SHRI GURU 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.) with Research

Based on NEP 2020

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

Effective from Academic Session 2024-2025

Patel Nagar, Dehradun, Uttarakhand

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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)

e n	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**

Shalini Manar Vishal Kumar

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 A1 (Botany or Physics/Chemistry) 5- (4** **DSC A2 (Botany or Physics/Chemistry) 5- (4)** **OR** **DSC B1 (Zoology or Maths /Chemistry) 5- (4)** **DSC B2 (Zoology or Maths/Chemistry) 5- (4** **(3T+1L)**	Choose one from a pool of courses, **DSE 3 (A/B/C) (4** credits) **(3T+1L/or 2T+2L)** **OR GE – 5 (4)** OR **MOOC**			Choose one from **SEC 5 – (2)** OR **Internship/Apprenticeship / Project/ Community Outreach (IAPC) – (2)**	22

VI	(Same combination taken in Vth semester) DSC A1 (Botany or Physics/Chemistry) 5-(4 DSC A2 (Botany or Physics/Chemistry) 5-(4) OR DSC B1 (Zoology or Maths /Chemistry) 5- (4) DSC B2 (Zoology or Maths/Chemistry) 5- (4 (3T+1L) *Either CBZ or PCM combination is allowed combination is allowed	Choose one from a pool of courses, DSE 3 (A/B/C) (4 credits) (3T+1L/or 2T+2L) OR GE – 5 (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 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)			22
VIII	DSC 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)			22

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 in Major (Discipline 1) and Minor (Discipline 2) as per guidelines	**Total = 176**

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 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 like chemistry of cosmetics & perfumes, pesticide and polymer chemistry will equip students with the knowledge and skills which will help them to make a successful career in the respective industries.

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

		CHEDC503	Environmental Chemistry	3	0	0	3
		CHEDL504	Lab course based on CHEDC503	0	0	2	1
VI		CHEDC601	Analytical Chemistry	3	0	0	3
		CHEDL602	Lab course based on CHEDC601	0	0	2	1
		CHEDC603	Pericyclic Reactions and Organic Photochemistry	3	0	0	3
		CHEDL604	Lab course based on CHEDC603	0	0	2	1
VII		CHEDC701	Inorganic Chemistry	3	0	0	3
		CHEDL702	Lab course based on CHEDC701	0	0	2	1
VIII		CHEDC801	Physical Chemistry	3	0	0	3
		CHEDL802	Lab course based on CHEDC801	0	0	2	1

Semester Wise Generic Elective

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-A/IAPCA (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	Chemistry of Soil and Water **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		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	DSE-C (Chemistry)	CHEDE506	Quantitative analytical methods	3	0	0	3
		CHEDL507	Lab course based on CHEDE506	0	0	2	1
VI		CHEDE606	Industrial Chemicals and Environment	3	0	0	3
		CHEDL607	Lab course based on CHEDE606	0	0	2	1
VII (The student has to choose any three elective theory papers and lab based on it)		CHEDE703	Biomolecules	3	0	0	3
		CHEDL704	Lab course based on CHEDE703	0	0	2	1
		CHEDE705	Coordination 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

VIII (The student has to choose any three elective theory papers and lab based on it)		CHEDE711	Research Methodology	3	1	0	4
		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	Advanced Methods of Chemical Analysis	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	Intellectual Property Right	3	1	0	4

Semester Wise Dissertation

Semester	Course Type	Course Code	Course Title	L	T	P	C
VII	IAPC	CHEDT712	Dissertation on Major Core/Minor Elective (from VII Semester papers) OR Academic Project/ Entrepreneurship	0	0	0	6
VIII	IAPC	CHEDT812	Dissertation on Major Core/Minor Elective (from VIII Semester papers) OR Academic Project/ Entrepreneurship	0	0	0	6

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	VAC		Choose from the pool of courses offered by the University	0	0	0	2
III	VAC		Choose from the pool of courses offered by the University	0	0	0	2
IV	VAC		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	Gain knowledge of the basics of atomic structure, periodic properties, chemical bonding,fundamentals of organic chemistry and states of matter.
CO2	Understand fundamentals of atomic structure, periodic properties, chemical bonding, mechanism of organic reactions, stereochemistry and states of matter.
CO3	Develop concept of atomic structure, periodic properties, chemical bonding and, reaction mechanism and stereochemistry.
CO4	Explain structure of different inorganic, organic molecules/ions, mechanism of organic reactions and solid-state chemistry.
CO5	Predict structure of organic/inorganic molecules on the basis of VSEPR and hybridization & determine configurations of organic compounds.
CO6	Solve problems related to chemical bonding, atomic structure and states of matter.

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, H2O, $H3O^+$, SF4, ClF3, $ICl2^-$, $NH4^+$ and other simple molecules/ions (CO2, SO2, Cl2O7, $SO4^{2-}$, $NO3^-$, 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.

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	Gain knowledge about the concepts of qualitative analysis of cations and anions in inorganic mixtures.
CO2	Understand lab hazards and safety precautions.
CO3	Determine of absolute configuration of organic molecules using ball and stick models.
CO4	Illustrate the structure of simple organic compounds showing their stereochemistry using Fischer Projection.
CO5	Evaluate surface tension of liquids using stalagmometer.
CO6	Solve problems related to configuration and surface tension.

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.

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	Gain knowledge of the basics of chemical bonding, properties of s and p block element, aliphatic & aromatic hydrocarbons, chemical kinetics, catalysis and thermodynamics.
CO2	Understand fundamentals of chemical bonding, properties of s and p block element, aliphatic & aromatic hydrocarbons, chemical kinetics, catalysis and thermodynamics.
CO3	Develop concept of chemical bonding, aliphatic & aromatic hydrocarbons, chemical kinetics and thermodynamics.
CO4	Explain MOT, s and p block element properties, preparation and aliphatic and aromatic hydrocarbons properties.
CO5	Derive integrated rate equations and half-lives for first, second and zero order reactions and also evaluate heat capacities at constant volume, pressure and Kirchhoff's equation.
CO6	Solve problems related to chemical kinetics and thermodynamics.

Units	**Content**

1	**Chemical Bonding-II:** Molecular Orbital Theory (MOT) as applied to diatomic homonuclear/heteronuclear inorganic molecules. MO diagrams and bond order of H2, He2, Li2, Be2, B2, C2, N2, O2, 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", VishalPublishing 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.

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	Gain knowledge about the concepts of qualitative analysis of cation and anions in inorganic mixtures.
CO2	Understand lab hazards and safety precautions.
CO3	Determine the strength of given solution by acid-base titration method.
CO4	Differentiate between alkanes, alkenes and alkynes.
CO5	Distinguish between aliphatic and aromatic compounds using chemical and physical tests.

CO6	Calculate relative viscosity of the given liquid using Ostwald viscometer.

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. Wardsworth 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.

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	Gain knowledge of transition elements, coordination chemistry, halides, alcohols, phenols,thermodynamics, chemical equilibria.
CO2	Understand concepts of transition elements, coordination chemistry, halides, alcohols, phenols,thermodynamics, chemical equilibria.

