	1	2	3	2
CO5	3	3	3	2	2	1	2	1	2	2	2	2	3	2
CO6	3	3	3	3	3	1	2	1	2	2	2	3	3	3

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

SEMESTER V

Course code : CHESC505				
Course Title : Fuel Chemistry				
Semester /Year : V				
	L	**T**	**P**	**C**
	2	**0**	**0**	**2**

Course outcomes (COs):

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

CO1	Recall the renewable and non-renewable sources of energy, different types of fuels and their calorific values
CO2	Discuss the uses of coal (fuel and nonfuel) in various industries, its composition, carbonization of coal.
CO3	Explain composition and uses of coal gas, producer gas and water gas.
CO4	Analyze knowledge in petroleum and petrochemical industry, different types of petroleum products and their applications.
CO5	Summarize lubricants and their classification, properties of lubricants (viscosity index, cloud point, pore point) and their determination.
CO6	Develop concepts of fuel chemistry.

Unit	**Contents**

1	Uses of coal (fuel and nonfuel) in various industries, its composition, proximate analysis, ultimate analysis, determination of % of carbon, hydrogen, nitrogen, sulphur, ash and oxygen. Carbonization of coal. Coal gas, producer gas and water gas—composition and uses. Fractionation of coal tar, requisites of a good metallurgical coke, Coal gasification (Hydro gasification and Catalytic gasification), Coal liquefaction and Solvent Refining.
2	Composition of crude petroleum, Refining and different types of petroleum products, Fractional Distillation (Principle and process), Cracking (Thermal and catalytic cracking), knocking, octane number, unleaded petrol, Reforming, Petroleum and non-petroleum fuels (LPG, CNG, LNG, bio-gas, fuels derived from biomass), fuel from waste, synthetic fuels (gaseous and liquids), clean fuels.
3	Classification of lubricants, lubricating oils (conducting and nonconducting), Solid and semisolid lubricants, synthetic lubricants. Properties of lubricants (viscosity index, cloud point, pore point, flash point, fire point) and their determination.

Books recommended

i. E. Stocchi: *Industrial Chemistry*, Vol -I, Ellis Horwood Ltd.
ii. P.C. Jain, M. Jain: *Engineering Chemistry*, Dhanpat Rai & Sons, Delhi
iii. B.K. Sharma: *Industrial Chemistry*, Goel Publishing House, Meerut.

CO-PO-PSO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4
CO1	3	3	2	2	2	1	1	1	2	2	1	2	3	2
CO2	3	2	2	2	2	1	1	1	2	2	1	2	3	2
CO3	3	2	3	2	2	1	2	1	2	2	1	2	3	2
CO4	3	2	3	2	2	1	2	1	2	2	1	2	3	2
CO5	3	3	3	2	2	1	2	1	2	2	2	2	3	2
CO6	3	3	3	3	3	1	2	1	2	2	2	3	3	3

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

SEMESTER VI

Course code : CHESC605				
Course Title : Business skills for Chemists				
Semester /Year : VI				
	L	**T**	**P**	**C**
	2	**0**	**0**	**2**

Course outcomes (COs):

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

CO1	Define the basic key business concepts including business plans, market need, project management and routes to market.
CO2	Summarize the current challenges and opportunities in chemical industry
CO3	Explain composition and uses of coal gas, producer gas and water gas.
CO4	Examine the role of chemistry in India and global economies.
CO5	Justify the financial aspects of business with case studies.
CO6	Summarize the concept of intellectual property including patent

Unit	Contents
1	Business Basics: Key business concepts: Business plans, market need, project management and routes to market
2	Chemistry in Industry: Current challenges and opportunities for the chemistry-using industries, role of chemistry in India and global economies
3	Making money: Financial aspects of business with case studies
4	Intellectual property: Concept of intellectual property, patents

CO-PO-PSO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4
CO1	3	1	3	1	1	2	1	1	1	1	1	1	3	1
CO2	3	2	3	2	1	2	2	2	2	1	2	1	3	1
CO3	3	3	3	2	2	2	2	3	1	1	1	2	3	2
CO4	3	2	3	2	1	2	2	2	2	1	2	2	3	1
CO5	3	1	3	2	1	2	1	1	2	1	2	1	3	1
CO6	3	2	3	2	1	2	2	2	2	1	2	1	3	1

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

Discipline Specific Electives

Semester-III

Course code : CHEDE306				
Course Title : Green Chemistry				
Semester /Year : III				
	L	**T**	**P**	**C**
	3	**0**	**0**	**3**

Course outcomes (COs):

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

CO1	Define and explain the concept, need, and goals of green chemistry and recognize the challenges in its implementation.
CO2	Describe and interpret the 12 principles of green chemistry with suitable examples.
CO3	Illustrate real-world green synthesis strategies for compounds like adipic acid, catechol, and disodium iminodiacetate.
CO4	Explain microwave and ultrasound-assisted green reactions and their applications in sustainable synthesis.
CO5	Compare and discuss green approaches in industries, such as trans-fat free oils and eco-friendly cleaning solvents.
CO6	Develop emerging trends in green chemistry, such as solvent-free reactions, biomimetic catalysts, and their role in sustainable development.

Unit	Content
1.	**Introduction to Green Chemistry:** What is Green Chemistry? Need for Green Chemistry. Goals of Green Chemistry. Limitations/ Obstacles in the pursuit of the goals of Green Chemistry
2.	**Principles of Green Chemistry:** Twelve principles of Green Chemistry with their explanations and examples.
3.	**Some real-world cases of Green Synthesis:** Green Synthesis of the following compounds: adipic acid, catechol, disodium iminodiacetate (alternative to Strecker synthesis). Microwave assisted reactions in water: Hofmann Elimination, methyl benzoate to benzoic acid, oxidation of toluene and alcohols; microwave assisted reactions in organic solvents Diels-Alder reaction and Decarboxylation reaction Ultrasound assisted reactions: sonochemical Simmons-Smith Reaction (Ultrasonic alternative to Iodine) Healthier fats and oil by Green Chemistry: Enzymatic interesterification for production of no Trans-Fats and Oils

	Surfactants for carbon dioxide – replacing smog producing and ozone depleting solvents with CO2 for precision cleaning and dry cleaning of garments.
4.	**Future Trends in Green Chemistry:** Oxidation reagents and catalysts; Biomimetic, multifunctional reagents; Combinatorial green chemistry; Proliferation of solventless reactions; co crystal controlled solid state synthesis (C2S3); Green chemistry in sustainable development.

Books Recommended:

i Anastas, P.T. & Warner, J.K.: Green Chemistry - Theory and Practical, Oxford University Press (1998).
ii Cann, M.C. & Connely, M.E. Real-World cases in Green Chemistry, American Chemical Society, Washington (2000).

CO-PO-PSO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4
CO1	3	2	2	1	1	1	3	1	1	2	1	1	3	2
CO2	3	3	2	1	1	2	3	1	2	2	2	1	3	3
CO3	2	2	3	2	2	1	3	1	2	2	2	2	2	3
CO4	2	2	3	2	2	1	3	1	2	2	2	2	2	3
CO5	2	2	2	2	2	2	3	2	2	3	2	2	2	3
CO6	2	2	2	2	2	2	3	2	2	3	3	3	3	3

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

Course code : CHEDL307				
Course Title : Lab course based on CHEDE306				
Semester /Year : III				
	L	**T**	**P**	**C**
	0	**0**	**2**	**1**

Course outcomes (COs):

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

CO1	Outline the essential laboratory safety rules and the core principles of Green Chemistry.
CO2	Discuss green synthesis of compounds like aspirin and adipic acid using eco-friendly or solvent-free methods.
CO3	Demonstrate natural dye extraction from plant sources and use them for sustainable fabric dyeing.
CO4	Analyze green purification methods such as recrystallization using safe solvents like water or ethanol.
CO5	Evaluate the concept of atom economy through simple reaction-based calculations and observations.

CO6	Oraganize strategies to reduce chemical waste during experiments.

Unit	Content
1	**Introduction to Green Laboratory Practices** Introduction to Laboratory Safety & Green Chemistry Principles (Basic lab safety, importance of sustainability, and 12 principles of Green Chemistry)
2	**Green Synthetic Approaches** Green synthesis of aspirin using safer solvents Solvent-free synthesis of adipic acid Demonstration of atom economy using a simple reaction (e.g., synthesis of salicylic acid)
3.	**Eco-Friendly Extraction and Waste Reduction** Extraction of natural dye (e.g., from spinach, turmeric, beetroot) and dyeing of fabric Recrystallization using water or ethanol (as eco-friendly solvents)

CO-PO-PSO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4
CO1	2	2	1	1	1	2	3	1	1	2	1	1	3	2
CO2	3	2	2	2	2	2	3	1	2	2	2	2	3	3
CO3	2	2	1	2	2	2	3	1	2	2	2	2	2	3
CO4	2	2	2	2	2	2	3	1	2	2	2	2	2	3
CO5	2	2	3	2	2	2	3	2	2	2	3	2	2	3
CO6	2	2	2	2	2	2	3	2	2	2	2	3	2	3

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

Course code : CHEDE406				
Course Title : Polymer Chemistry				
Semester /Year : III				
	L	**T**	**P**	**C**
	3	**0**	**0**	**3**

Course outcomes (COs):

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

CO1	Outline the history, classification, and nomenclature of polymers, including their molecular interactions and structure.
CO2	Discuss the concept of functionality and its role in polymer formation and polymerization processes.
CO3	Illustrate the mechanisms and kinetics of different types of polymerization including copolymerization.
CO4	Analyze polymer crystallinity, glass transition temperature, and the factors influencing polymer properties.
CO5	Evaluate methods to determine molecular weight and polydispersity of polymers.
CO6	Design the structure-property relationships in polymers to their practical applications.

Unit	Content
1.	**Introduction and History of Polymeric Materials**: Different schemes of classification of polymers, Polymer nomenclature, Molecular forces and chemical bonding in polymers, Texture of Polymers.
2.	**Functionality and its Importance:** Criteria for synthetic polymer formation, classification of polymerization processes, Relationships between functionality, extent of reaction and degree of polymerization. Bifunctional systems, Polyfunctional systems.
3.	**Kinetics and Crystallization of Polymer:** Mechanism and kinetics of step growth, radical chain growth, ionic chain (both cationic and anionic) and coordination polymerizations, Mechanism and kinetics of copolymerization, polymerization techniques. Determination of crystalline melting point and degree of crystallinity, Morphology of crystalline polymers, Factors affecting crystalline melting point. Glass Transition Temperature (Tg), Factors affecting glass transition temperature (Tg). Structure Property relationships
4.	**Determination of Molecular Weight of Polymers** (Mn, Mw, etc) by end group analysis, viscometry, light scattering and osmotic pressure methods. Molecular weight distribution and its significance. Polydispersity index.