CO3	Explain transition elements, coordination chemistry, halides, alcohols, phenols, thermodynamics, chemical equilibria.
CO4	Illustrate theories of coordination chemistry, properties of transition elements, mechanism of nucleophilic substitution and name reactions.
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, 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 HIO4] 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", VishalPublishing Co., India, 2020, 33rd edition. iii. Madan, R.L., "Chemistry for Degree Students, B. Sc. Second Year", S. ChandPublishing, New Delhi, India, 2011, 3rd edition.

Course code	**: CHEDL302**			
Course Title	**: Lab course based on CHEDC301**			
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	Gain knowledge of laboratory hazards and safety precautions.
CO2	Understand physical, inorganic and organic exercises.
CO3	Determine the critical solution temperature of partially miscible liquids.
CO4	Differentiate between alcohols and phenols.
CO5	Test the inorganic mixtures of acidic and basic radicals in given samples.

CO6	Solve practical problems related to physical chemistry.

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. Wordsworth PublishingCompany, Belmont, California, USA, 1988.

iii. Christian, G.D. Analytical Chemistry, 6th Ed. John Wiley & Sons, New York, 2004

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	Gain knowledge of basic concepts of acid and bases, inner transition elements, aldehydes, ketones, carboxylic acids and electrochemistry.

CO2	Understand the chemistry of acid and bases, inner transition elements, and electrochemistry.
CO3	Establish the mechanism of nucleophilic addition reactions of aldehydes, ketones, carboxylic acids.
CO4	Explain concepts of acid and bases, inner transition elements and carbonyl compounds.
CO5	Summarize the concepts of electrochemistry and its applications.
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 cellsreversible 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:

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

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	Gain knowledge of laboratory hazards and safety precautions.
CO2	Understand physical, inorganic and organic exercises.
CO3	Determine the concentrations of oxidising and reducing agents through double titration
CO4	Differentiate between aldehydes, ketones and carboxylic acids
CO5	Test the solubility of salts
CO6	Solve practical problems related to physical chemistry.

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. Wordsworth PublishingCompany, Belmont, California, USA, 1988.

iii. Christian, G.D. Analytical Chemistry, 6th Ed. John Wiley & Sons, New York, 2002

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	Gain knowledge of the basics of Reagents used in organic synthesis, nitrogen containing organic compound, carbohydrates and proteins.
CO2	Understand fundamentals of types of reagents, Chemical reactions of nitroalkanes nitroarenes.
CO3	Develop concept of types of dyes, carbohydrates, protiens etc
CO4	Explain mechanism of different organic reactions.
CO5	Illustrate and understand mechanism of different organic reactions
CO6	Summarize basics of organic synthesis, nitrogen containing,organic compounds, biomolecules and dyes.

Unit	Contents
1	**Reagents in Organic Synthesis:** Types of reagents, acetylene, ammonia, Bayer's reagent, NBS, n-butyl lithium, chromic acid, chromium trioxide, diborane, DMSO, Fehling reagent, Grignard reagent, hydrazide, hydrogen peroxide, potassium dichromate, potassium permanganate, Raney Ni, silver nitrate, sodium borohydride, NaH, 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, types of dyes, Alizarin, Indigo, Congo red, Malachite green, Methylene blue, Phenolphthalein, Methyl orange.

4	**Carbohydrates and Proteins:** Classification, mechanism of osazone formation, chain lengthening and chain shortening of aldoses. Configuration of monosaccharides. Erythro and threo diastereomers. Epimers and anomers Cyclic structure of D(+)-glucose. Mechanism of mutarotation. **Proteins:** Classification, structure and stereochemistry of amino acids. Acid base behavior, isoelectric point and electrophoresis.

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.

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	Gain knowledge of laboratory hazards and safety precautions.
CO2	Understand mechanism of organic synthesiss.
CO3	Determine the yield of synthesized organic compounds.
CO4	Analyze carbohydrate and protien
CO5	Separate the binary organic mixture.
CO6	Prepare organic and inorganic compounds.

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 protien

Course code : CHEDC503				
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	Get knowledge about the environment, its segments, and pollution.
CO2	Understand the composition of the environment and the pollutants present in it.
CO3	Explain the chemistry of water, soil and atmosphere.
CO4	Focus on environmental pollution and remedeation.
CO5	To use practical approach for determination of different pollutants.
CO6	Generalize the concept of pollution.

Unit	Contents
1	Environmental Segments (Atmosphere, Hydrosphere, Lithosphere, Biosphere), Natural Cycles of the environment (The Hydrologic, Oxygen, Nitrogen, Phosphate 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.

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	Gain knowledge of laboratory hazards and safety precautions.
CO2	Understand practical aspects of water and soil analysis
CO3	Determine concentration of pollutant.
CO4	Analyze water and waste water for physicochemical characterization
CO5	Identify Pollutants present in wastewater.
CO6	Calculate results obtained

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.

Semester-VI

Course code	**: CHEDC601**				
Course Title	**: Analytical Chemistry**				
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	Gain knowledge of basic concepts of spectroscopy, green chemistry, data analysis and analytical techniques.
CO2	Understand theory of spectroscopy, green chemistry, data analysis and analytical techniques..
CO3	Explain green chemistry, data analysis and analytical techniques.
CO4	Explain principle, applications and instrumentation of spectroscopic techniques.
CO5	Summarize concepts of green chemistry and spectroscopy.
CO6	Solve problems related with data analysis

Unit	Contents
1	**Data Analysis:** Errors; Definition, types of errors, precision, accuracy, absolute, Significant Figures; significant figures in Arithmetic-addition, subtraction, multiplication and division, Mean and Standard deviation.

2	**Analytical Techniques:** Basic concepts of electro-gravimetric and coulometric analysis. Thermogravimetric analysis. Chromatography: Introduction, Types, paper and column chromatography
3	**Spectroscopy:** Ultraviolet (UV) absorption spectroscopy- absorption laws (Beer-Lambert law), molar absorptivity, presentation and analysis of UV spectra, types of electronic transitions, effect of conjugation, concept of chromophore and auxochrome. Bathochromic, hypsochromic, hyperchromic and hypochromic shifts.
4	**Infra-Red (IR) absorption spectroscopy-** molecular vibrations, Hooke's Law, intensity and position of IR bands, fingerprint region, characteristic absorptions of various functional groups and interpretation of IR spectra of simple organic compounds.

Books Recommended:

i. Clark, J. H., and Macquarrie, D.J., Handbook of Green chemistry and Technology, Wiley-Blackwell, 2002.

ii. Anastas, P.T., and Williamson, T.C. Green Chemistry: Frontiers in Benign ChemicalSyntheses and Processes, Oxford University Press, New York, 1999.

iii. Ozin, G.A., Arsenault, A.C. and L. Cademartiri, Nanochemistry: A ChemicalApproach to Nanomaterials, Royal Society of Chemistry, 2008, 2

Course code	**: CHEDL602**				
Course Title	**: Lab course based on CHED601**				
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	Gain knowledge of laboratory hazards and safety precautions.
CO2	Understand the practical aspects of spectroscopic and chromatographic techniques and elemental analysis.
CO3	Determine the functional group of organic compounds by IR and UV.
CO4	Analyze organic compounds by spectrophotometer.
CO5	Demonstrate paper chromatography of amino acids/dyes and extraction of caffiene.

CO6	Interpret the spectral data and chromatograms of organic compounds.

Unit	Contents
1	Laboratory hazards and safety precautions
2	**Spectroscopic exercise:** Functional Group determination by UV and IR Spectroscopy; analysis of organic compounds including alcohols, phenols, carboxylic acids, carbonyl compounds, nitrogen containing compounds.
3	**Chromatographic technique:** Demonstrative Chromatography-paper chromatography (Analytical separation of organic compounds- Amino acids/ dyes)

Course code : **CHEDC603**				
Course Title : **Pericyclic Reactions and Organic Photochmistry**				
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	Get knowledge about the pericyclic and photochemical reactions.
CO2	Understand about the pericyclic and photochemical reactions.
CO3	Explain various pericyclic and photochemical reactions.
CO4	Illustrate different of pericyclic and photochemical reactions.
CO5	Compare the mechanism of pericyclic and photochemical reactions.
CO6	Write about different type 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).

Course code	:	**CHEDL604**			
Course Title	:	**Lab course based on CHEDE603**			
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 separation.
CO2	Distinguish a range of practical techniques used in science.
CO3	Develop the ability of performing accurate quantitative measurements.
CO4	Analyse the practical concept qualitatively and quantitatively.
CO5	Test the purity of separated compounds.
CO6	Develop Preparation of derivatives.

Unit	Contents
I	**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.

Semester-VII

Course code : CHEDC701				
Course Title : Inorganic 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	Learn and gain knowledge of main group compounds and coordination chemistry
CO2	Describe theories of coordination compounds and explain metal ligand equilibria and solutions.
CO3	Explain reaction mechanisms of transition metal complexes.

CO4	Illustrate CFT, MOT, VSEPR theory and chelate effect.
CO5	Assess different types of reaction mechanism.
CO6	Propose the structure of various inorganic compounds based on VSEPR model and hybridization.

Units	Content
1	**Stereochemistry and Bonding in Main Group Compounds** VSEPR model and its shortcomings. Hybridization and three-center bonds. Bents rule and energetic of hybridization.Walsh's diagrams for tri and tetra atomic molecules. pπ-pπ and pπ- dπbonding.
2	**Theories of Coordination Compounds** Crystal field theory, factors affecting the magnitude of Δ_o. Consequences of crystal field splitting. Merits and limitations of CFT Jahn-Teller distortion and its consequences on complex formation. Evidence of covalent character in Metal-Ligand bonding. Molecular orbital theory as applied to octahedral, tetrahedral and square planar complexes.
3	**Metal-Ligand Equilibria in Solution** Thermodynamic and kinetic stability of complexes. Stepwise and overall formation constants and their interaction.Trends in K value. Irving-Williams series. Chelate effect and its thermodynamic origin. Factors affecting the stability of metal complexes with reference to the nature of the metal ion and ligand. .
4	**Reaction Mechanism of Transition Metal Complexes** Energy profile of a reaction and reactivity of metal complexes. Inert and labile complexes. Ligand substitution reactions in octahedral complexes i.e.SN1, SN2 and SN1CB mechanism. Anation reactions without metal ligand bond cleavage. Electron transfer reactions (Redox reactions).Outer and inner sphere mechanism (OSM and ISM). Reactions of coordinated ligands. Substitution reactions in square-planer complexes

Books recommended

i) Inorganic chemistry, A Unified Approach, IIndEd.,WW.Porterfield, Academic Press,(1993). ii) Coordination Chemistry,IIIrdEd.,DBanerjea, Asian Book Pt. ltd.,(2009)

iii) Inorganic Chemistry,3th Ed.,GLMiessler and D.A.Tarr, Pearson Education, nc.(2004)

Course code : CHEDL702				
Course Title : Lab course based on CHED701				
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	Gain knowledge of laboratory hazards and safety precautions.
CO2	Understand the concept of complexometric and precipitation titrations
CO3	Determine the yield of synthesized inorganic compounds.
CO4	Analyze the concentrations of the compound by titration
CO5	Separate the pure compound by crystallization method.
CO6	Prepare inorganic compounds.

Unit	Contents
1	Laboratory hazards and safety precautions
2	Inorganic synthesis – cuprous chloride, potash alum, chrome alum, ferrous oxalate, ferrous ammonium sulphate, tetra ammine copper(II) sulphate and hexa ammine nickel(II) chloride. Crystallization of compounds.
3	Complexometric and precipitation titrations

Semester-VIII

Course code : CHEDC801				
Course Title : Physical 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	Gain knowledge of basic concepts of surface chemistry, photochemistry, quantum mechanics, solutions, radioactivity, and thermodynamics
CO2	Understand the basics of surface chemistry, quantum mechanics and photochemistry.
CO3	Explain chemistry of solutions, radioactivity, and thermodynamics.

Vishal kumar manav

CO4	Explain adsorption models, laws of photochemistry, Jablonski diagram, colligative properties, applications of radioactivity and third law of thermodynamics.
CO5	Summarize the applications of adsorption models, radioactivity, and elementary quantum mechanics.
CO6	Solve numerical problems related to surface chemistry, photochemistry, quantum mechanics, solutions, radioactivity and thermodynamics

Unit	Contents
1	**Surface Chemistry:** Definition of surface phenomenon- Adsorption. Chemical and physical adsorption, Factors affecting adsorption. Isotherm and Isobar. Free energy of adsorption. Quantitative treatment of adsorption, Freundlich's and Langmuir's adsorption model and their applications. Limitation of Langmuir adsorption model. Adsorption in catalysis, characteristics of catalyzed reactions.
2	**Elementary Quantum Mechanics:** Black-body radiation, Plank's radiation law, photoelectric effect, Bohr's model of hydrogen atom (no derivation) and its defects. Compton effect, de Broglie hypothesis, Heisenberg's uncertainty principle, operator concept, , Schrödinger wave equation and its importance, physical interpretation of the wave function, Numerical Problems.
3	**Photochemistry:** Interaction of radiation with matter, difference between thermal and photochemical processes. Laws of photochemistry; GrothussDrapper law, Lambert's law, Lambert- Beer's law, Stark-Einstein law, Jablonski diagram depicting various processes occurring in the excited state, fluorescence, phosphorescence, non-radiative processes (internal conversion, intersystem crossing), quantum yield, Numerical Problems.
4	**Solutions and Colligative Properties:** Ideal and non-ideal solutions, methods of expressing concentrations of solutions, activity and activity coefficient. Dilute solutions, colligative properties, Raoult's law, relative lowering of vapour pressure, molecular mass determination. Osmosis, law of osmotic pressure, determination of molecular mass from osmotic pressure. Elevation of boiling point and depression in freezing point, Numerical Problems.
5	**Thermodynamics III:** Statement and concept of residual entropy, third law of thermodynamics, unattainability of absolute zero, Nernst heat theorem. Evaluation of absolute entropy from heat capacity data, Numerical Problems
6	**Radioactivity:** Definition, nature of radioactivity, emission, types of radioactively, occurrence, Energetics and kinetics radioactivity, rates of radioactive transitions, Applications of radioactivity, Numerical Problems.