Books Recommended:

i Seymour's Polymer Chemistry, Marcel Dekker, Inc.
ii G. Odian: Principles of Polymerization, John Wiley.
iii F.W. Billmeyer: Text Book of Polymer Science, John Wiley.
iv P. Ghosh: Polymer Science & Technology, Tata Mcgraw-Hill.

CO-PO-PSO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4
CO1	3	2	1	1	1	1	2	1	1	1	1	1	3	2
CO2	3	3	2	2	2	1	2	1	1	1	1	1	3	2
CO3	3	3	3	3	2	1	2	1	2	2	2	2	3	3
CO4	2	3	2	2	2	2	2	1	2	2	2	2	3	2
CO5	2	2	3	3	3	2	2	1	2	2	2	2	2	3
CO6	3	2	2	2	2	2	2	2	2	2	2	2	3	3

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

Course code : CHEDL407				
Course Title : Lab course based on CHEDE406				
Semester /Year : IV				
	L	**T**	**P**	**C**
	0	**0**	**2**	**1**

Course outcomes (COs):

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

CO1	Recall the process and technique of preparing different types of polymers like Nylon 6/6 and resins.
CO2	Classify redox and emulsion polymerization methods for synthesizing polymers.
CO3	Interpret the thermosetting resins like urea-formaldehyde and phenol-formaldehyde (novolac/resol) using standard procedures.
CO4	Determine microscale polymerization techniques to reduce waste and improve laboratory safety.
CO5	Assess viscometric methods to determine molecular weight of synthetic polymers in various solvents.
CO6	Solve problems related to molecular weights.

Unit	Content
1	To prepare nylon 66/6
2	To carry out redox polymerization of acrylamide
3	To carry out the preparation of urea-formaldehyde resin
4	To prepare novalac resin/resold resin.
5	To carry out the microscale Emulsion Polymerization of Poly(methylacrylate)
6	To use viscometry for determination of molecular weight of Polyacrylamide-aq. $NaNO_2$ solution
7	To use viscometry for determination of molecular weight of Poly vinyl proplylidine (PVP) in water
8	To use viscometry for determination of molecular weight of Poly vinyl proplylidine (PVP) in water

CO-PO-PSO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4
CO1	3	2	2	2	1	1	2	1	2	2	1	2	3	2
CO2	3	2	3	2	2	1	2	1	2	2	1	2	3	3
CO3	3	2	3	2	2	1	2	1	2	2	1	2	3	3
CO4	2	3	2	2	2	3	3	2	2	2	2	2	2	3
CO5	2	3	3	3	3	2	2	2	2	2	2	3	3	3
CO6	2	3	3	3	2	2	2	2	2	2	2	3	3	3

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

Semester-V

Course code : CHEDE506				
Course Title : Environmental Chemistry				
Semester /Year : V				
	L	**T**	**P**	**C**
	3	**0**	**0**	**3**

Course outcomes (COs):
Upon successful completion of the course student will be able to:

CO1	Define the major environmental segments and different types of pollution.
CO2	Identify key air, water, and soil pollutants, including their sources, chemical behavior, and environmental impacts
CO3	Apply analytical methods and instrumentation techniques to measure major environmental pollutants in air, water, and soil samples
CO4	Compare various types of pollution in air, water, and soil
CO5	Evaluate the effectiveness of existing environmental quality standards and pollution mitigation strategies
CO6	Propose methods for pollution control and water treatment.

Unit	Contents
1	Environmental Segments (Atmosphere, Hydrosphere, Lithosphere, Biosphere), Natural Cycles of the environment (The Hydrological, Oxygen, Nitrogen, Phosphorus and Sulphur Cycle), Commonly Used Terms
2	Air-Chemical and photochemical reactions in atmosphere, smog formation, oxides of N, C, S, O and their effect, Acid rain, pollution by chemicals, petroleum, minerals, chlorofluorohydrocarbons. Analytical methods for measuring air pollutants. Continuous monitoring instruments
3	Soil-Mineral components in soil. Exchangeable cations and cation exchange capacity, Acid - Base ion exchange reaction in soils, Profile and Its Importance, Micro and macro-nutrients in soil, Nitrogen, phosphorous and potassium in soil, Wastes and pollutants in soil.
4	Aquatic pollution- inorganic, organic, pesticides, agricultural, industrial and sewage, detergents, oil spills and oil pollutants. Water quality parameters-dissolved oxygen, biochemical oxygen demand, solids, metals, content of chloride, sulphate, phosphate, nitrate and micro-organisms. Water quality standards. Analytical methods for measuring BOD, DO, COD, F, Oils, metals (As, Cd, Cr, Hg, Pb, Se etc.) residual chloride and chlorine demand. Purification and treatment of water

Books Recommended:

i. De., A.K., Environmental Chemistry, 4th ed., New Age international (P) Limited, New Delhi 2001
ii. Environmental Pollution Analysis, S.M. Khopkar, Wiley Eastern.
iii. Environmental Chemistry, Sharma and Kaur, Krishna Publishers.

CO-PO-PSO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4
CO1	3	2	2	1	1	2	3	2	1	2	0	1	3	1
CO2	3	3	2	1	2	2	3	2	1	2	0	1	3	2
CO3	2	2	2	0	3	2	3	3	1	2	1	2	3	3
CO4	2	2	2	2	2	2	3	3	2	2	1	2	3	2
CO5	2	3	2	3	2	3	3	3	2	3	2	2	2	2
CO6	2	3	3	3	2	3	3	3	2	3	3	3	2	2

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

Course code : CHEDL507				
Course Title : Lab course based on CHEDE506				
Semester /Year : V				
	L	**T**	**P**	**C**
	0	**0**	**2**	**1**

Course outcomes (COs):
Upon successful completion of the course, student will be able to:

CO1	Define key physicochemical parameters such as DO, BOD, COD, pH, alkalinity, TDS, turbidity, and conductivity in environmental samples.
CO2	Identify appropriate instruments and reagents used for analyzing water, wastewater, and soil samples for selected parameters.
CO3	Apply standard laboratory procedures to determine the physicochemical properties of environmental samples accurately.
CO4	Compare the results obtained from different environmental samples (e.g., potable water vs. wastewater) and interpret the differences based on parameter values.
CO5	Evaluate the quality of water or soil samples by analyzing the test results against national/international environmental standards.
CO6	Prepare detailed laboratory reports documenting objectives, procedures, observations, calculations, results, and environmental implications.

Unit	Contents
1	Laboratory hazards and safety precautions

2	Determination of physicochemical parameters of water and waste water and soil sample i.e DO, BOD, COD, pH, Alkalinity, TDS, turbidity, conductivity.

CO-PO-PSO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4
CO1	3	2	2	1	3	2	3	2	1	2	1	2	3	3
CO2	2	2	2	1	3	2	2	2	1	1	1	2	2	3
CO3	2	2	2	0	3	2	3	3	1	2	1	2	3	3
CO4	2	2	2	2	3	2	3	3	2	2	1	2	2	2
CO5	2	3	2	3	2	3	3	3	2	3	2	2	2	2
CO6	2	2	2	2	2	2	2	3	3	3	3	2	2	2

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

Semester-VI

Course code : CHEDE606				
Course Title : Quantitative analytical methods				
Semester /Year : VI				
	L	**T**	**P**	**C**
	3	**0**	**0**	**3**

Course outcomes (COs):
Upon successful completion of the course, students will be able to

CO1	Recall the basics of different titrations
CO2	Describe the concept of titrations and use of indicators.
CO3	Illustrate different titrimetric methods.
CO4	Explain fundamentals of titrations and use of indicators etc.
CO5	Summarize different types of titrations.
CO6	Solve the numerical based on theory.

Unit	Content
1	**Fundamental of volumetric analysis:** Methods of expressing concentrations, primary and secondary standards. Neutralization reactions: Theory of indicators and neutralizations indicators.
2	**Oxidation-reduction titration:** Principle of oxidation reduction filtrations, redox indicators & their use in pharmaceutical analysis.
3	**Precipitation titration:** Theory of precipitation titrations and use of adsorption indicators
4	**Complexometric titrations:** Complexometric methods using EDTA, principle of complexometric titrations, chelating agents, indicators, titrations with disodium edetate.

Books Recommended:

i H. Becket and J. B. Stenlake, Practical Pharmaceutical Chemistry, Part I, 4th ed., CBS Publishers & Distributors, New Delhi, 1997.
ii G.H. Jeffery, J. Bassett, J. Mendham and R.C. Denney Vogel's Text Book of Quantitative Chemical Analysis 5th ed., ELBS, U.K., 1989 .
iii A. Keneth & A. Connors, A Text Book of Pharmaceutical Analysis, 3rd ed., Wiley Interscience Singapore, 1982.

CO-PO-PSO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4
CO1	3	1	2	1	1	1	1	2	1	1	1	1	3	1
CO2	3	1	2	2	1	1	1	3	3	1	3	2	3	2
CO3	3	1	2	2	2	1	2	3	3	1	3	2	3	2
CO4	3	1	2	2	1	1	2	3	3	1	3	2	3	2
CO5	3	2	3	2	2	2	2	3	3	1	3	3	3	2
CO6	3	2	2	1	1	2	1	3	1	1	2	2	3	2

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

Course code : CHEDL607				
Course Title : Lab Course based on CHEDE606				
Semester /Year : VI				
	L	**T**	**P**	**C**
	0	**0**	**3**	**1**

Course outcomes (COs):
Upon successful completion of the course, students will be able to

CO1	Recall the basics of different titrations
CO2	Identify the reagents and indicator required for different types of titrations
CO3	Apply laboratory protocol to do titrimetric analysis.
CO4	Compare the results obtained from different titrations.
CO5	Evaluate the concentration and properties of primary and secondary standards.
CO6	Prepare detailed laboratory reports documenting objectives, procedures, observations, calculations, results.

Unit	Content
1	Preparation of primary and secondary standard solutions. Preparations of solutions with different normality and molarity.
2	Acid –base Titrations, Redox titration of $KMnO_4$, Iodine, $K_2Cr_2O_7$, complexometric titrations, Precipitation titration

Books Recommended:

i H. Becket and J. B. Stenlake, Practical Pharmaceutical Chemistry, Part I, 4th ed., CBS Publishers & Distributors, New Delhi, 1997.

ii G.H. Jeffery, J. Bassett, J. Mendham and R.C. Denney Vogel's Text Book of Quantitative Chemical Analysis 5th ed., ELBS, U.K., 1989 .

iii A. Keneth & A. Connors, A Text Book of Pharmaceutical Analysis, 3rd ed., Wiley Interscience Singapore, 1982.

CO-PO-PSO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4
CO1	3	1	2	1	1	1	1	2	1	1	1	1	3	1
CO2	3	1	2	2	1	1	1	3	3	1	3	2	3	2
CO3	3	1	2	2	2	1	2	3	3	1	3	2	3	2
CO4	3	1	2	2	1	1	2	3	3	1	3	2	3	2
CO5	3	2	3	2	2	2	2	3	3	1	3	3	3	2
CO6	3	1	2	3	3	2	1	3	1	1	2	3	3	3

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

Semester-VII

Course code : CHEDE703				
Course Title : Biomolecules				
Semester /Year : VII				
	L	**T**	**P**	**C**
	3	**0**	**0**	**3**

Course outcomes (COs):
Upon successful completion of the course, students will be able to

CO1	Define and recall molecules of life.
CO2	Compare and classify carbohydrates, enzymes, lipids and protiens.
CO3	Illustrate the concept of lipids, proteins, enzymes and carbohydrates etc.
CO4	Explain synthesis and properties of carbohydrates, enzymes, proteins and lipids.
CO5	Appraise the concept of different biomolecules.
CO6	Generalize the basics of biomolecules.

Unit	Content
1	**Carbohydrates: Classification** of carbohydrates, reducing and non-reducing sugars, General Properties of Glucose and Fructose, open chain structure of glucose. Epimers, mutarotation and anomers. Determination of configuration of Glucose (Fischer proof). Cyclic structure of glucose. Haworth projections. Linkage between monosachharides, structure of disacharrides (sucrose, maltose, lactose) and polysacharrides (starch and cellulose) excluding their structure elucidation.
2	**Amino Acids, Peptides and Proteins :** Classification of Amino Acids, Zwitterion structure and Isoelectric point. Overview of Primary, Secondary, Tertiary and Quaternary structure of proteins. Determination of primary structure of peptides, determination of N-terminal amino acid (DNFB method) and C-terminal amino acid (carboxypeptidase enzyme).
3	**Enzymes:** Mechanism of enzyme action, factors affecting enzyme action, Coenzymes and cofactors and their role in biological reactions, Specificity of enzyme action (Including stereospecifity), Enzyme inhibitors and their importance, phenomenon of inhibition (Competitive and Non-competitive inhibition including allosteric inhibtion).
4	**Lipids:** Introduction to lipids, classification. Oils and fats: Common fatty acids present in oils and fats, Omega fatty acids, Trans fats, Hydrogenation, Saponification value, Iodine number. Biological importance of triglycerides, phospholipids, glycolipids, and steroids (cholesterol).

Books Recommended:

i Morrison, R. T. & Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).

ii Nelson, D. L. & Cox, M. M. Lehninger's Principles of Biochemistry 7thEd., W. H. Freeman.

CO-PO-PSO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4
CO1	3	1	2	1	1	1	1	2	1	1	1	1	3	1
CO2	3	1	2	3	1	1	1	3	1	1	1	1	3	2
CO3	3	1	2	2	1	1	1	3	3	1	3	1	3	2
CO4	3	1	2	2	2	1	1	3	3	1	3	2	3	3
CO5	3	2	3	3	1	1	2	3	2	1	2	2	3	2
CO6	3	1	3	2	1	2	1	3	1	1	1	2	3	2

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

Course code : CHEDL704				
Course Title : Lab course based on CHEDE703				
Semester /Year : VII				
	L	**T**	**P**	**C**
	0	**0**	**2**	**1**

Course outcomes (COs):

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

CO1	Outline the principle of different assigned practicals.
CO2	Estimate saponification and iodine value of oil/fats.
CO3	Demonstrate the action of salivary amylase on starch.
CO4	Analyse the Rf value of different amino acid by chromatography.
CO5	Differentiate between reducing and non-reducing sugar.
CO6	Interpret the results of different experiments.

Unit	Content
1	Separation of amino acids by paper chromatography To determine the concentration of glycine solution by formylation method. Study of titration curve of glycine Differentiate between a reducing/ nonreducing sugar.

2	Action of salivary amylase on starch Effect of temperature on the action of salivary amylase on starch. To determine the saponification value of an oil/fat. To determine the iodine value of an oil/fat

Books Recommended:

i Trniss, B.S.; Hannaford, A.J.; Rogers, V.; Smith, P.W.G.; Tatchell, A.R. Vogel's Textbook of Practical Organic Chemistry, ELBS.

ii Dr O P Pandey, D N Bajpai & Dr D Giri, Practical Chemistry, S Chand

CO-PO-PSO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4
CO1	3	1	2	1	2	1	1	2	2	1	2	1	3	2
CO2	3	1	2	2	3	2	2	3	1	1	2	3	3	3
CO3	3	1	2	1	3	1	2	2	2	1	3	2	3	3
CO4	3	1	2	2	3	2	1	3	1	1	2	3	3	3
CO5	3	1	2	3	2	1	1	3	1	1	2	2	3	2
CO6	3	1	2	3	3	2	1	3	1	1	2	3	3	3

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

Course code : CHEDE705				
Course Title : Coordination Chemistry and Bioinorganic Chemistry				
Semester /Year : VII				
	L	**T**	**P**	**C**
	3	**0**	**0**	**3**

Course outcomes (COs):

Upon successful completion of the course, student will be able to:

CO1	Define the basic concepts and terminology of coordination chemistry and bioinorganic chemistry
CO2	Explain the principles of valence bond theory, crystal field theory (CFT), ligand field theory, and molecular orbital theory as applied to coordination compounds.
CO3	Apply theoretical models such as Crystal Field Theory (CFT) and Molecular Orbital (MO) theory to determine the geometry, magnetic properties, and stability of coordination complexes including octahedral, tetrahedral, and square planar systems.
CO4	Analyze the periodic trends and properties of transition elements such as variable oxidation states, colour, magnetic behaviour, catalytic activity, and their ability to form complexes.

CO5	Evaluate the electronic configuration, oxidation states, magnetic and spectral properties of lanthanoids and actinoids.
CO6	Construct a conceptual understanding of the role of metal ions in biological systems and propose mechanisms for essential bioinorganic processes, including sodium/potassium pump, iron transport, and the function of haemoglobin.

Unit	Contents
1	**Coordination Chemistry: Werner's** theory, valence bond theory (inner and outer orbital complexes), Crystal field theory, measurement of 10 Dq (Δo), CFSE in weak and strong fields, pairing energies, factors affecting the magnitude of 10 Dq (Δo, Δt). Octahedral vs. tetrahedral coordination, tetragonal distortions from octahedral geometry Jahn-Teller theorem, square planar geometry. Qualitative aspect of Ligand field and MO Theory. IUPAC nomenclature of coordination compounds, isomerism in coordination compounds. Stereochemistry of complexes with 4 and 6 coordination numbers. Chelate effect, Labile and inert complexes
2	**Transition Elements:** General group trends with special reference to electronic configuration, colour, variable valency, magnetic and catalytic properties, ability to form complexes. Stability of various oxidation states and e.m.f. (Latimer diagrams). Difference between the first, second and third transition series.
3	**Lanthanoids and Actinoids:** Electronic configuration, oxidation states, colour, spectral and magnetic properties, lanthanide contraction, separation of lanthanides (ion-exchange method only).
4	**Bioinorganic Chemistry:** Metal ions present in biological systems, classification of elements according to their action in biological system. Sodium / K-pump. Excess and deficiency of some trace metals. Iron and its application in bio-systems, Haemoglobin; Storage and transfer of iron

Books Recommended:

i. Purcell, K.F & Kotz, J.C. Inorganic Chemistry W.B. Saunders Co, 1977.
ii. Huheey, J.E., Inorganic Chemistry, Prentice Hall, 1993.
iii. Lippard, S.J. & Berg, J.M. Principles of Bioinorganic Chemistry Panima Publishing Company 1994.
iv. Cotton, F.A. & Wilkinson, G, Advanced Inorganic Chemistry. Wiley-VCH, 1999
v. Basolo, F, and Pearson, R.C., Mechanisms of Inorganic Chemistry, John Wiley & Sons, NY, 1967.
vi. Greenwood, N.N. & Earnshaw A., Chemistry of the Elements, Butterworth−Heinemann,1997.

CO-PO-PSO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4
CO1	3	2	2	1	1	1	1	2	1	1	0	2	3	1
CO2	3	2	3	1	1	1	2	2	1	1	0	2	3	2

CO3	3	2	3	2	2	1	2	3	1	1	1	2	3	2
CO4	3	2	3	2	1	2	2	3	1	1	0	2	3	2
CO5	3	2	3	2	1	2	2	3	1	1	0	2	3	2
CO6	3	3	3	2	1	2	3	3	2	2	1	2	3	2

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

Course code : CHEDL706				
Course Title : Lab course based on CHEDE705				
Semester /Year : VII				
	L	**T**	**P**	**C**
	0	**0**	**2**	**1**

Course outcomes (COs):
Upon successful completion of the course, student will be able to:

CO1	List the names, chemical formulas, and types of inorganic compounds synthesized in the laboratory, including coordination and double salts.
CO2	Explain the underlying chemical principles, oxidation states, coordination numbers, and bonding involved in the synthesis of selected inorganic compounds.
CO3	Perform the synthesis of coordination compounds using proper laboratory procedures.
CO4	Differentiate between synthesized inorganic complexes based on their structural features, coordination number, and ligand field characteristics.
CO5	Assess the purity, yield, and color changes of synthesized inorganic compounds and evaluate their success based on theoretical stoichiometry and observations.
CO6	Prepare detailed laboratory reports that include balanced equations, experimental procedures, observations, yield calculations, and interpretation of results.