Books Recommended:

ii. Madan, R.L., "Chemistry for Degree Students, B. Sc. Third Year", S. ChandPublishing, New Delhi, India, 2011, 3rd edition.

iii. Atkins P.W., "Atkin's Physical Chemistry: International", Oxford University Press,2018, 11th edition.

iv. Ball D.W., "Physical Chemistry", Cengage India Private Limited, 2017, 2nd edition.

v. Puri, B.R., Pathania, M.S. and Sharma, L.R., "Principles of Physical Chemistry",Vishal Publishing, India, 2020, 47th edition

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, student will be able to:

CO1	Gain knowledge of laboratory hazards and safety precautions.
CO2	Understand the physical and inorganic exercises.
CO3	Determine the solubility of organic compounds by titration method.
CO4	Analyze inorganic metal ions by gravimetric method.
CO5	Estimate different metal ions through gravimetric exercise.
CO6	Interpret the practical results.

Unit	Contents
1	Laboratory hazards and safety precautions
2	**Physical exercise:** Determination of solubility of organic compound (viz. oxalic acid) in water by titration method.
3	**Inorganic Exercise:** Gravimetric analysis of any one or two metal ions; Ba^{2+}, Fe^{3+}, Ni^{2+}, Cu^{2+}, Zn^{2+} etc..

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.

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	Gain knowledge of chemistry of s and p block elements and metallurgy
CO2	Understand concepts of s and p block elements and metallurgy
CO3	Explain general principles of metallurgy and chemistry of s and p block elements
CO4	Explain 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.

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	Gain knowledge of atomic structure and chemical bonding

CO2	Understand 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, BornHaber's cycle and atomic structure
CO5	Predict the structure of molecules on the basis of VSEPR theory and hybridization
CO6	Justify 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 $\psi 2$, 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:

J. D. Lee: A new Concise Inorganic Chemistry, E L. B. S.

i. F. A. Cotton & G. Wilkinson: Basic Inorganic Chemistry, John Wiley.
ii. Douglas, McDaniel and Alexader: Concepts and Models in 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.

SEMESTER III

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

Course outcomes (COs):

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

CO1	Get Knowledge about the fundamentals of organic chemistry, stereochemistry, aliphatic and aromatic hydrocarbons.
CO2	Understand about the fundamentals of organic chemistry, stereochemistry, aliphatic and aromatic hydrocarbons.
CO3	Explain various fundamentals of organic chemistry, stereochemistry, aliphatic and aromatic hydrocarbons.
CO4	Illustrate different type concepts of organic chemistry, stereochemistry, aliphatic and aromatic hydrocarbons.
CO5	Compare the different type concepts of organic chemistry, stereochemistry, aliphatic and aromatic hydrocarbons.
CO6	Write about different type 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 and Aromatic 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 antiMarkownikoff'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 vicinaldihalides. 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.

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	Learn the fundamentals of thermochemistry
CO2	To understand thermodynamics and its laws, important principles and definitions of thermochemistry.

CO3	Explain 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	Solve 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 ΔGo , 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)

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	Gain knowledge of chemistry of s and p block elements and metallurgy
CO2	Understand concepts of s and p block elements and metallurgy
CO3	Explain general principles of metallurgy and chemistry of s and p block

	elements
CO4	Explain 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.

Greenwood, N.N. & Earnshaw. Chemistry of the Elements, Butterworth-Heinemann.

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	Get Knowledge about the preparation and chemical properties of carboxylic acids, derivatives of carboxylic acids, amines, diazonium salts, amino acids, peptides and proteins.
CO2	Understand about the preparation and chemical properties of carboxylic acids, derivatives of carboxylic acids, amines, diazonium salts, amino acids, peptides and proteins
CO3	Explain various preparation and chemical properties of carboxylic acids, derivatives of carboxylic acids, amines, diazonium salts, amino acids, peptides and proteins
CO4	Illustrate different type preparation and chemical properties of carboxylic acids, derivatives of carboxylic acids, amines, diazonium salts, amino acids, peptides and proteins
CO5	Compare the different type preparation and chemical properties of carboxylic acids, derivatives of carboxylic acids, amines, diazonium salts, amino acids, peptides and proteins
CO6	Write about different type preparation and chemical properties of carboxylic acids, derivatives of carboxylic acids, amines, diazonium salts, amino acids, peptides and proteins

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 HNO_2, 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 $-NH_2$ group, complexation with Cu^{2+} 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).

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	Gain knowledge about the basic concepts of analytical chemistry.
CO2	Understand analytical approaches, lab equipment and concentrations of solutions.
CO3	Explain lab equipment, concentrations of solutions and various types of titrations.
CO4	Explain errors, precision, accuracy, sampling, measuring equipment and strength of solutions.
CO5	Summarize the concepts of analytical chemistry.
CO6	Solve numerical problems based on analytical chemistry

Unit	Contents
1	**Analytical approaches :** Types of errors,precision & accuracy,absolute a nd relative uncertainty. Significant figures; significant figuresinArithmaticsaddition,subtraction,multiplicationanddivision. Mean and standard deviation.

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	Gain knowledge about the basic concepts of analytical chemistry.
CO2	Understand analytical approaches, lab equipment and concentrations of solutions.
CO3	Explain lab equipment, concentrations of solutions and various types of titrations.
CO4	Explain errors, precision, accuracy, sampling, measuring equipment and strength of solutions.
CO5	Summarize the concepts of analytical chemistry.
CO6	Solve numerical problems based on analytical chemistry

Unit	Contents
1	**Analytical approaches :** Types of errors,precision & accuracy,absolute a nd relative uncertainty. Significant figures; significant figuresinArithmaticsaddition,subtraction,multiplicationanddivision. 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,fin e polishing of glass tubing or rod.
3	**Steps in Chemical Analysis:** Sampling, sample preparation, analysis,interpretation and preparation of report.
4	**Use of Measuring Equipments:** 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,HoYuAu-Yeung,Introductory Chemistry,Pearson India Education,2017,5th edition.
ii. Timberlake,K.C.,and Timberlake,W.,Basic Chemistry,Pearson India Education,2017,4th 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,2001,1st edition.
iv. Harris,D.C.,Exploring Chemical Analysis, W.H.Freemanand Company,NewYork,1993,4th edition.

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	Gain knowledge about the basic concepts of analytical chemistry.
CO2	Understand 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	Summarize the concepts of analytical chemistry.

CO6	Solve numerical problems related to polarimetr, 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/s,purification of compounds.Filtration- Gravityfiltration, 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,HoYuAu- Yeung,Introductory Chemistry,Pearson India Education,2017,5th edition.

ii. Timberlake,K.C.,and Timberlake,W.,Basic Chemistry,Pearson India Education,2017,4th 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,2001,1st edition.

iv. Harris,D.C.,Exploring Chemical Analysis, W.H.Freemanand Company,NewYork,1993,4th edition.

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	Gain knowledge about 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	Analyze 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).

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	Gain knowledge about pesticides
CO2	Develop understanding of various types of pesticides.
CO3	Learn about the applications of various synthetic classes of pesticides.
CO4	Explain benefits, adverse effects and types of pesticides.
CO5	Distinguish various types of pesticides.
CO6	Write 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.