Unit	Contents
1	To synthesize cuprous Chloride, [i.e., Cu_2Cl_2] To prepare manganese (III) phosphate, [i.e., $MnPO_4.H_2O$] To prepare aluminium potassium sulphate $KAl(SO_4)_2.12H_2O$ (Potash alum) or Chrome alum. To synthesize tetraamminecopper (II) sulphate, $[Cu(NH_3)_4]SO_4.H_2O$ To synthesize cis and trans $K[Cr(C_2O_4)_2.(H_2O)_2]$ Potassium dioxalatodiaquachromate (III) To synthesize tetraamminecarbonatocobalt (III) ion To synthesize ammonium iron(II) sulfate $(NH_4)_2Fe(SO_4)_2(H_2O)_6$ (Mohr's salt)

Recommended Books:

i. Inorganic Chemistry: A Laboratory Manual, Mala Nath. Narosa Publishing House
ii. Advanced Practical Physical Chemstry,J B Yadav. Educational Publishers

CO-PO-PSO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4
CO1	3	2	2	1	1	1	1	1	1	1	0	2	3	1
CO2	3	2	3	2	2	1	1	2	1	1	1	2	3	2
CO3	3	2	3	2	2	1	1	2	1	1	1	2	3	2
CO4	3	2	3	2	2	1	1	3	1	1	1	2	3	2
CO5	3	2	3	2	2	2	1	3	1	1	1	2	3	2
CO6	3	3	3	2	2	2	1	3	2	2	2	3	3	2

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

Course code : CHEDE707				
Course Title : Electrochemistry				
Semester /Year : VII				
	L	**T**	**P**	**C**
	3	**0**	**0**	**3**

Course outcomes (COs):
Upon successful completion of the course, students will be able to

CO1	Define the fundamental concepts of electrolytic dissociation, conductivity, and molar conductivity for electrolytes
CO2	Describe Kohlrausch's law and Debye-Hückel-Onsager equation to interpret ionic conductance behavior.
CO3	Apply Faraday's laws and electrochemical processes with relevance to metallurgy and industrial applications.
CO4	Explain electrochemical cell potentials using the Nernst equation and electrode potentials.
CO5	Evaluate principles and components of electroanalytical techniques like three-electrode systems and voltammetry.
CO6	Design the structure and behavior of electrode-electrolyte interfaces using theoretical models and electrochemical techniques (e.g., EIS, CV).

Unit	Content
1.	**Conductance:** Arrhenius theory of electrolytic dissociation. Conductivity, equivalent and molar conductivity and their variation with dilution for weak and strong

	electrolytes. Molar conductivity at infinite dilution. Kohlrausch law of independent migration of ions. Debye Hückel-Onsager equation
2.	**Electrochemistry:** Quantitative aspects of Faraday's laws of electrolysis, rules of oxidation/reduction of ions based on half-cell potentials, applications of electrolysis in metallurgy and industry. Chemical cells, reversible and irreversible cells with examples. Electromotive force of a cell and its measurement, Nernst equation; Standard electrode (reduction) potential and its application to different kinds of half-cells.
3.	**Introduction to Electroanalytical Methods:** Electrochemical Cells, electrode potential, Calculation of Cell Potentials from Electrode Potentials, reference electrode, three electrodes cell, supporting electrolyte, Currents in Electrochemical Cells, Types of Electroanalytical Methods, Reference Electrodes, Current-Voltage Relationships during an Electrolysis.
4.	**Fundamentals of Electrochemistry:** Electrode-electrolytes interfaces, Structure of electrical double layer, Helmholtz model, the Gouy-Chapman model, and the Stern model, Kinetics of electrode reactions and derivation of Butler-Volmer Equation, Tafel equations and Polarography theory.
5.	**Electrochemical Techniques:** Potentiostatic Coulometry, Amperostatic Coulometry, Cyclic Voltammetry, Linear sweep voltammetry, Electrochemical Impedance Spectroscopy (EIS), Mott-Schottky analysis.

Books Recommended

i. Modern Electrochemistry, Vol. I & II, J.O.M. Bockris and A.K.N. Reddy, Plenum.
ii. Physical Chemistry, P.W. Atkins, ELBS.
iii. Principles of Physical Chemistry, Puri, Sharma, and Pathania

CO-PO-PSO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4
CO1	3	2	2	2	1	1	1	1	2	2	1	2	3	2
CO2	3	3	2	3	2	1	1	1	2	2	1	2	3	2
CO3	3	2	2	2	2	1	2	1	2	2	2	2	3	3
CO4	3	3	2	3	2	1	2	1	2	2	2	3	3	3
CO5	3	3	3	3	3	2	2	2	2	2	2	3	3	3
CO6	3	3	3	3	3	2	2	2	2	2	2	3	3	3

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

Course code : CHEDL708				
Course Title : Lab course based on CHEDE707				
Semester /Year : VII				
	L	**T**	**P**	**C**
	0	**0**	**2**	**1**

Course outcomes (COs):

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

CO1	Outline the principles of conductometry and potentiometry used in analytical chemistry.
CO2	Discuss the cell constant using standard conductometric methods.
CO3	Demonstrate conductometric titrations of strong acid vs. strong base and weak acid vs. strong base.
CO4	Examine potentiometric titrations involving different acid-base combinations, including dibasic acids.
CO5	Assess the titration curves to determine equivalence points and reaction behavior.
CO6	Develop techniques to analyze unknown acid or base samples.

Unit	Content
1.	**Conductometry** i. To determine cell constant ii. To perform the following conductometric titrations: Iii. Strong acid vs. strong base **iv.** Weak acid vs. strong base
2.	**Potentiometry** i. To perform and study the following potentiometric titrations: ii. Strong acid vs. strong base iii. Weak acid vs. strong base iv. Dibasic acid vs. strong base

Books Recommended:

i. Atkins, P.W & Paula, J.D. Physical Chemistry, 9th Ed., Oxford University Press (2011).
ii. Mortimer, R. G. Physical Chemistry 3rd Ed., Elsevier: NOIDA, UP (2009).
iii. Principles of Physical Chemistry, Puri, Sharma, and Pathania

CO-PO-PSO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4

CO1	3	3	2	2	2	1	1	1	2	2	1	2	3	2
CO2	3	2	2	2	2	1	1	1	2	2	1	2	3	2
CO3	3	2	3	2	2	1	2	1	2	2	1	2	3	2
CO4	3	2	3	2	2	1	2	1	2	2	1	2	3	2
CO5	3	3	3	2	2	1	2	1	2	2	2	2	3	2
CO6	3	3	3	3	3	1	2	1	2	2	2	3	3	3

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

Course code	**:**	**CHEDE709**			
Course Title	**:**	**CHEMISTRY OF NATURAL PRODUCTS**			
Semester /Year	**:**	**VII**			
		L	**T**	**P**	**C**
		3	**0**	**0**	**3**

Course outcomes (COs):

Upon successful completion of the course student will be able to

CO1	Describe natural products like chemistry of natural products.
CO2	Classify natural products like alkaloids, carbohydrates and Terpenoids.
CO3	Structural elucidation of natural products like alkaloids, carbohydrates and Terpenoids.
CO4	Analyze medicinal properties of natural products like alkaloids, carbohydrates and Terpenoids.
CO5	Assess application of natural products like alkaloids, carbohydrates and Terpenoids.
CO6	Synthesis of natural products like alkaloids, carbohydrates and Terpenoids.

Unit	Contents
1	**Terpenoids and Carotenoids:** Classification, nomenclature, occurrence, isolation, general methods of structure determination, isoprene rule Structures of β-carotene.
2	**Alkaloids:** General introduction, distribution in plants, isolation & purification. General methods of structure determination. Structural elucidation of Quinine.
3	**Steroids:** Structural features of cholesterol and Testosterone (without synthesis). Prostaglandins: Occurrence, nomenclature, classification, biogenesis and physiological effects
4	**Porphyrins:** General Introduction of haemoglobin and chlorophyll. Chemistry of chlorophyll and haem (without synthesis).

Books Recommended

i I.L. Finar, Organic chemistry, Vol. II, 1st Indian ed., Pearson Education Pte Ltd Indian Branch, Delhi, 2002.

ii O.P. Agarwal, Chemistry of Natural Products, Vol. I & II, 7th ed., Goel Publishing House, Meerut, 1983.

CO-PO-PSO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4
CO1	1	2	1	2	2	2	1	1	1	2	2	1	2	2
CO2	2	2	2	2	3	2	1	2	2	3	2	2	1	2
CO3	2	2	2	2	2	2	1	2	1	2	2	2	2	3
CO4	1	2	1	2	2	2	1	2	2	2	2	2	1	2
CO5	2	2	2	2	3	2	1	2	1	3	2	1	2	2
CO6	2	2	2	2	2	2	1	2	1	2	2	2	1	2

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

Course code	**:**	**CHEDL710**			
Course Title	**:**	**Lab course based on CHEDE709**			
Semester /Year	**:**	**VII**			
		L	**T**	**P**	**C**
		0	**0**	**2**	**1**

Course outcomes (COs):
Upon successful completion of the course student will be able to

CO1	Describe the practical concepts underlying the purification, separation and analysis of a phytochemicals
CO2	Compare a range of practical techniques used in science such as the analysis of substances, the separation of substances and the use of instruments/ glassware.
CO3	Apply the ability of performing accurate quantitative measurements with an understanding of the theory and use of contemporary instrumentation.
CO4	Analyse the practical concept qualitatively and quantitatively.
CO5	Assess the purity of separated phytochemical.
CO6	Develop formulation of natural product.

Unit	Contents
1	**Qualitative Analysis** Separation, purification and identification of the phytochemicals from the plant extract/ natural products. using TLC for checking the purity of the separated compounds. **Spectroscopy** Identification of organic compounds by the analysis of their spectral data (UV, IR, PMR, CMR & MS)

Books Recommended:

i. Microscale Organic Experiments KL Willianson, DC Health & Co. Le Xington.
ii. Laboratory Manual of Organic Chemistry, RK Bansal, New Age International, Delhi.
iii. Introduction to Organic Laboratory Techniques (Third Edition), DL Pavia, GM Lampman and GS Kriz, Saunders College Publishing, Philadelphia, New York.

CO-PO-PSO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4
CO1	2	1	2	2	2	2	1	1	2	2	2	1	1	2
CO2	1	2	2	2	3	1	1	2	2	3	2	2	2	2
CO3	3	2	2	2	2	2	1	2	2	2	2	1	3	3
CO4	2	2	2	2	3	2	1	1	2	2	2	1	2	2
CO5	2	2	2	2	2	1	1	1	2	3	2	2	2	2
CO6	2	2	2	2	2	1	1	1	2	2	2	1	2	2

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

Course code	**:**	**CHEDE711**			
Course Title	**:**	**Research Methodology**			
Semester /Year	**:**	**VII**			
		L	**T**	**P**	**C**
		3	**1**	**0**	**4**

Course outcomes (COs):

Upon successful completion of the course student will be able to

CO1	Define various kind of research, objectives of doing research, research process and research design
CO2	Discuss the ability to choose methods appropriate to research aims and objectives.
CO3	Explain data and draw reasonable interpretations as well as communicate research findings in a clear and well-organized way.
CO4	Analyze statistical tools and techniques to carry out data analysis and hypothesis testing using suitable test of statistical significance.
CO5	Summarize the properties of mechanism of research methodology
CO6	Create a research methodology

Unit	Contents

1	**Meaning &Functions of Research:** Meaning of Research, Characteristics of Research, Steps involved in Research, Research in Pure and Applied Sciences, Inter Disciplinary Research, Trans disciplinary research, Significance of Research, Research and scientific methods, Research Process, Criteria of good Research, Problems encountered by Researchers, Literature review.
2	**Research Problem and Research Design:** Selecting the Research problem, Necessity of defining the problem, Goals and Criteria for identifying problems for research, Perception of Research problem, Formulation of Research design, Need for Research design, Features of good design, Basic principles of experimental designs, Computer and internet in designs.
3	**Interpretation and Report Writing:** Meaning and Technique of interpretation, Precautions in interpretation, Significance of report writing, Different steps in writing a report, Layout of a Research report, Types of report, Mechanics of writing a research report, Precautions for writing a research report
4	**Statistical Techniques and Tools:** Introduction of statistics, frequency distribution, Graphical representation of data, Measures of central tendency, Mean, Median, Mode, Standard deviation, Co-efficient of variation, Probability & distribution Correlation, coefficient of correlation, Scatter diagram, Regression, Sampling distribution, Standard error, Hypothesis testing, Level of significance, Degree of freedom, Chi Square, T-test, Analysis of variance (ANOVA)

Books Recommended:

i. Microscale Organic Experiments KL Willianson, DC Health & Co. Le Xington.
ii. Laboratory Manual of Organic Chemistry, RK Bansal, New Age International, Delhi.
iii. Introduction to Organic Laboratory Techniques (Third Edition), DL Pavia, GM Lampman and GS Kriz, Saunders College Publishing, Philadelphia, New York.
iv. Operational Organic Chemistry, A Laboratory Course, Second Edition, JW Lehman, Allyn& Bacon, Inc. Boston.

CO-PO-PSO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4
CO1	1	2	1	2	2	2	1	1	1	2	2	1	2	2
CO2	2	2	2	2	3	2	1	2	2	3	2	2	1	2
CO3	2	2	2	2	2	2	1	2	1	2	2	2	2	3
CO4	1	2	1	2	2	2	1	2	2	2	2	2	1	2
CO5	2	2	2	2	3	2	1	2	1	3	2	1	2	2
CO6	2	2	2	2	2	2	1	2	1	2	2	2	1	2

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

Course code	**: CHEDE712**
Course Title	**: Industrial Chemicals and Environment**

Semester /Year : VII				
	L	**T**	**P**	**C**
	3	**0**	**0**	**3**

Course outcomes (COs):

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

CO1	Define the large-scale production processes, uses, and storage requirements of common industrial gases and inorganic chemicals.
CO2	Describe the hazards associated with the handling of industrial gases and inorganic chemicals
CO3	Explain the sources, types, and effects of air and water pollutants
CO4	Apply standard analytical techniques to estimate air and water pollutants such as CO, NOx, and SOx.
CO5	Evaluate the efficiency of pollution control measures used in industrial and environmental contexts.
CO6	Propose appropriate industrial waste management strategies and water treatment technologies

Unit	Contents
1	**Industrial Gases:** Large-scale production, uses, storage and hazards in handling of the following gases: oxygen, nitrogen, argon, neon, helium, hydrogen, acetylene, carbon monoxide, chlorine, fluorine, sulfur dioxide and phosgene.
2	**Inorganic Chemicals:** Manufacture, application, analysis, and hazards in handling the following chemicals: hydrochloric acid, nitric acid, sulphuric acid, caustic soda, common salt, borax, bleaching powder, sodium thiosulphate, hydrogen peroxide, potash alum, chrome alum, potassium dichromate and potassium permanganate.
3	**Environment- Air Pollution:** Pollutants and their sources, pollution by SO_2, CO_2, CO, NOx, H_2S and other foul-smelling gases. Methods of estimation of CO, NOx, SOx and control procedures. Green House effect and Global warming, Ozone depletion by oxides of nitrogen, chlorofluorocarbons and Halogens, removal of sulphur from coal. Control of particulates.
4	**Water pollution and Water Quality Standards:** Pollutants and their sources, Effluent treatment plants (primary, secondary and tertiary treatment). Industrial effluent from the following industries and their treatment: electroplating, textile, tannery, dairy, petroleum and petrochemicals, agro, fertilizer, etc. Sludge disposal. Industrial waste management, incineration of waste. Water treatment and purification (reverse osmosis, electro dialysis,

	ion exchange). Water quality parameters for wastewater, industrial water and domestic water.

Books Recommended:

i. E. Stocchi: Industrial Chemistry, Vol-I, Ellis Horwood Ltd. UK.
ii. K. De, Environmental Chemistry: New Age International Pvt, Ltd, New Delhi.
iii. S. M. Khopkar, Environmental Pollution Analysis: Wiley Eastern Ltd, New Delhi.

CO-PO-PSO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4
CO1	3	2	2	1	2	2	3	2	1	2	1	2	3	1
CO2	2	3	2	2	2	2	3	3	1	3	1	2	2	1
CO3	3	2	2	1	2	2	3	2	1	2	0	2	3	2
CO4	2	2	2	1	3	2	3	3	1	2	1	2	3	3
CO5	2	3	2	2	2	3	3	3	2	3	2	3	2	2
CO6	2	3	3	2	2	3	3	3	2	3	2	3	2	2

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

Course code : CHEDL713				
Course Title : Lab course based on CHEDE712				
Semester /Year : VII				
	L	**T**	**P**	**C**
	0	**0**	**2**	**1**

Course outcomes (COs):

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

CO1	Define the principles behind iodometric titration used for determining available chlorine in bleaching powder.
CO2	Explain the titration method for estimating chloride, sulphate, and salinity in water samples using $AgNO_3$ and potassium chromate.
CO3	Apply the double titration technique to estimate total alkalinity (CO_3^{2-} and HCO_3^-) in water samples.
CO4	Analyze the role of biological indicators in assessing the pollution level of aquatic environments.
CO5	Assess the effectiveness and accuracy of the synthesis process of boric acid in terms of yield.

CO6	Prepare comprehensive laboratory reports including chemical reactions, observations, calculations, and interpretations of experimental outcomes.

Unit	Content
1	To determine the percentage of available chlorine in bleaching powder
2	To measure the chloride, sulphate and salinity of water samples by simple titration method ($AgNO_3$ and potassium chromate)
3	To estimation the total alkalinity (CO_3^{2-}, HCO_3^-) of water samples using double titration method.
4	To study some of the common bio-indicators of pollution.
5.	To prepare boric acid.

Books Recommended:

i. R.M. Felder, R.W. Rousseau: Elementary Principles of Chemical Processes, Wiley Publishers, New Delhi).
ii. J. A. Kent: Riegel's Handbook of Industrial Chemistry, CBS Publishers, New Delhi.

CO-PO-PSO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4
CO1	3	2	2	1	3	2	2	2	1	1	1	2	3	3
CO2	3	2	2	1	3	2	3	2	1	1	1	2	3	3
CO3	3	2	2	1	3	2	3	2	1	1	1	2	3	3
CO4	2	3	2	2	2	2	3	3	1	2	1	2	2	2
CO5	2	2	2	2	3	2	2	3	1	1	2	2	2	3
CO6	2	2	2	2	2	2	2	3	3	2	3	3	2	2

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

Course code : CHEDE714				
Course Name : Solid State Chemistry				
Semester /Year : VII				
	L	**T**	**P**	**C**
	3	**1**	**0**	**4**

Course outcomes (COs):

Upon successful completion of the course student will be able to

CO1	Recall crystal structure and symmetry in the crystalline state.
CO2	Discuss the applications of XRD in determining crystal structure and phase of a solid material.
CO3	Apply the XRD in determining crystal structure and phase of a solid material
CO4	Analyze the structures derived from HCP and CCP packing, the bonding in solids, band theory, and the properties of solids
CO5	Summarize the concept of crystal structure and symmetry in the crystalline state.
CO6	Predict the hard sphere model, structures derived from HCP and CCP packing, the bonding in solids, band theory, and the properties of solids.

Unit	Contents
1	**Symmetry in the Crystalline State**: Crystal symmetry, elements of translation-screw axis and glide planes, symmetry in a cube, crystal classes, stereographic projection of crystal systems, space symmetry and space groups, representation of monoclinic and orthorhombic space groups.
2	**X-Ray Diffraction**: Crystal planes and directions, Bragg's law in reciprocal space and Ewald sphere, structure factor, integrated intensity and systematic absences/presences, indexing and simulation of powder X-ray diffraction patterns for simple systems.
3	**Crystal Chemistry**: Hard sphere model, structures derived from HCP and CCP packing, crystal structures of various compositions, derived structures and polytypes, non-stoichiometry in solids, atomic order/disorder in solids, single crystals, polycrystals, quasicrystals, amorphous / glassy solids.
4	**Bonding in Solids**: Bonding in molecular solids - polymorphism, bonding in extended solids ionic, covalent and metallic. Band theory of solids classification of semiconductors, metals and insulators, free electron theory, Bloch's theorem, concept of density of state and elementary band theory, band structures of one-, two and three-dimensional solids, selected metals and insulators.
5	**Properties of solids**: Thermal, electrical, magnetic and dielectric properties of solids

Books Recommeded:

i. West, A. R., "Solid State Chemistry and its Applications", Reprint, Wiley India.
ii. Rao, C.N.R. and Gopalakrishnan, J., "New Directions in Solid State Chemistry", 2nd Ed., Cambridge University Press.
iii. Stout, G.H. and Jensen, L.H., "X-Ray Structure Determination: A Practical Guide", 2nd Ed., WileyInterscience.
iv. Giacovazzo, C., Artioli, G. and Monaco, H. L., "Fundamentals of Crystallography", Oxford University Press.

v. S. Nicola, "Magnetic Materials: Fundamentals and Device Applications", Cambridge University Press.
vi. Cox, P. A., "The Electronic Structure and Chemistry of Solids", Oxford University Press..