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	Understand and know the renewable and non-renewable sources of energy, different types of fuels and their calorific values
CO2	Learn the uses of coal (fuel and nonfuel) in various industries, its composition, carbonization of coal.
CO3	Explaincomposition and uses of coal gas, producer gas and water gas.
CO4	Apply knowledge in petroleum and petrochemical industry, different types of petroleum products and their applications.
CO5	Classify lubricants and their classification, properties of lubricants (viscosity index, cloud point, pore point) and their determination.
CO6	Summarize concept 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.

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	Understand and know the basic key business concepts including business plans, market need, project management and routes to market.
CO2	Le a r n and know the current challenges and opportunities in c he mic a l industries
CO3	Explain composition and uses of coal gas, producer gas and water gas.
CO4	Identify the role of chemistry in India and global economies.
CO5	Analyse 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

Vishal Verma

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	Gain knowledge about green chemistry, its need, limitations and future prospects of it.
CO2	Understand the principle and future trends of green chemistry.
CO3	Apply the principles of green chemistry to some real-world examples.
CO4	Analyze the concept of green chemistry.
CO5	Assess the role of green chemistry in sustainable development.
CO6	Design the green synthetic routes by applying 12 principles of green chemistry for preparation of compounds.

Unit	Content
1.	**Introduction to Green Chemistry** **[No. of Hours:10]** 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:

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

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	Remember the basis of Green chemistry
CO2	Understand use of green chemistry in practicals
CO3	Apply theoretical knowledge in practicals.
CO4	Do different synthesis using green chemistry .
CO5	Summarize the benefits of green chemistry through practicals.
CO6	Solve the experimental data.

Unit	Content
1	Safer starting materials Preparation of biodiesel from vegetable/ waste cooking oil.
2	Use of enzymes as catalysts.
3.	Synthesis of nanoparticles using microwave.

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

Course outcomes (COs):

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

CO1	Learn the polymers, molecular forces and chemical bonding in polymers, texture of polymers, criteria for synthetic polymer formation, classification of polymerization processes, and relationships between functionality
CO2	Understand the mechanism and kinetics of step growth, radical chain growth, ionic chain and coordination polymerizations, the mechanism and kinetics of copolymerization and polymerization techniques.
CO3	Explain the crystallization and crystallinity of polymers, the structure property relationships in polymers, molecular weight(s) and glass transition temperature of polymers
CO4	Explain physical, thermal, flow & mechanical properties of polymers.
CO5	Summarize mechanism and kinetics of step growth, radical chain growth, ionic chain and coordination polymerizations, the mechanism and kinetics of copolymerization and polymerization techniques..
CO6	Solve numerical based on different polymer related topics.

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:

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

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	Learn safety rules of lab
CO2	Synthesize different polymers
CO3	Apply theoretical knowledge in practical.
CO4	Do characterization of polymer .
CO5	Summarize the benefits of polymer chemistry through practicals.
CO6	Solve the experimental data.

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. NaNO2 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

Semester-V

Course code : CHEDE506				
Course Title : Quantitative analytical methods				
Semester /Year : V				
	L	**T**	**P**	**C**
	3	**0**	**0**	**3**

Course outcomes (COs):

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

CO1	Remember the basics of different titrations
CO2	Understand concept of 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. Complexometric titrations: Complexometric methods using EDTA, principle of complexometric titrations, chelating agents, indicators, titrations with disodium edetate.
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. A. 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.

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, students will be able to

CO1	Remember the basics different titrimetric methods
CO2	Understand calibration of weights and chemical balance
CO3	Apply theoretical knowledge in practicals.
CO4	Do quantitative analysis by titration methods.
CO5	Measure concentration of different solutions

CO6	Solve the experimental data.

Unit	Content
1	Standardization of analytical weights and calibration of volumetric apparatus.
2	Titrametric analysis including acid base titration, redox titration, precipitation titrations, gravimetric analysis..

Books Recommended:

i. A. 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

Semester-VI

Course code	**: CHEDE606**				
Course Title	**: Industrial Chemicals and Environment**				
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	Learn the fundamentals of chemical technology
CO2	Explain the different types of equipment used in chemical technology
CO3	Explain the manufacture, application, analysis, and hazards in handling the following chemicals.
CO4	Discuss the pollutants and their sources of air pollution.
CO5	Discuss the pollutants and their sources of water pollution.
CO6	Discuss about the Water treatment and purification

Unit	Content
1.	**Chemical Technology** Basic principles of distillation, solvent extraction, solid-liquid leaching and liquid-liquid extraction, separation by absorption and adsorption. An introduction to the scope of different types of equipment needed in chemical technology, including reactors, distillation columns, extruders, pumps, mills, and emulators Scaling up operations in the chemical industry. Introduction to clean technology.
2.	**Industrial Gases** 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.
3.	**Inorganic Chemicals** 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.
4.	**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.
5.	**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.

Course code : **CHEDL607**				
Course Title : **Lab course based on CHEDE606**				
Semester /Year : **VI**				
L	**T**	**P**	**C**	
0	**0**	**2**	**1**	

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

CO1	Remember the basics of chemistry practicals and lab rules
CO2	Understand the basics of Industrial chemicals and environment.
CO3	Apply practical knowledge.
CO4	Analyze and interpret the results of experiments.
CO5	Evaluate the experimental data of different experiments.
CO6	Calculate the results of different experiments.

Unit	Content
1	Percentage of available chlorine in bleaching powder.
2	Measurement of chloride, sulphate and salinity of water samples by simple titration method. ($AgNO_3$ and potassium chromate)
3	Estimation of total alkalinity of water samples (CO_3, HCO_3) using double titration method.
4	Measurement of dissolved CO_2.

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.

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	Learn and gain knowledge of molecules of life.
CO2	Understand the classifications and other details of carbohydrates, enzymes, lipids etc.
CO3	Illustrate the concept of lipids, proteins, enzymess etc.
CO4	Explain carbohydrates, enzymes, proteins, lipids,enzymes etc
CO5	Summarize the concept of different biomolecules.
CO6	Express the details 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

Recommen

1. Morrison, R. T. & Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
2. Nelson, D. L. & Cox, M. M. Lehninger's Principles of Biochemistry 7thEd., W. H. Freeman.

Course code	:	CHEDE 304
Course Title	:	Lab course based on CHEDE 303
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	Gain knowledge of separation amino acids.
CO2	Understand saponification and iodine value of oil/fats.
CO3	Examine the action of salivary amylase on starch.
CO4	Differentiate between reducing and non-reducing sugar.
CO5	Evaluate and interpret the obtained results
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:

1. Vmiss, B.S.; Hannaford, A.J.; Rogers, V.; Smith, P.W.G.; Tatchell, A.R. Vogel's Textbook of Practical Organic Chemistry, ELBS.
2. Dr O P Pandey, D N Bajpai & Dr D Giri, Practical Chemistry, S Chand

Course code	:	**CHEDE705**			
Course Title	:	**Coordination 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	Gain knowledge of transition elements, coordination chemistry, lanthanoids, actinides and bioinorganic chemistry
CO2	Understand concepts of transition elements, coordination chemistry, lanthanoids, actinides and bioinorganic chemistry
CO3	Explain theories and properties of transition and inner transition elements.
CO4	Illustrate splitting in Oh and Td complexes, Na/K Pump and Latimer diagram. Also explain the role of metal ions in biological process.
CO5	Predict geometry, magnetic nature of coordination compounds and lanthanides and actinides. Also predict the lability and inertness of complexes.
CO6	Solve problems related to coordination chemistry

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.

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	Gain knowledge of chemistry of coordination complexes
CO2	Understand concepts of formation of coordination complexes
CO3	Explain the preparation of various coordination compounds
CO4	Illustrate principle of formation of coordination complexes
CO5	Predict structure of coordination complexes
CO6	Synthesize coordination complexes

Unit	Contents
1	i. To synthesize cuprous Chloride, [i.e., Cu2Cl2] ii. To prepare manganese (III) phosphate, [i.e., MnPO4.H2O]

	iii. To prepare aluminium potassium sulphate KAl(SO4)2.12H2O (Potash alum) or Chrome alum. iv. To synthesize tetraamminecopper (II) sulphate, [Cu(NH3)4]SO4.H2O v. To synthesize cis and trans K[Cr(C2O4)2. (H2O)2] Potassium dioxalatodiaquachromate (III) vi. To synthesize tetraamminecarbonatocobalt (III) ion vii. To synthesize potassium tris(oxalate)ferrate(III) viii. To synthesize ammonium iron(II) sulfate (NH4)2Fe(SO4)2(H2O)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

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	Learn the fundamentals of electrochemistry
CO2	Explain the electrochemical cell with reference and counter electrode in electrochemistry
CO3	Explain the laws in electrochemistry
CO4	Illustrate the concepts of electrode-electrolyte interfaces and structure of double layer
CO5	Explain the various electrochemical techniques used in electrochemistry
CO6	Solve numerical related to the electrochemistry

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. DebyeHückel-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

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	Learn the fundamentals of electrochemistry

CO2	Explain the conductometric titration
CO3	Explain the potentiometric titration
CO4	Illustrate the concepts of strong acid and strong base
CO5	Explain the various curves in the conductometric and potentiometric titrations
CO6	Solve numerical related to the electrochemistry

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

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	Gain knowledge of chemistry of natural products.

CO2	Understand theory of heterocyclic compounds, alkaloids, carbohydrates and Terpenoids.
CO3	Explain theory of heterocyclic compounds, alkaloids, carbohydrates and Terpenoids..
CO4	Explain synthesis, properties of heterocyclic compounds, alkaloids, carbohydrates and Terpenoids.
CO5	Summarize mechanism of reactions.
CO6	Solve problems related with the of heterocyclic compounds, 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

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

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

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	Distinguish a range of practical techniques used in science such as the analysis of substances, the separation of substances and the use of instruments/ glassware's.
CO3	Develop 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	Test 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 Williamson, 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.

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, researchprocess and research design
CO2	Discuss the ability to choose methods appropriate to research aims and objectives.
CO3	Explain analyze data and draw reasonable interpretations as well as communicate research findings in a clear and well-organized way.
CO4	Explain 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:

v. Microscale Organic Experiments KL Willianson, DC Health & Co. Le Xington.

vi. Laboratory Manual of Organic Chemistry, RK Bansal, New Age International, Delhi.

vii. Introduction to Organic Laboratory Techniques (Third Edition), DL Pavia, GM Lampman and GS Kriz, Saunders College Publishing, Philadelphia, New York.

viii. Operational Organic Chemistry, A Laboratory Course, Second Edition, JW Lehman, Allyn& Bacon, Inc. Boston.

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	Learn and gain knowledge of main group compounds and coordination chemistry
CO2	Describe theories of coordination compounds and explain metal ligand equilibria in solutions.
CO3	Explain electronic spectra and magnetic properties of coordination compounds
CO4	Illustrate CFT, MOT, JTD and chelate effect.
CO5	Summarize the concepts of metal ligand equilibria in solution
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) $d\pi$ - $p\pi$ 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.

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	Gain knowledge of chemistry of coordination complexes
CO2	Understand concepts of formation of coordination complexes
CO3	Explain the preparation of various coordination compounds
CO4	Illustrate principle of formation of coordination complexes
CO5	Predict structure of coordination complexes
CO6	Synthesize coordination complexes

Unit	Contents
I	i. To synthesize ammonium ferric sulphate To ii. prepare chrome red. iii. To prepare chrome alum iv. To prepare Mohr's salt v. To prepare Nickel ammonium sulphate vi. To prepare potash alum

Recommended Books:

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

House iv. Advanced Practical Physical Chemstry,J B Yadav. Educational Publishers

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	Learn the fundamentals of reagents and reactions in organic chemistry.
CO2	To understand the various reagents in organic reactions and functional group transformations
CO3	Explain the methods for C–C, C–N, C–O single bonds formation
CO4	Illustrate the various models for stereochemical aspects of nucleophilic addition to carbonyl compounds.
CO5	Explain the methods for C–C, C–N, C–O multiple bonds formations.
CO6	Discuss about 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.

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	Learn the lab safety rules.
CO2	Explain and perform the experiments in the laboratory for carrying out organic chemical transformations such as Cannizaro reaction and Fischer Indole synthesis
CO3	Explain and perform the experiments in the laboratory for synthesizing specific and important organic compounds
CO4	Illustrate the mechanism behind synthesis.
CO5	Extract 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).

Course code	**:**	**CHEDE807**			
Course Title	**:**	**Advanced Methods of Chemical Analysis**			
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	Learn and gain knowledge about spectroscopy.
CO2	Understand basics of spectroscopic and chromatographic techniques.
CO3	Illustrate different chromatographic techniques.
CO4	Explain errors, sampling, chromatography, and spectroscopy.
CO5	Summarize different terms used in spectroscopic and chromatography .
CO6	Express the applications of different spectroscopic and separation techniques.

Unit	Content
1	**Qualitative and quantitative aspects of analysis** Sampling, evaluation of analytical data, errors, accuracy and precision, methods of their expression.
2	**Nuclear Magnetic Resonance**: Principal, Instrumentation of proton NMR, Shielding -Deshielding. Splitting of signal, Use of NMR in medical, Interpretation of spectra.
3	**Electron Spin Resonance Spectroscopy**: Principle, presentation of the spectrum, hyperfine coupling, hyperfine splitting in various structures, factors affecting magnitude of g, zero field splitting and Kramer's degeneracy, applications to transition metal complexes having one and more than one unpaired electron, applications to inorganic free radicals, study of electron exchange reactions
4	**Chromatography:** Classification, principal instrumentation of HPLC, GC and ion exchange chromatography and their uses. Development of chromatograms: Frontal, elution and displacement methods. .

Books recommended:

i. Drago, R.S., "Physical Methods in Inorganic Chemistry", Reinhold Publishing Corp., East West Press.
ii. Graybeal, J. D., "Molecular Spectroscopy", McCiraw-Hill, 1988.
iii. Slichter. C. P., "Principles of Magnetic Resonance", Springer Verlag,1981.
iv. Banweil, C.N. and McCash, E.L.M.,"Fundamentals of Molecular Spectroscopy",4th Ed. McGraw-Hill. 1999

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	Remember the basics of chemistry practicals and lab rules.
CO2	Understand separation of ions, sugars and pigments by chromatography.
CO3	Apply theoretical knowledge in practicals.
CO4	Analyse pH of different shampoo solutions.

CO5	Measure BOD, COD, DO and other parameters the obtained results
CO6	Solve the experimental data.

Unit	Content
1	Chromatography: Paper chromatographic separation of Fe3+, Al3+, and Cr3+. Separation and identification of the monosaccharides present in the given mixture (glucose & fructose) by paper chromatography. Reporting the Rf values. Chromatographic separation of the active ingredients of plants, flowers and juices by TLC
2	Determine the pH of the given aerated drinks fruit juices, shampoos and soaps. Determination of pH of soil, total soluble salt, Estimation of calcium, magnesium, phosphate, nitrate.

Books recommended:

1. Mikes, O. Laboratory Hand Book of Chromatographic & Allied Methods, Elles Harwood Series on Analytical Chemistry, John Wiley & Sons, 1979.
2. Ditts, R.V. Analytical Chemistry; Methods of Separation, van Nostrand, 1974.

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	Basics of computer applications.
CO2	Understand the elements of the basic language, basic keywords
CO3	Explain the language and operations of computer.
CO4	Analyze numerical Methods Roots of equations.
CO5	Eplain different terms of computer programming.
CO6	Solves problem related to theory.

Unit	Content
1	Constants, variables, bits, bytes, binary and ASCII formats, arithmetic expressions, hierarchy of operations, inbuilt functions. Elements of the BASIC language. BASIC keywords and commands. Annexure-3 [110] Logical and relative operators. Strings and graphics. Compiled versus interpreted languages. Debugging. Simple programs using these concepts. Matrix addition and multiplication. Statistical analysis.
2	Numerical Methods 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. 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. Conceptual background of molecular modelling: Potential energy surfaces. Elementary ideas of molecular mechanics and practical MO methods..

Books Recommended:

i. Harris, D. C. Quantitative Chemical Analysis. 6th Ed., Freeman (2007) Chapters 3-5.
ii. Levie, R. de, How to use Excel in analytical chemistry and in general scientific data analysis, Cambridge Univ. Press (2001) 487 pages.
iii. Noggle, J. H. Physical chemistry on a Microcomputer. Little Brown & Co. (1985).
iv. Venit, S.M. Programming in BASIC: Problem solving with structure and style. Jaico Publishing House: Delhi (1996).

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	Get Knowledge about roots of equation.
CO2	Understand about the numerical differentiation.
CO3	Apply numerical integration .
CO4	Apply matrix operations.

CO5	Learn simple exercises using molecular visualization software
CO6	Solve problems related to theory.

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

Books Recommended:

i. Harris, D. C. Quantitative Chemical Analysis. 6th Ed., Freeman (2007) Chapters 3-5.
ii. Levie, R. de, How to use Excel in analytical chemistry and in general scientific data analysis. Cambridge Univ. Press (2001) 487 pages.
iii. Noggle, J. H. Physical chemistry on a Microcomputer. Little Brown & Co. (1985).
iv. Venit, S.M. Programming in BASIC: Problem solving with structure and style. Jaico Publishing House: Delhi (1996).

Course code	:	**CHEDE811**			
Course Title	:	**Intellectual Property Right**			
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	Acquire knowledge about Intellectual property rights, copyrights, trademarks and patents.
CO2	Appraise about geographical indications, industrial designs, trade secrets and different international agreements including Paris convention, Budapest treaty etc
CO3	Analyse layout designs of integrated circuits, risks involved in trade secret protection, international design registration, rules for registration of geographical indications etc.
CO4	Anaylze to Research-IPR.Assess introduction and historical perspectives of trade secrets, working of WTO, Madrid protocol, different type of IPs, trademarks, copyrights etc.
CO5	Summarize the properties of mechanism of Research-IPR.
CO6	Create the Research-IPR.

Unit	Content
1	**Introduction to Intellectual Property:** Historical Perspective, Different Types of IP, Importance of protecting IP. **Copyrights:** Introduction, how to obtain, Differences from Patents.
2	**Trade Marks:** Introduction, how to obtain, Different types of marks – Collective marks, certification marks, service marks, Trade names, etc. Differences from Designs. **Patents:** Historical Perspective, Basic and associated right, WIPO, PCT system, Traditional Knowledge, Patents and Healthcare – balancing promoting innovation with public health, Software patents and their importance for India.
3	**Geographical Indications:** Definition, rules for registration, prevention of illegal exploitation, importance to India. **Industrial Designs:** Definition, how to obtain, features, international design registration. **Layout design of integrated circuits:** Circuit Boards, Integrated Chips, Importance for electronic industry.
4	**Trade Secrets:** Introduction and Historical Perspectives, Scope of Protection, Risks involved and legal aspects of Trade Secret Protection.Word Trade Organization (WTO): (i) General Agreement on Tariffs & Trade (GATT), Trade Related Intellectual Property Rights (TRIPS) agreement (ii) General Agreement on Trade related Services (GATS), (iii) Madrid Protocol (iv) Berne Convention, (v) Budapest Treaty (b) Paris Convention WIPO and TRIPS, IPR and Plant Breeders Rights, IPR and Biodiversity IP Infringement issue and enforcement-Role of Judiciary, Role of law enforcement Agencies-Police, Customs etc. Economic Value of Intellectual Property – Intangible assets and their valuation, Intellectual Property in the Indian Context – Various laws in India Licensing and technology transfer.

Books Recommend

1. Acharya, N.K.: Textbook on intellectual property rights, Asia Law House.
2. Guru, M,&Rao, M.B., Understanding Trips: Managing Knowledge in Developing Countries, Sage Publications.
3. Ganguli, P., Intellectual Property Rights: Unleashing the Knowledge Economy, Tata McGraw-Hill.
4. Miller,A, R,Micheal H.Davis; Intellectual Property: Patents, Trademarks and Copyright in a Nutshell, West Group Publishers.
5. Watal, J., Intellectual property rights in the WTO and developing countries, Oxford University Press, Oxford

ABILITY ENHANCEMENT COURSE

Semester-I

Course code : AEC-104				
Course Title : Environment Science- I				
Semester /Year : I	**L**	**T**	**P**	**C**
	3	**0**	**0**	**3**

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

CO1	Discover knowledge in ecological perspective and value of environment.
CO2	Understand the significance of various natural resources and its management
CO3	Demonstrate a comprehensive understanding of the world's biodiversity and the importance of its conservation.
CO4	Categorize different types of pollutions and their control measures. Discover effective methods of waste Management
CO5	Evaluate global environmental problems and come out with best possible solutions.
CO6	Create environmental laws and sustainable development

Unit	Content
1	Environment: Definition, scope and importance of environment, need for public awareness; Ecosystem: Definition, scope and importance of ecosystem, classification, structure, and function of an ecosystem, food chains, food web and ecological pyramids, flow of energy; Biogeochemical cycles Hydrological cycle, Phosphorous cycle, Nitrogen cycle
2	Natural resources: Classification of resources, living and nonliving resources; Water resources: Use and over utilization of surface and ground water, floods and droughts, dams, benefits and problems; Mineral resources: Use and exploitation; Land resources; Energy resources: Growing energy needs, renewable and non-renewable energy sources, use of alternate energy source, case studies.
3	Biodiversity and biotic resources: Introduction, definition, genetic, species and ecosystem diversity; Value of biodiversity: Consumptive use, productive use, social, ethical, aesthetic and optional values; India as a mega diversity nation.
4	Endangered and Endemic species, Hot spots of biodiversity. Threats to biodiversity: Habitat loss, poaching of wildlife, human-wildlife conflicts; Conservation of biodiversity: In situ and ex situ conservation; National biodiversity act..

Books Recommended:

1. Benny Joseph, "Environmental Studies", Tata Mc Graw Hill Publishing Co. Ltd, New Delhi, 1 st Edition, 2006.
2. Erach Bharucha, "Textbook of Environmental Studies for Under Graduate Courses", Orient Black Swan, 2nd Edition, 2013.
3. Dr. P. D Sharma, "Ecology and Environment", Rastogi Publications, New Delhi, 12th Edition, 201

Semester-II

Course code	:	AEC-204
Course Title	:	Environment Science- II
Semester /Year	:	II

L	T	P	C
3	0	0	3

Course outcomes (COs):

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

CO1	Discover knowledge in ecological perspective and value of environment.
CO2	Understand the significance of various natural resources and its management
CO3	Demonstrate a comprehensive understanding of the world's biodiversity and the importance of its conservation.
CO4	Categorize different types of pollutions and their control measures. Discover effective methods of waste Management
CO5	Evaluate global environmental problems and come out with best possible solutions.
CO6	Create environmental laws and sustainable development

Unit	Content
1	Environmental pollution: Definition, causes and effects of air pollution, water pollution, soil pollution, noise pollution; Solid waste: Municipal solid waste management, composition and characteristics of e-waste and its management; Pollution control technologies: Waste water treatment methods, primary, secondary and tertiary.
2	Concepts of bioremediation; Global environmental problems and global efforts: Global Warming, Climate change, Sea level rise, ozone depletion, ozone depleting substances, deforestation and desertification; International conventions/protocols: Earth summit, Kyoto protocol and Montreal protocol
3	Environmental legislations: Environmental protection act, air act1981, water act, forest act. Municipal solid waste management and handling rules, biomedical waste management and handling rules2016, hazardous waste management and handling rule.

4	Environmental impact assessment (EIA); Towards sustainable future: Concept of sustainable development, population and its explosion, crazy consumerism, environmental education, urban sprawl, concept of green building..

Book Recommended:

1. Benny Joseph, "Environmental Studies", Tata Mc Graw Hill Publishing Co. Ltd, New Delhi, 1 st Edition, 2006.
2. Erach Bharucha, "Textbook of Environmental Studies for Under Graduate Courses", Orient Black Swan, 2nd Edition, 2013.
3. Dr. P. D Sharma, "Ecology and Environment", Rastogi Publications, New Delhi, 12th Edition, 201

Semester-III

Course code	**: AEC-304**				
Course Title	**: English Communication- I**				
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	Remember the different techniques of word formation; and demonstrate knowledge of synonyms, antonyms and skills of sensible writing.
CO2	Understand and remember the principle, mechanism of Communication skills, essential techniques and features of effective writing and make use of them in written communication.
CO3	Applying, understanding and remembering the detailed processes of essential techniques and features of effective writing and make use of them in written communication. Knowledge of synonyms, antonyms and skills of sensible writing.
CO4	Analyzing, applying, remembering, understanding the detailed study related common errors in English and solve exercises based on them; apply acquired knowledge and skills of oral and written communication in personal and professional life.
CO5	Evaluating, analyzing, applying, remembering, and understanding the principle, methods, properties and functions of plant physiology.

CO6	Constructing (Creating), Evaluating, Analyzing, demonstrating, remembering, and understanding the Take part in individual and group communication activities; and determine and invent new forms and methods of communication to as per the situation.

Unit	Content
1	Theory of Communication, Types and Modes of Communication: Introduction, Definitions and Function of Communication, Needs for Effective Communication, Process of Communication, Barrier to Communication, Kinds of Communication; Intrapersonal,Personal, Group and Mass, Verbal and Non-verbal Communication
2	Listening and Speaking Skills: Types of Listening, Developing Effective Listening Skills, Academic Listening (Lectures), Listening to Talks and Presentation, Monologue, Dialogue, Group Discussion, Miscommunication, Interview, Public Speech, Pronunciation, Accent and Intonation and Rhythm.
3	Reading Skills: Skimming, Scanning, Summary, Paraphrasing, Comprehension.

Book Recommended:

1. Fluency in English- Part II, Oxford University Press, 2006.
2. Business English, Pearson, 2008.
3. Language, Literature and Creativity, Orient Blackswan, 2013.
4. Language through Literature (Forthcoming) ed. Dr. Gauri Mishra, Dr. RanjhanaKaul, Dr. Brati Biswas.

Semester-IV

Course code : AEC-404				
Course Title : English Communication- II				
Semester /Year : IV				
	L	**T**	**P**	**C**
	3	**0**	**0**	**3**

Course outcomes (COs):

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

CO1	Remember the different techniques of word formation; and demonstrate knowledge of synonyms, antonyms and skills of sensible writing.
CO2	Understand and remember the principle, mechanism of Communication skills, essential techniques and features of effective writing and make use of them in written communication.
CO3	Applying, understanding and remembering the detailed processes of essential techniques and features of effective writing and make use of them in written communication. Knowledge of synonyms, antonyms and skills of sensible writing.
CO4	Analyzing, applying, remembering, understanding the detailed study related common errors in English and solve exercises based on them; apply acquired knowledge and skills of oral and written communication in personal and professional life.
CO5	Evaluating, analyzing, applying, remembering, and understanding the principle, methods, properties and functions of plant physiology.
CO6	Constructing (Creating), Evaluating, Analyzing, demonstrating, remembering, and understanding the Take part in individual and group communication activities; and determine and invent new forms and methods of communication to as per the situation.

Unit	Content
1	Introductory English Grammar: Parts of Speech, Tenses, Punctuation, Common Errors in English.
2	Writing Skills; Social and Official Correspondence: Enquiries, Complaints and Replies, Letters to the Editor.
3	Social Appeals in the Form of Letter/ Pamphlets, Standard Business Letter, Email Drafting and Etiquettes, Preparing Agenda and Writing Minutes for Meetings.
4	Career Skills: Job Application, Cover Letter, Bio-data, CV and Resume and Effective Profiling, Mock Interviews, Group Discussions

Book Recommended:

1. Fluency in English- Part II, Oxford University Press, 2006.
2. Business English, Pearson, 2008.
1. Language, Literature and Creativity, Orient Blackswan, 2013.
2. Language through Literature (Forthcoming) ed. Dr. Gauri Mishra, Dr. RanjhanaKaul, Dr. Brati Biswas.