CO-PO-PSO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4
CO1	2	1	1	2	1	1	3	1	3	3	1	2	3	3
CO2	3	2	3	2	2	2	3	2	3	3	2	2	3	1
CO3	3	1	3	3	1	1	3	1	3	3	3	2	3	1
CO4	3	1	3	2	1	1	3	1	3	3	1	2	3	1
CO5	2	3	1	2	1	1	3	1	3	3	1	2	3	1
CO6	3	1	3	2	3	3	3	3	3	3	3	2	3	2

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

Semester-VIII

Course code : CHEDE803				
Course Title : Structure and Properties of Metal Complexes				
Semester /Year : VIII				
	L	**T**	**P**	**C**
	3	**0**	**0**	**3**

Course outcomes (COs):
Upon successful completion of the course student will be able to

CO1	Define key concepts and terminology related to VSEPR theory, dπ–pπ bonding, stereochemistry, isomerism, molecular magnetism, and ligand field theory.
CO2	Describe the principles of stereochemistry, types of isomerism in coordination compounds, Walsh diagrams, hybridization models, and magnetic behavior in transition metal complexes.
CO3	Explain electronic spectra and magnetic properties of coordination compounds
CO4	Illustrate CFT, MOT, JTD and chelate effect.
CO5	Evaluate factors affecting complex stability including chelation, stepwise formation constants, ligand characteristics, and thermodynamic parameters.
CO6	Propose the structure of various inorganic compounds based on VSEPR model and hybridization.

Unit	Contents
1	**Stereochemistry and bonding in main group compounds:** VSEPR theory, Walsh diagrams (tri- and penta-atomic molecules) dπ - pπ bonds, bent rule and energetics of hybridization, stereoisomerism in inorganic complexes, isomerism arising out of ligand and ligand conformation, chirality and nomenclature of chiral complexes.
2	**Metal-ligand bonding and molecular orbital theory (MOT):** Limitations of crystal field theory, d-orbitals splitting in linear, trigonal, octahedral, square planar, tetrahedral and square pyramidal complexes, Jahn-Teller distortion, nephelauxetic series, composition of ligand group orbitals, molecular orbital diagrams of octahedral, tetrahedral, including both σ and π bonding.
3	**Metal-ligand equilibria in solution:** Stepwise and overall formation constants and their interaction, trends in stepwise constants, factors affecting the stability of metal complexes with references to the nature of metal ion and ligand, chelate effect and its thermodynamic origin

4	**Electronic spectra of coordination compounds:** Spectroscopic ground states, correlation and spin-orbit coupling in free ions for 1" series of transition metals, Orgel and Tanabe Sugano diagrams for transition metal complexes (d'- d^9 states), calculation of Dq, B and B parameters,
5	**Magnetic properties of transition metal complexes:** Fundamental equations in molecular magnetism, magnetic susceptibility and magnetic moment, diamagnetic and paramagnetic behaviour of transition metal complexes, spin-orbit coupling effects (LS coupling and j-j coupling),temperature independent paramagnetism (TIP) of complexes, spin cross over, ferromagnetic, antiferromagnetic, ferrimagnetic behaviour of transition metal compounds, effect of temperature on their magnetic properties.

Books recommended:

i. Cotton, F. A., Wilkinson, G., Murillo, C. A. and Bochmann, M., "Advanced Inorganic Chemistry", 6th Ed., John Wiley & Sons, 1999.
ii. Douglas, B. E., McDaniel, D. H. and Alexander, J. J., "Concepts and Models in Inorganic Chemistry", 3rd Ed., John Wiley & Sons, 2001.
iii. Figgis, B. N., and Hitchman, M. A., "Ligand Field Theory and Its Applications", Wiley Eastern Ltd., 1999.
iv. Huheey, J. E., Keiter, E. A. and Keiter, R. L., "Inorganic Chemistry Principle of Structure and Reactivity", 4th Ed, Pearson Education, Inc., 2003.
v. Atkins, P., Overton, T., Rourke, J., Mark, W. and Armstrong, F., "Shriver and Atkins' Inorganic Chemistry", 4th Ed, Oxford university press, 2009.

CO-PO-PSO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4
CO1	3	2	1	1	1	1	1	1	1	1	1	1	3	2
CO2	3	3	2	2	2	1	1	1	1	1	1	1	3	3
CO3	3	3	2	2	2	1	1	1	1	1	1	1	3	3
CO4	3	3	2	2	2	1	1	1	1	1	1	2	3	3
CO5	3	3	3	3	2	1	2	1	1	1	1	2	3	3
CO6	3	3	3	3	2	1	2	1	1	1	1	2	3	3

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

Course code : CHEDL804				
Course Title : Lab course based on CHEDE803				
Semester /Year : VIII				
	L	**T**	**P**	**C**
	0	**0**	**2**	**1**

Course outcomes (COs):

Upon successful completion of the course, student will be able to:

CO1	Recall the basic principles and procedures involved in the synthesis of inorganic compounds like alums, chromates, and double salts.
CO2	Describe the crystallization techniques, color development, and chemical principles underlying the formation of compounds such as Mohr's salt, chrome red, and chrome alum.
CO3	Perform the synthesis of selected inorganic compounds such as potash alum, ammonium ferric sulphate, and nickel ammonium sulphate using standard lab procedures.
CO4	Differentiate between types of alums and double salts based on their physical and chemical properties.
CO5	Evaluate the purity, yield, and reproducibility of synthesized compounds using appropriate analytical techniques.
CO6	Prepare detailed laboratory reports documenting objectives, procedures, observations, calculations, results, and environmental implications.

Unit	**Contents**
1	To synthesize ammonium ferric sulphate, chrome red, chrome alum, Mohr's salt, Nickel ammonium sulphate, potash alum

Recommended Books:

i. Inorganic Chemistry: A Laboratory Manual, Mala Nath. Narosa Publishing House

ii. Advanced Practical Physical Chemistry, J B Yadav. Educational Publishers

CO-PO-PSO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4
CO1	3	2	1	1	1	1	1	1	1	1	1	1	3	2
CO2	3	3	2	2	1	1	1	1	1	2	1	1	3	3
CO3	3	3	3	2	2	2	1	1	2	2	2	2	3	3
CO4	3	3	2	2	2	2	1	1	2	2	1	1	3	3
CO5	3	3	3	3	2	2	1	2	2	2	1	2	3	3
CO6	3	2	2	2	1	2	2	2	3	3	2	2	3	3

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

Course code : CHEDE805				
Course Title : Reagents and Reactions in Organic Chemistry				
Semester /Year : VIII				
	L	**T**	**P**	**C**
	3	**0**	**0**	**3**

Course outcomes (COs):
Upon successful completion of the course, students will be able to

CO1	Identify the fundamentals of reagents and reactions in organic chemistry.
CO2	Compare the various reagents in organic reactions and functional group transformations
CO3	Apply the methods for C−C, C−N, C−O single bonds formation
CO4	Analyze the various models for stereochemical aspects of nucleophilic addition to carbonyl compounds.
CO5	Assess the methods for C−C, C−N, C−O multiple bonds formations.
CO6	Arrange the various name reactions.

Unit	Content
1.	Reagents in Organic Synthesis Use of the following reagents in organic synthesis and functional group transformations; complex metal hydrides organolithium, lithium dimethylcuprate, lithium diisopropylamide (LDA), organomagnesium (Grignard), organozinc, organocopper (Gilman & Normant) reagents in synthesis, dicyclohexylcarbodiimide, 1,3-dithiane (reactivity Umpoloung), trimethylsilyl iodide, tri-n-butyltin hydride, Woodward and pervost hydroxylation, osmium tetroxide, DDQ, selenium dioxide, Phase transfer catalysts, crown ethers and Merrifield resin, Peterson's synthesis, Wilkinson' s catalyst, Baker yeast.
2.	Single bond [C—X (X = C, O, N)] formations Various models (Cram, Cram chelation and Felkin-Anh models) of stereochemical aspects of nucleophilic additions to carbonyls chemistry of enolates (kinetic and thermodynamic) and examines, enolates, lithium and boron enolates in aldol and Michael reactions, alkylation and acylation of enolates, mechanism of aldol (Mukiyama aldol), Stobbe, Darzen, Acyloin condensations, epoxidations (Prilezhaev, Sharpless, Jacobsen and Shi), Metal catalysed C-C bond formations (Ullmann, BuchwaldHartwig, Sonogashira, Heck, Suzuki, Stille, Nozaki-Hiyama and Kumada reactions).
3.	Multiple bond [C—X (X = C, N)] formations Phosphorus, nitrogen and sulfur ylids, Wittig reaction, Wittig-Honer reaction, Tebbe olefination, Julia olefination, Robinson annulation, Mannich reaction, Peterson olefination, Shapiro reaction,

	βeliminations (Hoffman & ester pyrolysis), Cope elimination, selenoxide elimination, Cotey-Winter reaction, olefins from epoxides, olefin metathesis (Schrock's catalyst, Grubb's catalyst, ring closing metathesis, enyne metathesis, Thorpe reaction, Corey-Fuchs reaction, Ohira-Bestmann modification

Books Recommended:

i. Carey, F. A. and Sundberg, R.I., "Advanced organic Chemistry, Part B: Reaction and Synthesis", 5th Ed. Springer

ii. Anslyn, E. V. and Dougherty, D. A., "Modern Physical Organic Chemistry", University Science Books.

iii. Clayden,J.,Greeves,N.andWarren,S.,"OrganicChemistry",OxfordUniversityPress.

iv. Smith, M.B., "Organic Synthesis", 3s Ed., Academic Press.

v. Bruckner, R,, "Organic Mechanisms: Reactions, Stereochemistry and Synthesis",Springer.

CO-PO-PSO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4
CO1	1	2	1	2	2	2	1	1	1	2	2	1	2	2
CO2	2	2	2	2	3	2	1	2	2	3	2	2	1	2
CO3	1	2	1	2	2	2	1	2	1	2	2	2	2	3
CO4	1	2	1	2	2	2	1	2	2	2	2	2	1	2
CO5	2	2	2	2	3	2	1	2	1	3	2	1	2	2
CO6	2	2	2	2	2	2	1	2	1	2	2	2	1	2

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

Course code : CHEDL806				
Course Title : Lab course based on CHEDE805				
Semester /Year : VIII				
	L	**T**	**P**	**C**
	0	**0**	**2**	**1**

Course outcomes (COs):

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

CO1	Define the lab safety rules.
CO2	Describe the experiments in the laboratory for carrying out organic chemical transformations such as Cannizaro reaction and Fischer Indole synthesis
CO3	Apply the experiments in the laboratory for synthesizing specific and important organic compounds

CO4	Analyze the mechanism behind synthesis.
CO5	Assess oil with the help of Soxhlet
CO6	Calculate yield of product.

Unit	Content
1.	[1] Preparation of p-nitroaniline of acetanilide [2] Preparation of pyridium dichromate and its uses in oxidation of benzyl alcohol. [3] Cannizzaro reaction of an aromatic Aldehyde (p-nitrobenzaldehyde). [4] Synthesis of ω-nitrostyrene from an aromatic aldehyde and nitromethane. [5] Synthesis of chalcone from an aromatic aldehyde and acetophenone. [6] Extraction of oils from ground nuts using soxhlet apparatus. [7] Synthesis of α-bromo cinnamic acid or phenyl acetylene from benzaldehyde. (formation of cinnamic acid, bromination and elimination reactions). [8] Preparation of meso-stilbene dibromide and its conversion to diphenylacetylene. [9] Fisher indole synthesis.

Books Recommended:

i. Arthur, I. V.," Quantitative Organic Analysis," Pearson.
ii. Furniss, B.S., Handford, A. J., Smith P. W. G. & Tatchell A. R., "Vogel's Text Book of Practical Organic Chemistry" 5 th Ed. Longman (1996).
iii. Leonard J., Lygo B. & Procter G., "Advanced Practical Organic Chemistry", Champan and Hall. (1995)
iv. Mann, F. G. & Saunders, B.C. "Practical Organic Chemistry", Pearson. (2009)
v. Furniss, B.S., Handford, A. J., Smith P. W. G. & Tatchell A. R., "Practical Organic Chemistry" 5 th Ed., Pearson (2012).

CO-PO-PSO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4
CO1	2	1	2	2	2	2	1	1	2	2	2	1	1	2
CO2	1	2	2	2	3	1	1	2	2	3	2	2	2	2
CO3	3	2	2	2	2	2	1	2	2	2	2	1	3	3
CO4	2	2	2	2	3	2	1	1	2	2	2	1	2	2
CO5	2	2	2	2	2	1	1	1	2	3	2	2	2	2
CO6	2	2	2	2	2	1	1	1	2	2	2	1	2	2

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

Course code : CHEDE807				
Course Title : Medicinal Chemistry				
Semester /Year : VIII				
	L	**T**	**P**	**C**
	3	**0**	**0**	**3**

Course outcomes (COs):

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

CO1	Recall the basic concept of medicinal chemistry.
CO2	Discuss the classification and structure of drug molecules.
CO3	Illustrate SAR studies of drug molecules.
CO4	Explain mode of action and therapeutic uses of different drug molecules.
CO5	Summarize the properties, structure and mode of action of drugs. .
CO6	Predict the SAR studies of different class of drugs.

Unit	Content
	Chemical Classifications, SAR Studies, Mode of actions and Therapeutic uses of
1	Beta lactam antibiotics: Penicillins, Cephalosprins including their semi-synthetic products. Monobactams
2	Tetracyclines, Semi-synthetic tetracyclines, Gentamycins, Neomycins, Kanamycins, Fluoroquinoolines type of antibacterials.
3	Sulfonamides, Antileprotics, Antimycobacterials, Antifungals
4	Anticancer, Antivirals
5	Antiprotozoal includes – Antimalarials, Antiamoebics, Antihelminths

Books recommended:

i. William O. Foye, Principles of Medicinal Chemistry, 3rd ed., Varghese Publishing House, Mumbai, 1989.
ii. Jaime N. Delgado & William A. Remers, Wilson and Gisvold's, Text Book of Organic Medicinal and Pharmaceutical Chemistry, 9th ed. J.B. Lippincott Company, Philadelphia, 1991.
iii. Manfred E. Wolff, Burger's Medicinal Chemistry & Drug Discovery, 5th ed., Wiley Interscience, New York, 1995.
iv. H. Singh and V.K. Kapoor, Medicinal and Pharmaceutical Chemistry, 1st ed., Vallabh Prakashan, Delhi, 1996.
v. Ashutosh Kar, Medicinal Chemistry, New Age International (P) Limited, New Delhi, 1993.

CO-PO-PSO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4
CO1	3	2	2	2	2	1	1	1	1	1	1	1	3	3
CO2	3	2	2	2	2	1	1	1	1	1	1	1	3	3
CO3	3	3	3	2	2	2	1	2	1	1	1	1	3	3
CO4	3	2	3	3	2	2	1	2	1	1	1	1	3	3
CO5	3	2	3	3	3	2	2	2	1	1	1	2	3	3
CO6	3	2	3	2	3	2	1	1	1	1	1	2	3	3

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

Course code : CHEDL808				
Course Title : Lab course based on CHEDE807				
Semester /Year : VIII				
	L	**T**	**P**	**C**
	0	**0**	**2**	**1**

Course outcomes (COs):

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

CO1	Define the lab safety rules.
CO2	Discuss the experiments used in synthesis of drug molecules.
CO3	Apply the experiments in the laboratory for synthesizing specific and important organic compounds
CO4	Analyze the mechanism behind synthesis.
CO5	Assess the reaction mechanism involve in synthesis process,
CO6	Calculate yield of product.

Unit	Content
1	Preparation of following drugs and intermediates; Sulphanilamide, 7-Hydroxy, 4-methyl coumarin, Chlorobutanol, Triphenyl imidazole, Tolbutamide, Hexamine, Isoniazid, Isonicotinic acid hydrazide, Chloroquine, Metronidazole, Dapsone, Chlorpheniramine maleate, Benzyl penicillin.
2	Preparation of medicinally important compounds or intermediates by Microwave irradiation technique.

Books recommended:

i. William O. Foye, Principles of Medicinal Chemistry, 3rd ed., Varghese Publishing House, Mumbai, 1989.

ii. Jaime N. Delgado & William A. Remers, Wilson and Gisvold's, Text Book of Organic Medicinal and Pharmaceutical Chemistry, 9th ed. J.B. Lippincott Company, Philadelphia, 1991.
iii. Manfred E. Wolff, Burger's Medicinal Chemistry & Drug Discovery, 5th ed., Wiley Interscience, New York, 1995.
iv. H. Singh and V.K. Kapoor, Medicinal and Pharmaceutical Chemistry, 1st ed., Vallabh Prakashan, Delhi, 1996.
v. Ashutosh Kar, Medicinal Chemistry, New Age International (P) Limited, New Delhi, 1993.

CO-PO-PSO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4
CO1	3	2	2	2	2	1	1	1	1	1	1	1	3	3
CO2	3	2	2	2	2	1	1	1	1	1	1	1	3	3
CO3	3	3	3	2	2	2	1	2	1	1	1	1	3	3
CO4	3	2	3	3	2	2	1	2	1	1	1	1	3	3
CO5	3	2	3	3	3	2	2	2	1	1	1	2	3	3
CO6	3	2	3	2	3	2	1	1	1	1	1	2	3	3

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

Course code : CHEDE809				
Course Title : Applications of Computers in Chemistry				
Semester /Year : VIII				
	L	**T**	**P**	**C**
	3	**0**	**0**	**3**

Course outcomes (COs):

Upon successful completion of the course student will be able to

CO1	Define and memorize the terms related to basics of computers, numerical methods and modelling.
CO2	Describe various numerical methods and mathematics pertaining to computers.
CO3	Acquire knowledge on molecular modelling.
CO4	Explain rules associated with numerical methods.
CO5	Summarize basics of computers.
CO6	Solve simple numerical using computers.

Unit	Content
1	**Basics of Computers:** Constants, variables, bits, bytes, binary and ASCII formats, arithmetic expressions, hierarchy of operations, inbuilt functions. Elements of the BASIC

	language. BASIC keywords and commands. Logical and relative operators. Strings and graphics. Compiled versus interpreted languages. Debugging. Simple programs using these concepts.
2	**Numerical Methods I:** Matrix addition and multiplication. Statistical analysis. Roots of equations: Numerical methods for roots of equations: Quadratic formula, iterative method, Newton-Raphson method, Binary bisection and Regula-Falsi. Differential calculus: Numerical differentiation
3	**Numerical Methods II**: Integral calculus: Numerical integration (Trapezoidal and Simpson's rule), probability distributions and mean values. Simultaneous equations: Matrix manipulation: addition, multiplication. Gauss-Siedal method. Interpolation, extrapolation and curve fitting: Handling of experimental data.
4	**Molecular Modelling:** Conceptual background of molecular modelling: Potential energy surfaces. Elementary ideas of molecular mechanics and practical MO methods

Books Recommended:

i. Finar, I. L. (1956). Organic Chemisfly, Volume 2: Stereochemistry and The Chemistry Natural Products, 5th Ed. Pearson Education India.
ii. Singh, J.; Ali, S.M. & Singh, *J. Natural Product Chemistry,* Prajati Parakashan 2010.
iii. Agarwal, O. P. *Chemistry of Organic Natural Products, Vol 1 and 2,* Goel Pub. House, 2002.
iv. Chatwal, Gurdeep. *Chemistry of Organic Natural Products, Vol 1 and 2,* Goel Pub. House, 2002.

CO-PO-PSO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4
CO1	3	1	2	1	1	1	1	2	1	1	1	1	2	1
CO2	3	2	3	2	1	1	2	3	3	1	3	2	3	1
CO3	3	2	3	2	2	1	2	3	2	1	2	3	3	2
CO4	3	2	2	3	1	1	2	3	3	1	3	2	3	1
CO5	3	1	3	2	1	2	2	3	3	1	3	2	2	1
CO6	3	3	3	3	3	2	2	3	1	1	2	3	3	2

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

Course code	**:**	**CHEDL810**			
Course Title	**:**	**Lab course based on CHEDE809**			
Semester /Year	**:**	**VIII**			
		L	**T**	**P**	**C**
		0	**0**	**2**	**1**

Course outcomes (COs):

Upon successful completion of the course student will be able to

CO1	Recall the basics of computer.
CO2	Describe the equations in chemistry in the form of computer program.
CO3	Apply numerical differentiation, integration and matrix operations.
CO4	Analyze numerical differentiation, integration and matrix operations.
CO5	Summarize application of computers in chemistry.
CO6	Create the programmes related to chemistry.

Unit	Content
1	Computer programs based on numerical methods for roots of equations: (e.g., volume of van der Waals gas and comparison with ideal gas, pH of a weak acid). Numerical differentiation (e.g., change in pressure for small change in volume of a van der Waals gas, potentiometric titrations). Numerical integration (e.g., entropy/ enthalpy changes from heat capacity data), probability distributions (gas kinetic theory) and mean values. Matrix operations. Application of Gauss-Siedel method in colourimetry. Simple exercises using molecular visualization software.

CO-PO-PSO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4
CO1	3	1	2	1	1	1	1	2	1	1	1	1	2	1
CO2	3	2	3	2	2	1	2	3	3	1	3	2	3	2
CO3	3	2	3	3	3	2	2	3	2	1	2	3	3	2
CO4	3	2	3	3	3	2	2	3	2	1	2	3	3	2
CO5	3	2	3	2	2	2	3	3	3	1	3	3	3	2
CO6	3	3	3	3	3	2	3	3	2	1	3	3	3	3

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

Course code	**:**	**CHEDE811**			
Course Title	**:**	**Research Publication and Ethics**			
Semester /Year	**:**	**VIII**			
		L	**T**	**P**	**C**
		3	**1**	**0**	**4**

Course outcomes (COs):

Upon successful completion of the course student will be able to

CO1	Define philosophy, ethics, and moral philosophy, scientific misconduct (FFP) and publication ethics violations.
CO2	Describe the scope of philosophy in ethical decision-making, consequences of scientific misconduct like FFP, the role of COPE/WAME in ensuring publication ethics.
CO3	Apply ethical principles to resolve a publication conflict of interest and use journal finder tools to select appropriate publication venues.
CO4	Assess impact of FFP on research credibility, open access policies across publishers using SHERPA/RoMEO, Break down authorship disputes using COPE guidelines.
CO5	Evaluate the ethicality of open access publishing for a specific research field, reliability of a journal based on its impact factor and publisher policies, and check the plagiarism complaint using Turnitin reports.
CO6	Create a policy to prevent publication misconduct in a research group, propose a new research metric to complement h-index or altmetrics.

Unit	Content
1	**Philosophy and Ethics** Introduction to philosophy: definition, nature and scope, concept, branches. Ethics: definition, moral philosophy, nature of moral judgements and reactions.
2	**Scientific Conduct** Ethics with respect to science and research Intellectual honesty and research integrity Scientific misconducts: Falsification, and Plagiarism (FFP) Redundant publication: duplicate and overlapping publication, salami slicing Selective reporting and misrepresentation of data.
3	**Publication Ethics** Publication ethics: definition, introduction and importance Best practices / standards setting initiatives and guidelines: COPE, WAME, etc. Conflicts of interest Publication misconduct: definition, concept, problems that lead to unethical behavior and vice versa, types Violation of publication ethics, authorship and contributorship Identification of publication misconduct, complaints and appeals Predatory publishers and journals Practice
4	**Open Access Publishing** Open access publications and initiatives SHERPA / ROMEO online resource to check publisher copyright and self-archiving policies Software tools to identify predatory publications developed by SPPU Journal finder / journal suggestion tools viz. JANE, Elsevier journal Finder, Springer, Journal Suggester, etc.

5	**Publication Misconduct** **Group Discussion** Subject specific ethical issues, FFP, authorship Conflicts of interest Complaints and appeals: examples and fraud from India and abroad. **Software tools** Use of plagiarism software like Turnitin, Urkund and other open source software tools. **Databases** Indexing databases Citation databases: Web of Science, Scopus, etc. **Research Metrics** Impact factor of journal as per journal Citation report, SNP, SJR, IPP, Cite score Metrics: h-index, g index, i10 index, altimetrics

Books Recommend

1. TodorovichM, KurtzP,The Ethics of Teaching and Scientific Research, Sidney Hook.
2. Michael P Marder (2004) Research Methods for Science. Oxford Press
3. MurthySN, BhojannaU (2008) Business Research Methods Excel Books

CO-PO-PSO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4
CO1	1	2	1	2	2	2	1	1	1	2	2	1	2	2
CO2	2	2	2	2	3	2	1	2	2	3	2	2	1	2
CO3	2	2	2	2	2	2	1	2	1	2	2	2	2	3
CO4	1	2	1	2	2	2	1	2	2	2	2	2	1	2
CO5	2	2	2	2	3	2	1	2	1	3	2	1	2	2
CO6	2	2	2	2	2	2	1	2	1	2	2	2	1	2

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

Course code : CHEDE812				
Course Title : Pericyclic Reactions and Organic Photochemistry				
Semester /Year : VIII				
	L	**T**	**P**	**C**
	3	**0**	**0**	**3**

Course outcomes (COs):
Upon successful completion of the course, student will be able to:

CO1	Outline concepts of pericyclic and photochemical reactions.
CO2	Discuss pericyclic and photochemical reactions.

CO3	Explain various pericyclic and photochemical reactions.
CO4	Classify different of pericyclic and photochemical reactions.
CO5	Evaluate the mechanism of pericyclic and photochemical reactions.
CO6	Summarize different types of pericyclic and photochemical reactions.

Unit	Contents
1	**Pericyclic Reactions** Molecular orbital symmetry, Frontier orbitals of ethylene, 1,3-butadiene, 1,3,5hexatriene and allyl system. Classification of pericyclic reactions. WoodwardHoffmann correlation diagrams. Conservation of orbital symmetry, State correlation diagrams, aromatic transition state (ATS) theory, generalized orbital symmetry (GOS) rule. Frontier Molecular Orbital (FMO) and Perturbation Molecular Orbital (PMO) approach. ***Electrocyclic reaction***; conrotatory and disrotatory motions, orbital correlation diagrams for 4n, 4n+2 and allyl systems, torquoselectivity. ***Cycloaddition***: antarafacial and suprafacialaddition, 4n and 4n+2 systems, 2+2 addition of ketenes , 1,3 dipolar cycloaddition, Diels-Alder Reaction and its variants, Cheleotropic and ene reactions.
2	**Organic Photochemistry** Quantum yields, intersystem crossing, photosensitization and energy transfer reactions. Photochemistry of olefins and carbonyl compounds, photo oxygenation and photo fragmentation, Photochemistry of aromatic compounds: isomerisation, additions and substitutions. Singlet molecular oxygen reactions. Patterno-Buchi reaction, Dipimethane rearrangement, Bartons reaction and Photo-Fries rearrangement. Norrish I and II reactions.

Books Recommended:

i. I. Fleming & John Wiley "Frontier Orbital and Organic Chemical Reactions" 1976.
ii. W. Carruthers "Some modern Methods of Organic Synthesis" Cambridge University Press, (1990).

CO-PO-PSO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4
CO1	2	1	1	2	2	2	1	1	2	2	2	1	1	2
CO2	2	2	2	2	2	2	1	2	2	3	1	2	1	2
CO3	2	1	3	3	2	2	1	2	2	2	3	2	1	2
CO4	2	1	2	2	1	2	1	1	2	2	2	2	1	2
CO5	2	2	2	2	2	2	1	1	2	3	2	2	1	2
CO6	2	1	2	2	2	2	1	1	2	2	2	2	1	2

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

Course code : CHEDL813

Course Title : Lab course based on CHEDE812				
Semester /Year : VIII				
	L	T	P	C
	0	0	2	1

Course outcomes (COs):

Upon successful completion of the course student will be able to

CO1	Describe the practical concepts underlying the separation.
CO2	Compare a range of practical techniques used in science.
CO3	Apply the ability of performing accurate quantitative measurements.
CO4	Analyse the practical concept qualitatively and quantitatively.
CO5	Assess the purity of separated compounds.
CO6	Develop Preparation of derivatives.

Unit	Contents
1	**Qualitative Analysis** Separation, purification and identification of the components of a mixture of three organic compounds (three solids or two liquids and one solid, two solids and one liquid), using TLC for checking the purity of the separated compounds.

Books Recommended:

i. Microscale Organic Experiments KL Willianson, DC Health & Co. Le Xington.
ii. Laboratory Manual of Organic Chemistry, RK Bansal, New Age International, Delhi.

CO-PO-PSO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4
CO1	2	1	2	2	2	2	1	1	2	2	2	1	1	2
CO2	1	2	2	2	3	1	1	2	2	3	2	2	2	2
CO3	3	2	2	2	2	2	1	2	2	2	2	1	3	3
CO4	2	2	2	2	3	2	1	1	2	2	2	1	2	2
CO5	2	2	2	2	2	1	1	1	2	3	2	2	2	2
CO6	2	2	2	2	2	1	1	1	2	2	2	1	2	2

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

Course code : CHEDE814				
Course Title : Quantum Chemistry Chemistry				
Semester /Year : VIII				
	L	T	P	C

	3	1	0	4

Course outcomes (COs):
Upon successful completion of the course, student will be able to:

CO1	Describe fundamental postulates and operator formalism.
CO2	Interpret quantum numbers and relate them to atomic orbital structures and energy levels.
CO3	Demonstrate the Schrödinger equation for simple systems such as hydrogen atom, particle in a box, and harmonic oscillator.
CO4	Apply approximation methods such as time-dependent perturbation and variation principles to real systems.
CO5	Explain the Hückel Molecular Orbital Theory to analyze π-electron systems in conjugated molecules their stability also.
CO6	Solve the numerical problems related to quantum chemistry.

Unit	Contents
1	**Quantum Mechanics – Foundations:** Need for quantum mechanics, Operators: linear, Hermitian, commutator, Postulates of quantum mechanics, Time-independent and time-dependent Schrödinger wave equations, Physical interpretation of the wave function and normalization
2	**Applications of Schrödinger Equation:** Schrödinger equation for- Particle in a one-dimensional box, Harmonic oscillator (qualitative)and Rigid rotor (qualitative), Solution for hydrogen atom: radial and angular parts
3	**Approximate Methods:**Time-dependent perturbation theory (non-degenerate), Variation method: principles and applications, First-order correction to energy and wave function Applications: Ground state of helium atom, Particle in 1D box with potential and Harmonic oscillator
4	**Molecular Orbital Theory:** Basic concepts of molecular orbital (MO) theory, LCAO approximation, Hückel molecular orbital theory: π-electron approximation, Applications for 1,3-butadiene

Books Recommended:

i. I.N. Levine, "Quantum Chemistry", Pearson Education, 7th Edition, (2013).
ii. R.K. Prasad, "Quantum Chemistry", New Age International Publishers, 4th Edition, (2009).

CO-PO-PSO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4
CO1	2	1	1	2	2	2	1	1	2	2	2	1	1	2
CO2	2	2	2	2	2	2	1	2	2	3	1	2	1	2
CO3	2	1	3	3	2	2	1	2	2	2	3	2	1	2
CO4	2	1	2	2	1	2	1	1	2	2	2	2	1	2

CO5	2	2	2	2	2	2	1	1	2	3	2	2	1	2
CO6	2	1	2	2	2	2	1	1	2	2	2	2	1	2

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated