CURRICULUM & SYLLABUS

CHOICE BASED CREDIT SYSTEM (CBCS)

FOR

BACHELOR OF SCIENCE (B.Sc.)

(3 Year Undergraduate Degree Programme)

IN

CHEMISTRY (H)

[w. e. f. 2020-21]

FACULTY OF SCIENCE & HUMANITIES
SRM UNIVERSITY DELHI-NCR, SONEPAT
Plot No.39, Rajiv Gandhi Education City, P.S. Rai, Sonepat
Haryana-131029

SRM UNIVERSITY DELHI-NCR, SONEPAT (HARYANA)

VISION

SRM University Delhi-NCR, Sonepat, Haryana aims to emerge as a leading world-class university that creates and disseminates knowledge upholding the highest standards of instruction in Medicine & Health Sciences, Engineering & Technology, Management, Law, Science & Humanities. Along with academic excellence and skills, our curriculum imparts integrity and social sensitivity to mould our graduates who may be best suited to serve the nation and the world.

MISSION

- To create a diverse community campus that inspires freedom and innovation.
- Promote excellence in educational & skill development processes.
- Continue to build productive international alliances.
- Explore optimal development opportunities available to students and faculty.
- Cultivate an exciting and rigorous research environment.

DEPARTMENT OF CHEMISTRY

VISION

Department of Chemistry is committed to provide Intellectual, Innovative &Motivational surroundings to students and faculty members. Department is focused to contribute for academic, scientific, research and experimental knowledge through excellence and to produce scientist, researchers and bureaucrats. Department wants to strive and achieve reputation of seeking attention of Government of India and use of others to be invited to provide services on the subjects involving Chemistry and allied areas.

MISSION

- To improve the problem-solving capability of students through continual learning to produce quality Chemists, Scientists, Academic intellectuals etc. in the field of Science and Technology.
- To bridge the gap between industry and academia by imparting technical/experimental knowledge, along with its application in the practical world.
- To encourage innovation through multidisciplinary research and development activities.
- To inculcate human values and ethics into students to serve the society and nation, in all possible ways.
- Personality development of students is also given priority simultaneously.

PROGRAM REQUIREMENT

General Education Requirements: Applied Science and Humanities (ASH)

Basic Science Requirements: Fundamental and Core Sciences (FS) through regular/online mode

Disciplinary Requirements comprising of:

Department Name: Department of Chemistry-Core courses (through regular/online mode)

Department Name: Department of Chemistry/Mathematics/Physics/CSE-Electives (through regular/online mode)

Department Name: Department of Chemistry-Open Electives (through regular/online mode)

Practical and Research component:

1. Regular Practical and Research
2. Summer Internships
3. Specialized courses through the Study Abroad program
4. Minor and Major Project
5. Industry internship through the semester.

SEMESTER-I

Code	Category	Course	L	T	P	C
Theory						
20CYH-200	P	English Communications (AEC)	**3**	**0**	**0**	**3**
20CYH-201	B	Inorganic Chemistry-I	**4**	**0**	**0**	**4**
20CYH-202	B	Physical Chemistry-I	**4**	**0**	**0**	**4**
20CYH-203	P	GE-I	**4**	**0**	**0**	**4**
20GE-0107	G	Yoga	**1**	**0**	**0**	**1**
Practical						
20CYH-201P	B	Inorganic Chemistry Practical -I	**0**	**0**	**4**	**2**
20CY-313	B	Physical Chemistry Practical -I	**0**	**0**	**4**	**2**
20CYH-203P	P	GE-I Practical	**0**	**0**	**4**	**2**
Total			**16**	**0**	**12**	**22**
Total Contact Hours			**330**			

SEMESTER-II

Code	Category	Course	L	T	P	C
Theory						
20CYH-204	B	Environmental Science (AEC)	**3**	**0**	**0**	**3**
20CYH-205	B	Organic Chemistry-I	**4**	**0**	**0**	**4**
20CYH-206	B	Physical Chemistry-II	**4**	**0**	**0**	**4**
20CYH-207	P	GE -II	**4**	**0**	**0**	**4**
Practical						
20CYH-205P	B	Organic Chemistry Practical -I	**0**	**0**	**4**	**2**
20CYH-206P	B	Physical Chemistry Practical -II	**0**	**0**	**4**	**2**
20CYH-207P	P	**GE-II Practical**	**0**	**0**	**4**	**2**
Total			**15**	**0**	**12**	**21**
Total Contact Hours			**315**			

SEMESTER-III

Code	Category	Course	L	T	P	C
Theory						
20CYH-208	B	**Inorganic Chemistry-II**	**4**	**0**	**0**	**4**
20CYH-209	B	**Organic Chemistry-II**	**4**	**0**	**0**	**4**
20CYH-210	B	**Physical Chemistry-III**	**4**	**0**	**0**	**4**
20CYH-211	P	**GE-III**	**4**	**0**	**0**	**4**
20CYH-212	P	**SEC -I**	**2**	**0**	**0**	**2**
Practical						
20CYH-208P	B	**Inorganic Chemistry Practical -II**	**0**	**0**	**4**	**2**
20CYH-209P	B	**Organic Chemistry Practical -II**	**0**	**0**	**4**	**2**
20CYH-210P	B	**Physical Chemistry Practical -III**	**0**	**0**	**4**	**2**
20CYH-211P	P	**GE-III Practical**	**0**	**0**	**4**	**2**
Total			**18**	**0**	**16**	**26**
Total Contact Hours			**390**			

SEMESTER-IV

Code	Category	Course	L	T	P	C
Theory						
20CYH-213	B	**Inorganic Chemistry-III**	**4**	**0**	**0**	**4**
20CYH-214	B	**Organic Chemistry-III**	**4**	**0**	**0**	**4**
20CYH-215	B	**Physical Chemistry-IV**	**4**	**0**	**0**	**4**
20CYH-216	P	**GE-IV**	**4**	**0**	**0**	**4**
20CYH-217	P	**SEC -II**	**2**	**0**	**0**	**2**
Practical						
20CYH-213P	B	**Inorganic Chemistry Practical -III**	**0**	**0**	**4**	**2**
20CYH-214P	B	**Organic Chemistry Practical -III**	**0**	**0**	**4**	**2**
20CYH-215P	B	**Physical Chemistry Practical -IV**	**0**	**0**	**4**	**2**
20CYH-216P	P	**GE-IV Practical**	**0**	**0**	**4**	**2**
Total			**18**	**0**	**16**	**26**
Total Contact Hours			**390**			

SEMESTER-V

Code	Category	Course	L	T	P	C
Theory						
20CYH-218	B	**Inorganic Chemistry -IV**	**4**	**0**	**0**	**4**
20CYH-219	B	**Organic Chemistry-IV**	**4**	**0**	**0**	**4**
20CYH-220	B	**Physical Chemistry-V**	**4**	**0**	**0**	**4**
20CYH-221	P	**DSE-I**	**4**	**0**	**0**	**4**
Practical						
20CYH-218P	B	**Practical Inorganic Practical-IV**	**0**	**0**	**4**	**2**
20CYH-219P	B	**Organic Chemistry Practical -IV**	**0**	**0**	**4**	**2**
20CYH-220P	B	**Physical Chemistry Practical -V**	**0**	**0**	**4**	**2**
20CYH-221P	P	**DSE –I Practical**	**0**	**0**	**4**	**2**
Total			**16**	**0**	**16**	**24**
Total Contact Hours			**360**			

SEMESTER-VI

Code	Category	Course	L	T	P	C
Theory						
20CYH-222	**B**	**Organic Chemistry-V**	**4**	**0**	**0**	**4**
20CYH-223	**B**	**Physical Chemistry-VI**	**4**	**0**	**0**	**4**
20CYH-224	**P**	**DSE-II**	**4**	**0**	**0**	**4**
Practical						
20CYH-222P	**B**	**Organic Chemistry Practical -V**	**0**	**0**	**4**	**2**
20CYH-223P	**B**	**Physical Chemistry Practical-VI**	**0**	**0**	**4**	**2**
20CYH-224P	**P**	**DSE-II Practical**	**0**	**0**	**4**	**2**
Total			**12**	**0**	**12**	**18**
Total Contact Hours			**270**			

SUMMARY OF CREDITS

Category	I Sem	II Sem	III Sem	IV Sem	V Sem	VI Sem	Total	%
G (General)	1						1	0.73
B (Basic Science)	12	15	18	18	18	12	93	67.88
E (Engineering Science)								
P (Professional)	9	6	8	8	6	6	43	31.39
Total	22	21	26	26	24	18	137	100

EVALUATION SCHEME

INTERNAL EVALUATION (THEORY)

Assessment	Internal Assessment				Assignment/Presentation/ Class participation	Total
	UNIT-1	UNIT-II	UNIT-III	UNIT-IV		
Marks	10	10	10	10	10	50

INTERNAL EVALUATION (PRACTICAL)

Assessment	Daily Assessment/Observation	Programs performed during Lab hours	Programs performed during Internal practical Examinations	Viva- Voce	Total
Marks	10	15	15	10	50

EXTERNAL EVALUATION (THEORY)

Assessment	End Semester Examination	Total
Marks	100	Will be scaled in 50

EXTERNAL EVALUATION (PRACTICAL)

Assessment	Record File	Programs performed during External Practical Examinations	Written Work	Viva- Voce	Total
Marks	15	15	10	10	50

Note:

1. The evaluation Scheme may change as per the university guidelines.
2. Evaluation scheme of Industrial training may vary department wise.
3. Evaluation scheme project/minor project may vary department wise.
4. Department are advised to add the evaluation scheme in their respective curriculum.

PROGRAM OBJECTIVE

Degree is awarded to candidates who have completed the course and who have met the assessment criteria for all written, major/minor projects and practical examination/assignments. The overall assessment aims for each topic are that candidates should be able to:

- Grasp the concepts while teaching in classes
- Interpret and analyze the questions
- Bridge the multiple concepts of various topics via numerical and Practicals/Project
- Extract critical knowledge from the comprehensive topics.
- Ability to write & review of scientific articles

PROGRAM OUTCOME

- Students should have a working knowledge of the main areas of chemistry: Organic, Inorganic, Analytical and Physical Chemistry.
- Students should possess critical thinking and problem solving abilities.
- Students should be able to perform and understand chemical research.
- Students should be able to describe, both in writing and orally, chemical processes and procedures.
- Students should be able to work in a chemical or related field.
- Students will be able to clearly communicate the results of scientific work in oral, written and electronic formats to both scientists and the public at large.
- Students will be able to explore new areas of research in chemistry.
- Students will appreciate the central role of chemistry in our society and use this as a basis for ethical behavior in issues facing chemists including an understanding of safe handling of chemicals, environmental issues and key issues facing our society in energy, health and medicine.
- Students will be able to explain why chemistry is an integral activity for addressing social, economic, and environmental problems.
- Students will be able to function as a member of an interdisciplinary problem solving team.

LIST OF OPEN ELECTIVES

Code	Category	Course	L	T	P	C
Open Elective-I						
20CYH-203A	B	**Physics I–Thermal Physics**	4	0	0	4
20CYH-203PA	B	**Physics Practicals Thermal Physics**	0	0	4	2
20CYH-203B	B	**Physics-II: Modern Physics**	4	0	0	4
20CYH-203PB	B	**Physics Practicals Elements of Modern Physics**	0	0	4	2
Open Elective-II						
20CYH-207A	B	**Mathematics-I: Algebra & Calculus**	4	0	0	4
20CYH-207B	B	**Mathematics-II: Differential equations & Determinants**	3	1	0	4
Open Elective-III						
20CYH-211A	P	**Computer for Chemists**	4	0	0	4
20CYH-211PA	P	**Computer for Chemists Practicals**	0	0	4	2
20CYH-211B	P	**Molecular Modeling & Drug Designing**	4	0	0	4
20CYH-211PB	P	**Molecular Modelling & Drug Design Practical**	0	0	4	2
Open Elective-IV						
20CYH-216A	P	**Pharmaceutical Chemistry**	4	0	0	4
20CYH-216AP	P	**Pharmaceutical Chemistry Practical**	0	0	4	2
20CYH-216B	P	**Chemical Technology in Society and Business Skill for Chemists**	4	0	0	4

LIST OF MODULE ELECTIVES

Code	Category	Course	L	T	P	C
Departmental Elective-I						
20CYH-221A	P	**Environment & Industrial Chemistry**	4	0	0	4
20CYH-221PA	P	**Industrial Chemicals & Environment Practicals**	0	0	2	2
20CYH-221B	P	**Green Chemistry**	4	0	0	4
20CYH-221PB	P	**Green Chemistry Practical**	0	0	4	2
Departmental Elective-II						
20CYH-224A	P	**Analytical Methods in Chemistry**	4	0	0	4
20CYH-224PA	P	**Analytical Methods in Chemistry Practical**	0	0	2	2
20CYH-224B	P	**Industrial Methods of Analysis**	4	0	0	4
20CYH-224PB	P	**Industrial Methods of Analysis Practical**	0	0	4	2
SKILL ENHANCEMENT COURSE-I						
20CYH-212A	P	**Intellectual Property Rights**	2	0	0	2
20CYH-212B	P	**Pesticide Chemistry**	2	0	0	2
SKILL ENHANCEMENT COURSE -II						
20CYH-217A	P	**Chemistry of Cosmetics & Perfumes**	2	0	0	2
20CYH-217B	P	**Biology for Chemists**	2	0	0	2

SEMESTER-1

Course Code-20CYH-201	**Subject Name-Inorganic Chemistry-I**	**4**	**4**	**0**	**4**
Course Category-B	**Pre-requisite- NIL**				
	Co-requisite-YES				
	Designed –Department of Chemistry				

COURSE OBJECTIVE

1. To understand the atomic structure, wave functions, periodic table and some properties of the elements.

2. To understand chemical bonding and chemical bonds and their properties.

UNIT	Course contents	Contact Hours
Unit-I	**Atomic Structure:** Recapitulation of Bohr's theory, its limitations and atomic spectrum of hydrogen atom. Wave mechanics: de Broglie equation, Heisenberg's Uncertainty Principle and its significance. Schrödinger's wave equation, significance of ψ and ψ^2. Quantum numbers and their significance. Normalized and orthogonal wave functions. Sign of wave functions. Radial and angular wave functions for hydrogen atom. Radial and angular distribution curves. Shape of s, p, d and f orbitals. Pauli's Exclusion Principle, Hund's rule of maximum multiplicity, Aufbau principle, applications and its limitations.	15
Unit-II	**Periodicity of Elements:** Brief discussion of the following properties of the *s* & *p*-block elements: (a) Effective nuclear charge, shielding or screening effect, Slater rule, variation of effective nuclear charge in periodic table. (b) Atomic and ionic radii. (c) Ionization enthalpy, successive ionization enthalpies and factors affecting ionization enthalpy and trends in groups and periods. (d) Electron gain enthalpy and trends in groups and periods. (e) Electronegativity, Pauling's/Allred Rochow's scale, Variation of electronegativity with bond order, partial charge, hybridization, group electronegativity.	10
Unit-III	**Chemical Bonding:** (i) *Ionic bond:* General characteristics, types of ions, size effects, radius ratio rule and its limitations. Packing of ions in crystals. Born-Landé equation with derivation and importance of Kapustinskii	20

	equation for lattice energy. Madelung constant, Born-Haber cycle and its application, solvation energy. (ii) *Covalent bond:* Lewis structure, Valence Bond theory (Heitler-London approach). Energetics of hybridization, equivalent and non-equivalent hybrid orbitals. Bent's rule, resonance and resonance energy, Molecular orbital theory. Molecular orbital diagrams of diatomic and simple polyatomic molecules N_2, O_2, C_2, B_2, F_2, CO, NO, and their ions. Formal charge, Valence shell electron pair repulsion theory (VSEPR), shapes of the following simple molecules and ions containing lone pairs and bond pairs of electrons: H_2O, NH_3, PCl_3, PCl_5, SF_6, ClF_3, I_3^-, BrF_2^+, PCl_6^-, ICl_2^-, $ICl_4^-$and SO_4^{2-}.	
Unit-IV	Multiple bonding (ζ and π bond approach) and bond lengths. Covalent character in ionic compounds, polarizing power and polarizability. Fajans' rules and consequences of polarization. Ionic character in covalent compounds: Bond moment and dipole moment. Percentage ionic character from dipole moment and electronegativity difference. (iii) *Metallic Bond:* Qualitative idea of valence bond and band theories of solid. Semiconductors and insulators, defects in solids. (iv) *Non-covalent Forces:* Van der Waals forces, ion-dipole forces, dipole-dipole interactions, induced dipole interaction. Hydrogen bonding (theories of hydrogen bonding, valence bond treatment). Effects of non-covalent forces on physical properties.	15

LEARNING OUTCOME:

1. Students should be able to solve the conceptual questions about all the models of the atom, quantum numbers, electronic configuration, radial and angular distribution curves, shapes of s, p, and d orbitals, and periodicity in atomic radii, ionic radii, ionization energy and electron affinity of elements.
2. Students should be able to draw the plausible structures and geometries of molecules using VSEPR theory and MO diagrams (homo- & hetero-nuclear diatomic molecules).
3. Students should be able to describe the importance and applications of chemical bonding and their effect on physical & chemical properties.

Learning Resources	
Text Book	1. Cotton, F.A., Wilkinson, G. & Gaus, P.L. *Basic Inorganic Chemistry*, Wiley. 2. Douglas, B.E., McDaniel, D.H. & Alexander, J.J. *Concepts and Models in Inorganic Chemistry*, John Wiley& Sons. 3. Ajai Kumar, *Basic Inorganic Chemistry.*
Reference Books	4. Lee, J.D. *Concise Inorganic Chemistry.* 5. Huheey, J.E., Keiter, E.A., Keiter, R.L. & Medhi, O.K. *Inorganic Chemistry: Principles of Structure and Reactivity*, Pearson Education India.

		L	T	P	C
Course Code-20CYH-202	**Subject Name-Physical Chemistry-I**	**4**	**4**	**0**	**4**
Course Category-B	**Pre-requisite- No**				
	Co-requisite-yes				
	Designed –Department of Chemistry				

COURSE OBJECTIVE:

1. To understand states of gases, behavior of real gases and chemical kinetics.
2. To understand the theory of reaction rates and effect of catalysts on the reaction.

UNIT	Course contents	Contact Hours
Unit-I	**Gaseous state:** Kinetic molecular model of a gas: postulates and derivation of the kinetic gas equation, collision frequency, collision diameter, mean free path and viscosity of gases, including their temperature and pressure dependence, relation between mean free path and coefficient of viscosity, calculation of ζ from η; variation of viscosity with temperature and pressure. Maxwell distribution and its use in evaluating molecular velocities (average, root mean square and most probable) and average kinetic energy, law of equipartition of energy, degrees of freedom and molecular basis of heat capacities.	20
Unit-II	**Behavior of real gases:** Deviations from ideal gas behavior, compressibility factor Z, and its variation with pressure and temperature for different gases. Causes of deviation from ideal behavior. Van der Waals equation of state, its derivation and application in explaining real gas behavior, calculation of Boyle temperature. Isotherms of real gases and their comparison with van der Waals isotherms, continuity of states, critical state, relation between critical constants and van der Waals constants, law of corresponding states.	15
Unit-III	**Chemical kinetics:** Order and molecularity of a reaction, rate laws in terms of the advancement of a reaction, differential and integrated form of rate expressions up to second order reactions, experimental methods of the determination of rate laws, kinetics of complex reactions (integrated rate expressions up to first order only): (i) opposing reactions (ii) parallel reactions and (iii)	15

	consecutive reactions and their differential rate equations (steady-state approximation in reaction mechanisms) (iv) chain reactions. Temperature dependence of reaction rates; Arrhenius equation; activation energy.	
Unit-IV	Collision theory of reaction rates, Lindemann mechanism, qualitative treatment of the theory of absolute reaction rates. **Catalysis:** Types of catalyst, specificity and selectivity, mechanisms of catalyzed reactions at solid surfaces. Enzyme catalysis, Michaelis-Menten mechanism, acid-base catalysis.	10

LEARNING OUTCOME:

1. Students should be able to derive mathematical expressions for different properties of gas and understand their physical significance.
2. Students should be able to apply the concepts of gas equations, pH and electrolytes while studying other chemistry courses and everyday life.
3. Students should be able to interpret rate law and rate of reaction and theories of catalysis (both chemical and enzymatic)
4. Students should be able to calculate rate constant using differential and integrated form of rate expressions.

Learning Resources	
Text Book	1. Barrow, G.M. *Physical Chemistry* Tata McGraw Hill. 2. Kapoor, K.L. (Vol. 1 to 5) *Physical Chemistry*, Macmillan.
Reference Book	3. Atkins, P.; Paula, J.P. *Physical Chemistry*, Oxford 4. Castellan, G. W. Physical Chemistry 4th Ed. Narosa.

INORGANIC CHEMISTRY PRACTICAL-I

		L	T	P	C
Course Code-20CYH-201P	**Subject Name: Inorganic Chemistry Practical -I**	**0**	**0**	**4**	**2**
Course Category-B	**Pre-requisite- No**				
	Co-requisite-yes				
	Designed –Department of Chemistry				

COURSE OBJECTIVE:

1. To understand the calibration and use of apparatus, preparation of standard solutions.
2. To understand the volumetric titration and redox titrimetry.

(A)	**Titrimetric Analysis** (i) Calibration and use of apparatus (ii) Preparation of solutions of titrants of different Molarity/Normality & standardization of solutions.	10
(**B**)	**Volumetric Titrations** (i) Estimation of sodium carbonate using standardized HCl. (ii) Estimation of carbonate and hydroxide present together in a mixture. (iii) Estimation of carbonate and bicarbonate present together in a mixture.	10
(**C**)	**Redox Titrimetry** (i) Estimation of Fe(II) and oxalic acid using standardized $KMnO_4$ solution (ii) Estimation of Fe(II) with $K_2Cr_2O_7$ using internal indicator (diphenylamine, *N*-phenylanthranilic acid) and discussion of external indicator.	10

LEARNING OUTCOME:

1. Students should be able to illustrate the calibration and use of laboratory apparatus
2. Students should be able to prepare standard solutions of different concentrations.

Learning Resources	
Text Book	1. Vogel, A.I.A Textbook of Quantitative Inorganic Analysis. 2. Ahluwalia, V. K.; Dhingra, S.; Dhingra, S. *College*

	Practical Chemistry, Universities Press.

		L	T	P	C
Course Code-20CYH-202P	**Subject Name: Physical Chemistry Practical - I**	**0**	**0**	**4**	**2**
Course Category-B	**Pre-requisite- No**				
	Co-requisite-yes				
	Designed –Department of Chemistry				

COURSE OBJECTIVE:

1. To study the kinetics of the reaction by different method.
2. To understand the saponification by kinetics.

	Chemical Kinetics: Study the kinetics of the following reactions. **1**. Iodide-persulphate reaction (i) Initial rate method (ii) Integrated rate method. **2**. Acid hydrolysis of methyl acetate with hydrochloric acid. **3**. Saponification of ethyl acetate. **4**. Comparison of the strengths of HCl and H_2SO_4 by studying kinetics of hydrolysis of methyl acetate.	30

LEARNING OUTCOME:

1. Students should be able to describe the steps of reaction kinetics by different methods.
2. Students should be able to calculate the half-life of reactions based on chemical kinetics.

Learning Resources	
Text Book	1. Khosla, B. D.; Garg, V. C. & Gulati, A. Senior Practical Physical Chemistry, R. Chand & Co.: New Delhi. **2.** Yadav J. B. *Advanced Practical Physical Chemistry*.
Reference Book	3. Garland, C. W.; Nibler, J. W. & Shoemaker, D. P. McGraw-Hill: New York.

SEMESTER II

		L	T	P	C
Course Code-20CYH-205	**Subject Name-Organic Chemistry-I**	**4**	**0**	**0**	**4**
Course Category-B	**Pre-requisite- No**				
	Co-requisite-yes				
	Designed –Department of Chemistry				

COURSE OBJECTIVE:

1. To understand the basics of organic chemistry and different types of organic reactions.
2. To understand the stereochemistry, geometries and conformation of organic molecules.
3. To understand the general methods for the synthesis of alkanes, alkenes, alkynes and their properties and chemical reactions.

UNIT	Course contents	Contact Hours
Unit-I	**Recapitulation of basics of Organic Chemistry:** Hybridization, shapes of molecules. Inductive, electromeric, resonance and mesomeric effects, hyperconjugation, dipole moment; hydrogen bonding. Homolytic and heterolytic fission with suitable examples. Curly arrow rules, formal charges; electrophiles and nucleophiles; types, shape and relative stability of carbocations, carbanions, free radicals and carbenes, nitrenes, benzyne. Introduction to types of organic reactions: addition, elimination and substitution reactions. Aromaticity: Hückel's rule, aromatic character of arenes, cyclic carbocations/carbanions and heterocyclic compounds with suitable examples.	15
Unit-II	**Stereochemistry:** Fischer, Newman and Sawhorse projection, wedge formulae and their inter-conversions. Geometrical isomerism: cis–trans, syn-anti and E/Z notations with C.I.P. rules. Optical Isomerism: Optical activity, specific rotation, chirality/symmetry, enantiomers, molecules with two or more chiral-centers, distereoisomers, meso structures, racemic mixture and their resolution. Relative and absolute	10

	configuration: D/L and R/S designations.	
Unit-III	**Cycloalkanes and Conformational Analysis:** Conformational analysis of alkanes: Relative stability and Energy diagrams. Types of cycloalkanes and their relative stability, Baeyer strain theory: Chair, Boat and Twist boat forms of cyclohexane with energy diagrams; Relative stability of mono substituted cycloalkanes. Chromatography**:** definition, general introduction on principles of chromatography, R_f, role of polarity on R_f, paper chromatographic separation of various mixtures.	10
Unit-IV	**Chemistry of Aliphatic Hydrocarbons: (A) Carbon-Carbon sigma bonds:** General methods of preparation, physical and chemical properties of alkanes: Wurtz reaction, Wurtz-Fittig reactions, free radical substitutions: mechanism of halogenation, relative reactivity and selectivity. **(B) Carbon-Carbon pi bonds:** General methods of preparation, physical and chemical properties of alkenes and alkynes, mechanism of E_1, E_2, E_1cb reactions. Saytzeff and Hofmann eliminations. Electrophilic additions their mechanisms (Markownikoff/Anti Markownikoff addition), mechanism of oxymercuration-demercuration, hydroboration-oxidation, ozonolysis, reduction (catalytic and chemical), syn and anti-hydroxylation (oxidation). 1,2- and 1,4-addition reactions in conjugated dienes and Diels-Alder reaction; Allylic and benzylic bromination and mechanism, e.g. propene, 1-butene, toluene, ethyl benzene. **(C) Reactions of alkynes:** Acidity, electrophilic and nucleophilic additions. Hydration to form carbonyl compounds, alkylation of terminal alkynes. **(D) Aromatic hydrocarbons:** Electrophilic aromatic substitution: halogenation, nitration, sulphonation and Friedel-Craft's alkylation/acylation with their mechanism. Directing effects of the groups.	25

LEARNING OUTCOME:

1. Students should be able to describe the fundamental concepts of different nature and behavior of organic compounds.

2. Students should be able to formulate the mechanism of organic reactions by the chemical properties of the organic compounds involved.
3. Students should be able to identify many organic reaction mechanisms including free Radical, substitution, electrophilic addition and electrophilic aromatic substitution along with their mechanism.
4. Students should be able to discuss the importance and fundamental concepts of stereochemistry.

Learning Resources	
Text Book	1. Morrison, R. N. & Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education). 2. Finar, I. L. Organic Chemistry (Volume 1), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education). 3. Finar, I. L. Organic Chemistry (Volume 2: Stereochemistry and the Chemistry of Natural Products), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education). 4. Graham Solomon, T.W., Fryhle, C.B. & Dnyder, S.A. *Organic Chemistry,* John Wiley & Sons. 5. McMurry, J.E. *Fundamentals of Organic Chemistry*.Cengage Learning India Edition. 6. Bahl, A. & Bahl, B.S. *Advanced Organic Chemistry,* S. Chand.
Reference Books	7. Sykes, P. *A Guidebook to Mechanism in Organic Chemistry*, Orient Longman, New Delhi. 8. Eliel, E.L. *Stereochemistry of Carbon Compounds*, Tata McGraw Hill education. 9. Clayden, Organic Chemistry.

		L	T	P	C
Course Code-20CYH-206	**Subject Name-Physical Chemistry-II**	**4**	**0**	**0**	**4**
Course Category--B	**Pre-requisite-**				
	Co-requisite- Yes				
	Designed –Department of Chemistry				

COURSE OBJECTIVE (Specific Course objective should be mentioned below)

1. To understand the liquid and solid states of matter and properties in both the states.
2. To understand the ionic equilibrium of various electrolytes and other effects like common ion effect, solubility products etc.
3. To understand chemical equilibria in ideal gases.

UNIT	Course contents	Contact Hours
Unit-I	**Liquid state:** Qualitative treatment of the structure of the liquid state; physical properties of liquids; vapour pressure, surface tension and coefficient of viscosity, and their determination. Effect of addition of various solutes on surface tension and viscosity. Micelles formation and explanation of cleansing action of detergents. Temperature variation of viscosity of liquids and comparison with that of gases.	10
Unit-II	**Solid state:** Nature of the solid state, law of constancy of interfacial angles, law of rational indices, Miller indices, elementary ideas of symmetry, symmetry elements and symmetry operations, qualitative idea of point and space groups, seven crystal systems and fourteen Bravais lattices; X-ray diffraction, Bragg's law, a simple account of rotating crystal method and powder pattern method. Analysis of powder diffraction patterns of NaCl, CsCl and KCl.	10
Unit-III	**Ionic equilibria:** Strong, moderate and weak electrolytes, degree of ionization, factors affecting degree of ionization, ionization constant and ionic product of water. Ionization	20

	of weak acids and bases, pH scale, common ion effect; dissociation constants of mono and diprotic acids. Salt hydrolysis-calculation of hydrolysis constant, degree of hydrolysis and pH for different salts. Buffer solutions; derivation of Henderson equation and its applications. Solubility and solubility product of sparingly soluble salts – applications of solubility product principle. Qualitative treatment of acid -base titration curves. Theory of acid–base indicators; selection of indicators and their limitations.	
Unit-IV	**Systems of Variable Composition:** Partial molar quantities, dependence of thermodynamic parameters on composition; Gibbs-Duhem equation, chemical potential of ideal mixtures, change in thermodynamic functions in mixing of ideal gases. **Chemical Equilibrium:** Criteria of thermodynamic equilibrium, degree of advancement of reaction, chemical equilibria in ideal gases. Thermodynamic derivation of relation between Gibbs free energy of reaction and reaction quotient. Equilibrium constants and their quantitative dependence on temperature, pressure and concentration (Le Chatelier Principle). Free energy of mixing and spontaneity, equilibrium between ideal gases and pure condensed phase.	20

LEARNING OUTCOME:

1. Students should be able to derive mathematical expressions for different properties of gas, liquid and solids and understand their physical significance.
2. Students should be able explain the crystal structure and calculate related properties of cubic systems.
3. Students should be able describe the concept of ionization of electrolytes with emphasis on weak acid and base and hydrolysis of salt.

4. Students should be able apply the concepts of gas equations, pH and electrolytes while studying other chemistry courses and everyday life.

Learning Resources

Text Book	1. Kapoor, K. L. (Vol. 1 to 5) *Physical Chemistry*, Macmillan. 2. Atkins, P.; Paula, J.P. *Physical Chemistry*, Oxford. 3. Puri, B. R.; Sharma, L.R.; Pathania, M. S. *Principles of Physical Chemistry.* 4. Gurtu, J. N.; Gurtu, A. *Advanced Physical Chemistry*, Pragati Prakashan.
Reference Books	5. Barrow, G.M. *Physical Chemistry* Tata McGraw Hill. 6. Engel, T. & Reid, P. Physical Chemistry 3rd Ed., Prentice-Hall. 7. McQuarrie, D. A. & Simon, J. D. Molecular Thermodynamics Viva Books Pvt. Ltd.: New Delhi.

Course Code-20CYH-205P	**Subject Name-Organic Chemistry Practical–I**	**0**	**0**	**4**	**2**
Course Category-B	**Pre-requisite-**				
	Co-requisite-20CYH-205P				
	Designed –Department of Chemistry				

COURSE OBJECTIVE:

1.To understand the calibration of thermometer.

2. To understand the purification of organic compounds by crystallization method.

3. To understand the determination of boiling and melting point of organic compounds.

Course Contents

1. Calibration of the thermometer

2. Purification of organic compounds by crystallization using the following solvents:

a. Water

b. Alcohol

c. Alcohol-Water

3. Determination of the melting points of unknown organic compounds (Kjeldahl method and electrically heated melting point apparatus).

4. Effect of impurities on the melting point – mixed melting point of two unknown organic compounds.

5. Determination of boiling point of liquid compounds. (boiling point lower than and more than 100 °C by distillation and capillary method).

6. Chromatography.

a. Separation of a mixture of two amino acids by ascending and horizontal paper chromatography.

b. Separation of a mixture of two sugars by ascending paper chromatography.

c. Separation of a mixture of o-and p-nitrophenol or o-and p-aminophenol by thin layer chromatography (TLC).

7. Detection of extra elements.

LEARNING OUTCOME:

1. Students should be able to demonstrate the calibration and use of laboratory apparatus
2. Students should be able determine boiling and melting point of organic compounds.
3. Students should be able to analyze the effect of impurity in organic compounds and their purification by crystallization method.
4. Students should be able to apply the concepts of separation techniques such as chromatography to separate mixtures.
5. Students should be able to explain detecting various extra elements present in an organic compound.

Learning Resources	
Text Book	1. Mann, F.G. & Saunders, B.C. Practical Organic Chemistry, Pearson Education. 2. Furniss, B.S.; Hannaford, A.J.; Smith, P.W.G.; Tatchell, A.R. Practical Organic Chemistry, 5th Ed., Pearson. 3. Vogel, A.I., Tatchell, A.R., Furnis, B.S., Hannaford, A.J. & Smith, P.W.G., Textbook of Practical Organic Chemistry, Prentice-Hall.

Course Code-20CYH-206P	**Subject Name-Physical Chemistry Practical – II**	**0**	**0**	**4**	**2**
Course Category-B	**Pre-requisite-**				
	Co-requisite- 20CYH-206P				
	Designed –Department of Chemistry				

COURSE OBJECTIVE:

1.To understand the determination of surface tension by different methods.
2. To understand the viscosity measurement by Ostwald method.
3. To understand the powder diffraction pattern.

Course Contents

1. **Surface tension measurement using stalagmometer.**

a. Determine the surface tension by (i) drop number (ii) drop weight method.

b. Study the variation of surface tension with different concentration of detergent solutions. Determine CMC.

2. **Viscosity measurement using Ostwald's viscometer.**

a. Determination of co-efficient of viscosity of an unknown aqueous solution.

b. Study of variation of co-efficient of viscosity with different concentration of Poly Vinyl Alcohol (PVA).

c. Study of variation of viscosity with different concentration of sugar solutions.

3. **Solid State:**

a. Interpretation of a given powder diffraction pattern of a cubic crystalline system.

LEARNING OUTCOME:

1. Students should be able to describe the concept of surface tension and its measurement by different methods.
2. Students should be able to apply the concepts of coefficient of viscosity of different concentrations.

3. Students should be able to illustrate the concept of crystal structures.

Learning Resources	
Text Book	1. Khosla, B. D.; Garg, V. C. & Gulati, A., Senior Practical Physical Chemistry, R. Chand & Co.: New Delhi 2. Athawale, V. D. &Mathur, P. Experimental Physical Chemistry New Age International: New Delhi.

Semester-III

		L	**T**	**P**	**C**
Course Code-20CYH-208	**Subject Name-INORGANIC CHEMISTRY II**	**4**	**0**	**0**	**4**
Course Category-B	**Pre-requisite-**				
	Co-requisite-20CYH-208				
	Designed –Department of Chemistry				

COURSE OBJECTIVE (Specific Course objective should be mentioned below)

1. To understand the principle of metallurgy, properties if s and p-block elements.
2. To understand the methods for the preparation, structure and properties of some inorganic compounds.
3. To understand the methods of purification of metals, such as electrolytic, oxidative refining, Van Arkel-De Boer process and Mond's process.

UNIT	Course contents	Contact Hours
Unit-I	**General Principles of Metallurgy:** 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 process for silver and gold. Methods of purification of metals: Electrolytic process, van Arkel-de Boer process and Mond's process, Zone refining.	10

Unit-II	**Chemistry of *s*-Block Elements:** i) General characteristics: melting point, flame color, reducing nature, diagonal relationships and anomalous behavior of first member of each group. (ii) Reactions of alkali and alkaline earth metals with oxygen, hydrogen, nitrogen and water. (iii) Common features such as ease of formation, thermal stability and solubility of the following alkali and alkaline earth metal compounds: hydrides, oxides, peroxides, superoxides, carbonates, nitrates, sulphates. (iv) Complex formation tendency of s-block elements; structure of the following complexes: crown ethers and cryptates of Group I; basic beryllium acetate, beryllium nitrate, EDTA complexes of calcium and magnesium. (v) Solutions of alkali metals in liquid ammonia and their properties.	20
Unit-III	**Chemistry of *p*-Block Elements:** Electronic configuration, atomic and ionic size, metallic/non-metallic character, melting point, ionization enthalpy, electron gain enthalpy, electronegativity, Allotropy of C, P, S; inert pair effect, diagonal relationship between B and Si and anomalous behavior of first member of each group. Structure, bonding and properties: acidic/basic nature, stability, ionic/covalent nature, oxidation/reduction, hydrolysis, action of heat of the following: • Hydrides: hydrides of Group 13 (only diborane), Group 14, Group 15 Group 16 and Group 17. • Oxides: oxides of phosphorus, sulfur and chlorine • Oxoacids: oxoacids of phosphorus and chlorine; peroxoacids of sulphur. • Halides: halides of silicon and phosphorus	20
Unit-IV	**Preparation, properties, structure and uses of the following compounds** • Borazine • Silicates, silicones, • Phosphonitrilic halides $\{(PNCl_2)_n$ where n = 3 and 4$\}$ • Interhalogen and pseudohalogen compounds • Clathrate compounds of noble gases, xenon fluorides (MO treatment of XeF_2).	10

LEARNING OUTCOME:

1. Students should be able to describe the fundamental principles of metallurgy and understand the importance of recovery of byproducts during extraction.
2. Students should be able to emply basic and practical applications in various fields of metals and alloy behavior and their manufacturing processes.

3. Students should be able to apply the thermodynamic concepts like that of Gibbs energy and entropy to the principles of extraction of metals.
4. Students should be able to identify the periodicity in atomic and ionic radii, electronegativity, ionization energy, electron affinity of elements of the periodic table.
5. Students should be able to estimate the oxidation states with reference to elements in unusual and rare oxidation states like carbides and nitrides.
6. Students should be able to explain the vital role of sodium, potassium, calcium and magnesium ions in biological systems and the use of cesium in devising photoelectric cells.

Learning Resources	
Text Book	1. Cotton, F.A. & Wilkinson, G. *Basic Inorganic Chemistry*, Wiley. 2. Shriver, D.F. & Atkins, P.W. *Inorganic Chemistry*, Oxford University Press. 3. Lee, J.D. *Concise Inorganic Chemistry.* 4. Ajai Kumar, *Basic Inorganic Chemistry.*
Reference Books	5. Wulfsberg, G. *Inorganic Chemistry*, Viva Books Pvt. Ltd. 6. Rodgers, G.E. *Inorganic & Solid State Chemistry*, Cengage Learning India Ltd. 7. Huheey, J.E., Keiter, E.A., Keiter, R.L. & Medhi, O.K. *Inorganic Chemistry: Principles of Structure and Reactivity*, Pearson Education India.

		L	**T**	**P**	**C**
Course Code-20CYH-209	**Subject Name-ORGANIC CHEMISTRY II**	**4**	**0**	**0**	**4**
Course Category-B	**Pre-requisite-**				
	Co-requisite-20CYH-209				
	Designed –Department of Chemistry				

COURSE OBJECTIVE

1. To understand the reaction mechanism of organic halides and effect of various parameters on the rate of reaction.
2. To understand the chemistry of oxygen containing molecules like alcohols, phenols, ethers and epoxides.
3. To understand the chemistry of carbonyl compounds and carboxylic acid and its derivatives.

UNIT	Course contents	Contact Hours
Unit-I	**Chemistry of organic halides:** Alkyl halides: Methods of preparation and properties, nucleophilic substitution reactions – S_N1, S_N2 and S_Ni mechanisms with stereochemical aspects and effect of solvent etc.; nucleophilic substitution vs elimination. Aryl halides: Preparation (including preparation from diazonium salts) and properties, nucleophilic aromatic substitution; S_NAr, Benzyne mechanism. Relative reactivity of alkyl, allyl, benzyl, vinyl and aryl	15

	halides towards nucleophilic substitution reactions.	
Unit-II	**Alcohols, Phenols, Ethers and Epoxides:** *Alcohols:* preparation, properties and relative reactivity of 1°, 2°, 3° alcohols, Bouvaelt-Blanc reduction; Oxidation of diols by periodic acid and lead tetra-acetate, Pinacol-Pinacolone rearrangement; **Phenols:** Preparation and properties; Acidity and factors effecting, Ring substitution reactions, Reimer–Tiemann and Kolbe's–Schmidt Reactions, Fries and Claisen rearrangements with mechanism. **Ethers and Epoxides***:* Preparation and reactions with acids. Reactions of epoxides with alcohols, ammonia derivatives and $LiAlH_4$.	15
Unit-III	**Carbonyl Compounds:** Structure, reactivity, preparation and properties; nucleophilic additions, nucleophilic addition-elimination reactions with ammonia derivatives with mechanism; mechanisms of Aldol and Benzoin condensation, Knoevenagel condensation, Claisan-Schmidt, Perkin, Cannizzaro and Wittig reactions, Beckmann and Benzil-Benzilic acid rearrangements, Haloform reaction and Baeyer Villiger oxidation, α - substitution reactions, oxidations and reductions (Clemmensen, Wolff-Kishner, $LiAlH_4$, $NaBH_4$, MPV, PDC). Addition reactions of α, β-unsaturated carbonyl compounds: Michael addition. Active methylene compounds: Keto-enol tautomerism. Preparation and synthetic applications of diethyl malonate and ethyl acetoacetate.	10
Unit-IV	**Carboxylic Acids and their derivatives:** General methods of preparation, physical properties and reactions of monocarboxylic acids, effect of substituents on acidic strength. Typical reactions of dicarboxylicacids, hydroxy acids and unsaturated acids. Preparation and reactions of acid chlorides, anhydrides, esters and amides; Comparative study of nucleophilic substitution at acyl group. Mechanism of acidic and alkaline hydrolysis of esters, Claisen condensation, Dieckmann and Reformatsky reactions, Curtius rearrangement.	20

LEARNING OUTCOME:

1. Students should be able to describe the preparation, properties and reactions of haloalkanes, haloarenes and oxygen containing functional groups.
2. Students should be able to apply the synthetic chemistry to do functional group transformations.
3. Students should be able to propose plausible mechanisms for any relevant reaction.

Learning Resources	
Text Book	1. Graham Solomon, T.W., Fryhle, C.B. &Dnyder, S.A. *Organic Chemistry*, John Wiley & Sons. 2. McMurry, J.E. *Fundamentals of Organic Chemistry*, 7th Ed. Cengage Learning India. 3. Bahl, A. &Bahl, B.S. *Advanced Organic Chemistry*, S. Chand. 4. Mehta, B.;Mehta, M. *Organic Chemistry 2nd Edition*, Kindle Edition. 5. Yadav, L. D. S., Singh, *J. Advanced Organic Chemistry*,Pragati Edition.
Reference Books	6. Finar, I.L. *Organic Chemistry* (Vol. I & II). 7. Morrison, R.T. & Boyd, R.N. *Organic Chemistry*, Pearson. 8. Clayden, Organic Chemistry 9. Sykes, P. *A Guidebook to Mechanism in Organic Chemistry*, Orient Longman, NewDelhi.

		L	**T**	**P**	**C**
Course Code-20CYH-210	**Subject Name-Physical Chemistry-III**	**4**	**0**	**0**	**4**
Course Category-B	**Pre-requisite- No**				
	Co-requisite-yes				
	Designed –Department of Chemistry				

COURSE OBJECTIVE

1**.** To understand the various phases of a system and equilibrium between all phases.
2. To understand the extensive and intensive variables, three law's of thermodynamics, concept of entropy, Gibbs free energy etc.

UNIT	Course contents	Contact Hours
Unit-I	**Phase Equilibria**: Concept of phases, components and degrees of freedom, derivation of Gibbs Phase Rule for non-reactive and reactive systems; Clausius-Clapeyron equation and its applications to solid-liquid, liquid-vapor and solid-vapor equilibria, phase diagram for one component systems (H_2O and S), with applications. Phase diagrams for systems of solid-liquid equilibria involving	15

	eutectic, congruent and incongruent melting points. Three component systems: triangular plots, water-chloroform-acetic acid system.	
Unit-II	**Binary solutions:** Gibbs-Duhem-Margules equation, its derivation and applications to fractional distillation of binary miscible liquids (ideal and non-ideal), azeotropes, lever rule, partial miscibility of liquids, CST, LCST, UCST, miscible pairs, steam distillation, Nernst distribution law: its derivation and applications. **Solutions and Colligative Properties:** Dilute solutions; lowering of vapour pressure, Raoult's and Henry's Laws and their applications. Thermodynamic derivation using chemical potential to derive relations between the four colligative properties (i) relative lowering of vapour pressure, (ii) elevation of boiling point, (iii) Depression of freezing point, (iv) osmotic pressure and amount of solute. Applications in calculating molar masses of normal dissociated and associated solutes in solution.	15
Unit-III	**Chemical Thermodynamics:** Intensive and extensive variables; state and path functions; isolated, closed and open systems. **First law:** Concept of heat Q, work W, internal energy U, and statement of first law; enthalpy H, relation between heat capacities, calculations of Q, W, ΔU and ΔH for reversible, irreversible and free expansion of gases (ideal and van der Waals) under isothermal and adiabatic conditions. Thermochemistry: Heats of reactions: standard states; enthalpy of formation and enthalpy of combustion and its applications; effect of temperature (Kirchhoff's equations) and pressure on enthalpy of reactions.	10
Unit-IV	**Second Law:** Concept of entropy; thermodynamic scale of temperature, statement of the second law of thermodynamics. Calculation of entropy change for reversible and irreversible processes. Free energy Functions: Gibbs and Helmholtz energy; variation of S, G, A with T, V, P; Free energy change and spontaneity. Relation between Joule-Thomson coefficient and other thermodynamic parameters; inversion temperature; Gibbs-Helmholtz equation; Maxwell relations; thermodynamic equation of state. **Third Law:** Statement of third law, concept of residual entropy, calculation of absolute entropy of molecules. Introduction to Clausius-Clapeyron Equation.	20

LEARNING OUTCOME:

1. Students should be able to draw the phase diagram, and describe the criteria, CST, Gibbs-Duhem-Margules equation.
2. Students should be able to explain the various thermodynamics parameter and processes involved in day-to-day life.

Learning Resources	
Text Book	1. Kapoor, K.L. (Vol. 1 to 5) *Physical Chemistry*, Macmillan. 2. Atkins, P.; Paula, J.P. *Physical Chemistry*, Oxford 3. Zundhal, S.S. *Chemistry concepts and applications* Cengage, India.
Reference Books	4. Barrow, G.M. *Physical Chemistry* Tata McGraw Hill. 5. Castellan, G.W. *Physical Chemistry*. 6. Ball, D. W. *Physical Chemistry* Cengage India. 7. Mortimer, R. G. *Physical Chemistry 3rd Ed.*, Elsevier: NOIDA, UP. 8. Levine, I. N. *Physical Chemistry 6th Ed.*, Tata McGraw-Hill. 9. Metz, C. R. *Physical Chemistry 2nd Ed.*, Tata McGraw-Hill.

		L	**T**	**P**	**C**
Course Code-20CYH-208P	**Subject Name: Inorganic Chemistry Practical-II**	**0**	**0**	**4**	**2**
Course Category-B	**Pre-requisite-**				
	Co-requisite-20CYH-208P				
	Designed –Department of Chemistry				

COURSE OBJECTIVE

1.To understand the iodimetric and complexometric titration.
2. To understand the synthesis of inorganic compounds.

COURSE CONTENT

1. Iodo / Iodimetric Titrations

(i) Estimation of Cu(II) and $K_2Cr_2O_7$ using sodium thiosulphate solution (Iodometrically).

(ii) Estimation of antimony in tartar-emetic iodimetrically.

2.Complexometric titrations using disodium salt of EDTA

(i) Estimation of Mg^{2+}, Zn^{2+}

(ii) Estimation of Ca^{2+} by substitution method

3. Inorganic preparations

(i) Cuprous chloride, Cu_2Cl_2
(ii) Manganese (III) phosphate, $MnPO_4.H_2O$
(iii) Aluminium potassium sulphate $K_2SO_4.Al_2(SO_4)_3.24H_2O$ (Potash alum) or Chrome alum.

LEARNING OUTCOME:

1. Students should be able to apply the concept of iodimetric titration and estimation of metals.
2. Students should be able to the demonstrate the concept and application of complexometric titration and preparations of different inorganic compounds.

Learning Resources	
Text Book	1. Khosla, B. D.; Garg, V. C. & Gulati, A. *Senior Practical Physical Chemistry*, R. Chand & Co.: New Delhi. 2. Ahluwalia, V. K.; Dhingra, S.; Dhingra, S. *College Practical Chemistry*, Universities Press. 3. Pandey, O. P.; Bajpai, D. N.; Giri, S. *Practical Chemistry*, S. Chand Limited.
Reference Books	4. Svehla, G. *Vogel's Qualitative Inorganic Analysis*, Pearson Education. 5. Mendham, J. *Vogel's Quantitative Chemical Analysis*, Pearson.

		L	**T**	**P**	**C**
Course Code- 20CYH-209P	**Subject Name: Organic Chemistry Practical- II**	**0**	**0**	**4**	**2**
Course Category-B	**Pre-requisite- No**				
	Co-requisite-yes				
	Designed –Department of Chemistry				

COURSE OBJECTIVE

1. To understand the qualitative analysis of unknown organic compound.
2. To understand the synthesis of organic compounds by conventional method as well by greener approach.

COURSE CONTENT

1. Qualitative analysis of unknown organic compounds containing simple functional groups (alcohols, carboxylic acids, phenols, carbonyl compounds and esters).

2. Organic preparations:

i. Benzoylation, bromination & nitration of organic compounds.

a. Using conventional method.

b. Using green approach

ii. Acylation of organic compounds.
iii. Iodoform reaction.
iv. Semicarbazone synthesis.

LEARNING OUTCOME:
1. Students should be able to perform the qualitative analysis of unknown organic compounds.
2. Students should be able to prepare different organic compounds by conventional method as well as green approach.

Learning Resources	
Text Book	1. Mann, F.G. & Saunders, B.C. *Practical Organic Chemistry* Orient-Longman. 2. Mendham, J. *Vogel's Quantitative Chemical Analysis*, Pearson. 3. Ahluwalia, V. K.; Dhingra, S.; Dhingra,S. *College Practical Chemistry*, Universities Press.
Reference Books	4. Vogel, A.I., Tatchell, A.R., Furnis, B.S., Hannaford, A.J. & Smith, P.W.G., *Textbook of Practical Organic Chemistry*, Prentice-Hall. 5. Pandey, O.P.; Bajpai, D. N.; Giri, S. *Practical Chemistry*, S. Chand Limited.

		L	**T**	**P**	**C**
Course Code-	**Subject Name: PHYSICAL CHEMISTRY PRACTICAL-III**	**0**	**0**	**4**	**2**
Course Category-B	**Pre-requisite-**				
	Co-requisite-20CYH-210P				
	Designed –Department of Chemistry				

COURSE OBJECTIVE

1.To understand the determination of critical solution temperature and composition.
2. To study the equilibrium of reactions by distribution method.

COURSE CONTENT

1. Phase Equilibria:

I. Determination of critical solution temperature and composition at CST of the phenol-water system and to study the effect of impurities of sodium chloride and succinic acid on it.

II. Phase equilibria: Construction of the phase diagram using cooling curves or ignition tube method: a. simple eutectic and b. congruently melting systems.

III. Distribution of acetic/ benzoic acid between water and chloroform or cyclohexane.

IV. Study the equilibrium of at least one of the following reactions by the distribution method:

(i) I_2 (aq) + I^- (aq) → I_3^- (aq)

(ii) Cu^{2+}(aq) + nNH_3 → $Cu(NH_3)_n^{2+}$

2. pH metric titration:

I. Study the effect of addition of HCl/NaOH on pH to the solutions of acetic acid, sodium acetate and their mixtures.

II. Preparation of buffer solutions of different pH values i.e. sodium acetate-acetic acid

III. pH metric titration of (i) strong acid with strong base, (ii) weak acid with strong base.

(iii) Determination of dissociation constant of a weak acid.

3. Thermochemistry:

(a) Determination of heat capacity of a calorimeter for different volumes using

(i) Change of enthalpy data of a known system (method of back calculation of heat capacity of calorimeter from known enthalpy of solution of sulfuric acid or enthalpy of neutralization)

(ii) Verification of heat law.

(b) Determination of enthalpy of neutralization of hydrochloric acid with sodium hydroxide.

(c) Determination of the enthalpy of ionization of ethanoic acid.

(d) Determination of integral enthalpy (endothermic and exothermic) solution of salts.

LEARNING OUTCOME:

1. Students should be able to determine the critical solution temperature and composition.
2. Students should be able to estimate the equilibrium of reactions by distribution method.
3. Students should be able to explain the effect of heat in reactions.

Learning Resources	
Text Book	1. Khosla, B. D.; Garg, V. C. & Gulati, A. *Senior Practical Physical Chemistry*, R. Chand & Co.: New Delhi. 2. Ahluwalia, V. K.;Dhingra, S.;Dhingra,S. *College Practical Chemistry*, Universities Press. 3. Pandey, O.P.; Bajpai,D. N.; Giri,S.*Practical Chemistry*, S. Chand Limited.

Semester-IV

		L	T	P	C
Course Code-20CYH-213	**Subject Name-Inorganic Chemistry-III**	**4**	**0**	**0**	**4**
Course Category-B	**Pre-requisite-**				
	Co-requisite-20CYH-213				
	Designed –Department of Chemistry				

COURSE OBJECTIVE

1. To understand the chemistry of coordination compounds formation, their properties.
2. To understand the chemistry of transition metal elements, lanthanoides and actinoides
3. To understand the inorganic reaction mechanism and various factors which can influence the rate of reaction.

UNIT	Course contents	Contact Hours
Unit-I	**Coordination Chemistry:** Werner's theory, IUPAC nomenclature of coordination compounds, isomerism in coordination compounds & its types. Stereochemistry of complexes with 4 and 6 coordination numbers. Chelate effect, Labile and inert complexes. Valence bond theory (inner and outer orbital complexes), electroneutrality principle and back bonding. 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.	20
Unit-II	**Transition Elements:** General group trends to electronic configuration, color, variable valency, magnetic and catalytic properties, ability to form complexes. Stability of various oxidation states. Difference between the first, second and third transition series. Chemistry of potassium dichromate, potassium permanganate, potassium ferrocyanide, potassium ferricyanide.	15
Unit-III	**Lanthanoids and Actinoids:** Electronic configuration, oxidation states, color, spectral and magnetic properties, lanthanide contraction, separation of lanthanides (ion-exchange method only).	15

Unit-IV	**Inorganic Reaction Mechanism:** Introduction to Inorganic reaction mechanisms. Substitution reactions in square planar complexes, Trans-effect, theories of trans-effect. Thermodynamic and kinetic stability.	10

LEARNING OUTCOME:

1. Students should be able to describe the basic concept of coordination compounds.
2. Students should be able to identify the properties of transition elements.
3. Students should be able to correlate the electronic configuration with magnetic properties of lanthanoids and actinoids.
4. Students should be able to explain the reaction mechanism of coordination compounds.

Learning Resources	
Text Book	1. G.L. Miessler & Donald A. Tarr: *Inorganic Chemistry,* Pearson Publication. 2. J.D. Lee: *A New Concise Inorganic Chemistry.* 3. Ajai Kumar, *Basic Inorganic Chemistry.* *4.* Ajai Kumar, *Coordination Chemistry.*
Reference Book	5. Huheey, J.E., Keiter, E.A., Keiter, R.L. & Medhi, O.K. *Inorganic Chemistry: Principles of Structure and Reactivity*, Pearson Education India. *6.* Chemistry of the Elements, N.N. Greenwood and A. Earnshaw, Pergamon.

		L	T	P	C
Course Code-20CYH-214	**Subject Name-Organic Chemistry-III**	**4**	**0**	**0**	**4**
Course Category-B	**Pre-requisite-**				
	Co-requisite-20CYH-214				
	Designed –Department of Chemistry				

COURSE OBJECTIVE

1. To understand the preparation and properties of nitrogen containing molecules.
2. To understand the polynuclear hydrocarbons, their structure elucidation and preparation with properties.
3. To impart the knowledge about heterocyclic molecules, methods of preparation and properties of heterocyclic molecules.
4. To impart the knowledge about terpenes and natural occurrence of alkaloids, structure elucidation of few alkaloids and terpenes and their properties.

UNIT	Course contents	Contact Hours
Unit-I	**Nitrogen Containing Functional Groups:** Preparation and properties of nitro compounds, nitriles and isonitriles. **Amines:** Preparation: Gabriel phthalimide synthesis, carbylamine reaction, Mannich reaction, Hoffmann's exhaustive methylation, Hofmann-elimination reaction. Properties: effect of substituent and solvent on basicity distinction between 1°, 2° and 3° amines with Hinsberg reagent and nitrous acid. Diazonium salts: preparation and their synthetic applications.	15
Unit-II	**Polynuclear Hydrocarbons:** Aromaticity of polynuclear hydrocarbons, structure elucidation of naphthalene; Preparation and properties of naphthalene, phenanthrene and anthracene.	10
Unit-III	**Heterocyclic Compounds:** Classification and nomenclature, Structure, aromaticity in 5-numbered and 6-membered rings containing one heteroatom; Synthesis, reactions and mechanism of substitution reactions of: Furan, Pyrrole (Paal-Knorr synthesis, Knorr pyrrole synthesis, Hantzsch synthesis), Thiophene, Pyridine (Hantzsch synthesis), Indole (Fischer indole synthesis and Madelung synthesis), Quinoline and isoquinoline, (Skraup synthesis, Friedlander's synthesis, Knorr quinoline synthesis, Doebner-Miller synthesis, Bischler-Napieralski reaction, Pictet-Spengler reaction, Pomeranz-Fritsch	20

	reaction).	
Unit-IV	**Alkaloids:** Natural occurrence, General structural features, Isolation and their physiological action, Hoffmann's exhaustive methylation, Emde's modification; Structure elucidation and synthesis of Nicotine. Medicinal importance of Nicotine, Hygrine, Quinine, Morphine, Cocaine, and Reserpine. **Terpenes:** Occurrence, classification, isoprene rule; Elucidation of structure and synthesis of Citral.	15

LEARNING OUTCOME:

1. Students should be able to describe the preparation and properties of nitrogen containing molecules.
2. Students should be able to explain about the polynuclear hydrocarbons, their structure elucidation and preparation with properties.
3. Students should be able to discuss the heterocyclic molecules, methods of preparation and properties of heterocyclic molecules.

Learning Resources	
Text Book	1. Morrison, R. T. & Boyd, R. N. *Organic Chemistry*, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education). 2. Finar, I. L. *Organic Chemistry (Volume 1),* Dorling Kindersley (India) Pvt. Ltd. (Pearson Education). 3. Finar, I. L. *Organic Chemistry (Volume 2: Stereochemistry and the Chemistry of Natural Products)*, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education). 4. Kalsi, P. S. *Textbook of Organic Chemistry 1st Ed.*, New Age International (P) Ltd. Pub. 5.
Reference Book	6. Graham Solomons, T.W. *Organic Chemistry*, John Wiley & Sons, Inc. 7. Clayden, Organic Chemistry. 8. Acheson, R.M. *Introduction to the Chemistry of Heterocyclic compounds*, John Welly& Sons.

		L	T	P	C
Course Code-20CYH-215	**Subject Name:PHYSICAL CHEMISTRY IV**	**4**	**0**	**0**	**4**
Course Category-B	**Pre-requisite-**				
	Co-requisite-20CYH-215				
	Designed –Department of Chemistry				

COURSE OBJECTIVE

1. To understand the law of electrolysis, effects of electrolytes on the conductivity, molar conductance etc.
2. To understand the electrochemical cells, their formulation and importance.
3. To get knowledge about the surface chemistry and photochemistry, quantum yields and photosensitizers.

UNIT	Course contents	Contact Hours
Unit-I	**Conductance:** Quantitative aspects of Faraday's laws of electrolysis, Arrhenius theory of electrolytic dissociation. Conductivity, equivalent and molar conductivity and their variation with dilution for weak and strong electrolytes.Molar conductivity at infinite dilution. Kohlrausch law of independent migration of ions.Debye-Hückel-Onsager equation, Wien effect, Debye-Falkenhagen effect, Walden's rules.Ionic velocities, mobilities and their determinations, transference numbers and their relation to ionic mobilities, determination of transference numbers using Hittorf and Moving Boundary methods. Concentration cells with and without transference, liquid junction potential; determination of activity coefficients and transference numbers.Applications of conductance measurement: (i) degree of dissociation of weak electrolytes (ii) ionic product of water (iii) solubility and solubility product of sparingly soluble salts (iv) conductometrictitrations and (v) hydrolysis constants of salts.	20

Unit-II	**Electrochemical Cells:** 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. Application of EMF measurements in determining (i) free energy, enthalpy and entropy of a cell reaction (ii) equilibrium constants and (iii) pH values using hydrogen, quinone-hydroquinone, glass and gold electrodes. Qualitative discussion of potentiometric titrations (acid-base, redox, precipitation).	15
Unit-III	**Surface chemistry:** Physical adsorption, chemisorption, adsorption isotherms (Langmuir and Freundlich), adsorption kinetics, nature of adsorbed state. Qualitative discussion of BET, application of BET theory and Langmuir adsorption.	10
Unit-IV	**Photochemistry:** Characteristics of electromagnetic radiation, Lambert-Beer's law and its limitations, physical significance of absorption coefficients. Laws, of photochemistry, quantum yield, actinometry, examples of low and high quantum yields, photochemical equilibrium and the differential rate of photochemical reactions, photosensitized reactions, quenching. Role of photochemical reactions in biochemical processes, photostationary states, chemiluminescence.	15

LEARNING OUTCOME:

1. Students should be able to explain the chemistry of conductance and its variation with dilution, migration of ions in solutions.
2. Students should be able to demonstrate the applications of conductance measurements.
3. Students should be able to formulate the rate law and rate of reaction, theories of reaction rates and catalysts; both chemical and enzymatic.
4. Students should be able to describe the laws of absorption of light energy by molecules and the subsequent photochemical reactions.

Learning Resources

Text Book	1. Atkins, P.W.& Paula, J.D. *Physical Chemistry, 9th Ed.*, Oxford University Press. 2. Castellan, G. W. *Physical Chemistry 4th Ed.*, Narosa. 3. Mortimer, R. G. *Physical Chemistry 3rd Ed.*, Elsevier: NOIDA, UP.
Reference Book	4. Barrow, G. M. *Physical Chemistry 5th Ed.*, Tata McGraw Hill: New Delhi. 5. Engel, T. & Reid, P. *Physical Chemistry 3rd Ed.*, Prentice-Hall. 6. Rogers, D. W. *Concise Physical Chemistry* Wiley. 7. Bockris Reddy, Modern Electrochemistry volume 1 and 2A.

		L	T	P	C
Course Code-	**Subject Name:INORGANIC CHEMISTRY PRACTICAL- III**	**0**	**0**	**4**	**2**
Course Category-B	**Pre-requisite-**				
	Co-requisite-20CYH-213P				
	Designed –Department of Chemistry				

COURSE OBJECTIVE

1. To understand the gravimetric analysis of different transition metals.
2. To understand the properties of transition metal complexes by practically.

UNIT	Course contents	Contact Hours
	1. Gravimetric Analysis: i. Estimation of nickel (II) using Dimethylglyoxime (DMG). ii. Estimation of copper as CuSCN iii. Estimation of iron as Fe_2O_3 by precipitating iron as $Fe(OH)_3$. iv. Estimation of Al(III) by precipitating with oxine and weighing as $Al(oxine)_3$ (aluminiumoxinate). **2. Inorganic Preparations:** i. Tetraamminecopper (II) sulphate, $[Cu(NH_3)_4]SO_4.H_2O$ ii. Acetylacetonate complexes of Cu^{2+}/Fe^{3+} iii. Tetraamminecarbonatocobalt (III) nitrate iv. Potassium tri(oxalato)ferrate(III) **3. Properties of Complexes** i. Measurement of 10 Dq by spectrophotometric method ii. Verification of spectrochemical series. iii. Synthesis of ammine complexes of Ni(II) and its ligand exchange reactions (e.g.bidentate ligands like acetylacetone, DMG, glycine) by substitution method.	30

LEARNING OUTCOME:

1. Students should be able to execute gravimetric analysis of different transition metals.
2. Students should be able to explain the properties of transition metal complexes experimentally.
3. Students should be able to demonstrate how to prepare coordination compounds.

Learning Resources	
Text Book	1. Vogel,A.I. *Quantitative Chemical Analysis*, Prentice Hall. 2. Ahluwalia, V. K.; Dhingra, S.;Dhingra,S. *College Practical Chemistry*, Universities Press. 3. Pandey, O.P.;Bajpai, D. N.; Giri,S.*Practical Chemistry*, S. Chand Limited.

		L	T	P	C
Course Code-	**Subject Name: Organic Chemistry Practical -III**	**0**	**0**	**4**	**2**
Course Category-B	**Pre-requisite-**				
	Co-requisite-20CYH-214P				
	Designed –Department of Chemistry				

COURSE OBJECTIVE

1. To understand the Qualitative analysis of unknown organic compounds containing simple functional groups.
2. Have the practical experience about organic preparation and selective reduction.

UNIT	Course contents	Contact Hours
	1. Qualitative analysis of unknown organic compounds containing simple functional groups (nitro, amine, amide and halogen groups). 2. Organic preparations: i. Selective reduction of m-dinitrobenzene to m-nitroaniline. ii. Hydrolysis of amides and esters. iii. Aldol condensation using either conventional or green method.	30

LEARNING OUTCOME:

1. Students should be able to perform qualitative analysis of unknown organic compounds containing simple functional groups.

2. Students should be able to employ the practical experience about organic preparation and selective reduction.

Learning Resources	
Text Book	1. Mann, F.G.; Saunders, B.C. *Practical Organic Chemistry*, Pearson Education. 2. Furniss, B.S.; Hannaford, A.J.; Smith, P.W.G.; Tatchell, A.R. *Practical Organic Chemistry, 5th Ed.*, Pearson. 3. Ahluwalia, V. K.;Aggarwal, R. *Comprehensive Practical Organic Chemistry: Preparation and Quantitative Analysis*, Universities Press. 4. Ahluwalia, V.K.;Dhingra, S. *Comprehensive Practical Organic Chemistry: Qualitative Analysis*, Universities Press.

		L	T	P	C
Course Code-	**Subject Name: Physical Chemistry Practical-IV**	**0**	**0**	**4**	**2**
Course Category-B	**Pre-requisite-**				
	Co-requisite-20CYH-215P				
	Designed –Department of Chemistry				

COURSE OBJECTIVE

1. To understand the determination of cell constant and conductivity by conduct meter.
2. To understand the working principle of pH meter by different combination of acid, base and buffer solutions.

UNIT	Course contents	Contact Hours
	1. Conductometry: I. Determination of cell constant II. Determination of conductivity, molar conductivity, degree of dissociation and dissociation constant of a weak acid. III. Conductometric titrations: (i) To determine the strength of unknown strong acid conductometrically using strong base. (ii) To determine the strength of unknown weak acid conductometrically using strong base. (iii) To determine the strength of unknown mixture of strong acid and weak acid conductometrically using strong base. (iv) To determine the strength of unknown strong acid conductometrically using weak base.	30

	2. Potentiometry: (i) To determine the strength of unknown strong acid potentiometrically using strong base. (ii) To determine the strength of unknown weak acid potentiometrically using strong base. (iii) To determine the strength of unknown dibasic acid potentiometrically using strong base. **3. Adsorption** Verify the Freundlich and Langmuir isotherms for adsorption of acetic acid on activated charcoal.	

LEARNING OUTCOME:

1. Students should be able to determine the cell constant and conductivity by conduct meter.
2. Students should be able to describe the concept of buffer solution and working principle of pH meter and its applications.
3. Students should be able to study the adsorption properties of some acids.

Learning Resources	
Text Book	1. Khosla, B. D.; Garg, V. C. & Gulati, A. *Senior Practical Physical Chemistry*, R. Chand & Co.: New Delhi. 2. Ahluwalia, V. K.;Dhingra, S.;Dhingra,S. *College Practical Chemistry*, Universities Press. 3. Pandey, O.P.;Bajpai,D. N.; Giri,S.*Practical Chemistry*, S. Chand Limited.

Semester-V

		L	T	P	C
Course Code-	**Subject Name: Inorganic Chemistry-IV**	**4**	**0**	**0**	**4**
Course Category-B	**Pre-requisite-**				
	Co-requisite-20CYH-218				
	Designed –Department of Chemistry				

COURSE OBJECTIVE

1. To understand about the formation of transition metal complexes, their properties and bonding.
2. To understand the concept of 18-electron rule, bonding metal carbonyls, structure, properties and their preparation.
3. To understand the bioinorganic chemistry, importance of inorganic elements for human beings.
4. To understand the concept of iron and electron transport and storage.

UNIT	Course contents	Contact Hours
Unit-I	**Zeise's salt:** Preparation and structure, evidences of synergic effect and comparison of synergic effect with that in carbonyls. **Metal Alkyls:** Important structural features of methyl lithium (tetramer) and trialkylaluminium (dimer), concept of multicentre bonding in these compounds. **Ferrocene:** Preparation and reactions (acetylation, alkylation, metallation, Mannich condensation). Structure and aromaticity. Comparison of aromaticity and reactivity with that of benzene.	15

Unit-II	**Organometallic Compounds:** Definition and classification of organometallic compounds on the basis of bond type. Concept of hapticity of organic ligands. Metal carbonyls: 18 electron rule, electron count of mononuclear, polynuclear and substituted metal carbonyls of 3d series. General methods of preparation (direct combination, reductive carbonylation, thermal and photochemical decomposition) of mono and binuclear carbonyls of 3d series. Structures of mononuclear and binuclear carbonyls of Cr, Mn, Fe, Co and Ni using VBT. π-acceptor behavior of CO (MO diagram of CO to be discussed), synergic effect and use of IR data to explain extent of back bonding.	20
Unit-III	**Catalysis by Organometallic Compounds:** Study of the following industrial processes and their mechanism: 1. Alkene hydrogenation (Wilkinson's Catalyst) 2. Synthetic gasoline (Fischer Tropsch reaction) 3. Polymerisation of ethene using Ziegler-Natta catalyst	10
Unit-IV	**Bioinorganic Chemistry:** Metal ions present in biological systems, classification of elements according to their action in biological system. Geochemical effect on the distribution of metals. Sodium / K-pump, carbonic anhydrase and carboxypeptidase. Excess and deficiency of some trace metals. Toxicity of metal ions (Hg, Pb, Cd and As), reasons for toxicity, Use of chelating agents in medicine, Cisplatin as an anti-cancer drug. Iron and its application in bio-systems, Haemoglobin, Myoglobin; Storage and transfer of iron.	15

LEARNING OUTCOME:

1. Students should be able to discuss the nature of Zeise's salt and compare its synergic effect with that of carbonyls.
2. Students should be able to identify important structural features of the metal alkyls tetrameric methyl lithium and dimeric trialkyl aluminium and explain the concept of multicenter bonding in these compounds.
3. Students should be able to diagrammatically explain the working of the sodium-potassium pump in organisms and the factors affecting it and understand and describe the

active sites and action cycles of the metallo-enzymes carbonic anhydrase and carboxypeptidase.

4. Students should be able to explain the use of chelating agents in medicine and, specifically, the role of cisplatin in cancer therapy and explain the applications of iron in biological systems with particular reference to haemoglobin, myoglobin, ferritin and transferrin.
5. Students should be able to describe the idea of catalysis and describe in detail the mechanism of Wilkinson's catalyst, Zeigler- Natta catalyst and synthetic gasoline manufacture by Fischer-Tropsch process.

Learning Resources	
Text Book	1. Huheey, J. E.; Keiter, E.; Keiter,R. *Inorganic Chemistry: Principles of Structure and Reactivity,* Pearson Publication. 2. Kumar, A.; *Organometallic & Bioinorganic Chemistry,*Aaryush education. 3. Lee,J.D. *A New Concise Inorganic Chemistry.* 4. Cotton,F.A.;Wilkinson,G. *Basic Inorganic Chemistry*, John Wiley & Sons.
Reference Books	5. Miessler,G. L.; Tarr,D. A. *Inorganic Chemistry*, Pearson Publication. 6. Ivano Bertini & Harry B. Gray Bioinorganic Chemistry

		L	T	P	C
Course Code-20CYH-219	**Subject Name: ORGANIC CHEMISTRY -V**	**4**	**0**	**0**	**4**
Course Category-B	**Pre-requisite- No**				
	Co-requisite-20CYH-219				
	Designed –Department of Chemistry				

COURSE OBJECTIVE

1.To impart the knowledge about nucleic acid components, amino acids, peptides and proteins and their preparation and importance.
2. To understand about enzymes, mechanism of their action.
3. To understand the chemistry of oils, fats and carbohydrates and their importance.

UNIT	Course contents	Contact Hours
Unit-I	**Nucleic Acids:** Components of nucleic acids, Nucleosides and nucleotides; Structure, synthesis and reactions of: Adenine, Guanine, Cytosine, Uracil and Thymine; Structure of polynucleotides (DNA and RNA). **Amino Acids, Peptides and Proteins:** Amino acids, Peptides and their classification. α-Amino Acids - Synthesis, ionic properties and reactions. Zwitter ions, pKa values, isoelectric point and electrophoresis; Study of peptides: determination of their primary structures-end group analysis, methods of peptide synthesis. Synthesis of peptides using *N*-protecting, *C*-protecting and *C*-activating	20

	groups, Solid-phase synthesis; primary, secondary and tertiary structures of proteins, Protein denaturation.	
Unit-II	**Enzymes:** Introduction, classification and characteristics of enzymes. Salient features of active sites of enzymes. Mechanism of enzyme action (trypsin only), factors affecting enzyme action, coenzymes and cofactors, specificity of enzyme action (including stereospecificity), enzyme inhibitors and their importance. **Lipids:** Introduction to oils and fats; common fatty acids present in oils and fats, Hydrogenation of fats and oils, Saponification value, acid value, iodine number. Reversion and rancidity.	15
Unit-III	**Concept of energy in biosystems:** Source of energy (organic molecules). Introduction to metabolism (catabolism, anabolism).ATP: The universal currency of cellular energy, ATP hydrolysis and free energy change. Agents for transfer of electrons in biological redox systems: NAD^+, FAD. Conversion of food to energy: Outline of catabolic pathways of carbohydrate- glycolysis, fermentation, Krebs cycle. Calorific value of food, standard calorific content of food types.	10
Unit-IV	**Carbohydrates:** Occurrence, classification and their biological importance. Monosaccharides: Constitution and absolute configuration of glucose and fructose, epimers and anomers, mutarotation, determination of ring size of glucose and fructose, Haworth projections and conformational structures; Interconversions of aldoses and ketoses; Killiani- Fischer synthesis and Ruff degradation; Disaccharides - Structure elucidation of maltose, lactose and sucrose. Polysaccharides -Elementary treatment of starch, cellulose and glycogen.	15

LEARNING OUTCOME:

1. Students should be able to demonstrate how structure of biomolecules determines their reactivity and biological functions.

2. Students should be able to describe the concepts of heredity through the study of genetic code, replication, transcription and translation.
3. Students should be able to interpret the metabolic pathways, their inter-relationship, regulation and energy production from biochemical processes.

Learning Resources	
Text Books	1. Finar, I. L. *Organic Chemistry* (*Volume 1*), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education). 2. Finar, I. L. *Organic Chemistry* (*Volume 2)*, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education). 3. Nelson, D. L. & Cox, M. M. *Lehninger's Principles of Biochemistry*, W. H.Freeman.
Reference Books	4. Berg, J.M., Tymoczko, J.L. &Stryer, L. *Biochemistry*, W.H. Freeman. 5. Clayden, J.; Greeves, N.; Warren, S.; Wothers, P.; *Organic Chemistry*, Oxford University Press.

		L	T	P	C
Course Code-	**Subject Name: Physical Chemistry-V**	**4**	**0**	**0**	**4**
Course Category-B	**Pre-requisite-**				
	Co-requisite-20CYH-220				
	Designed –Department of Chemistry				

COURSE OBJECTIVE

1. To impart the knowledge about the interaction of electromagnetic radiation with molecule and spectra of molecules.
2. To understand the concept of various spectroscopies, their principles, selection rules and spectra.

UNIT	Course contents	Contact Hours
Unit-I	**Molecular Spectroscopy:** Interaction of electromagnetic radiation with molecules and various types of spectra; Born Oppenheimer approximation. **Rotation spectroscopy:** Selection rules, intensities of spectral lines, determination of bond lengths of diatomic and linear triatomic molecules, isotopic substitution.	15
Unit-II	**Vibrational spectroscopy:** Classical equation of vibration, computation of force constant, amplitude of diatomic molecular vibrations, anharmonicity, Morse potential, dissociation energies, fundamental frequencies, overtones, hot bands, degrees of freedom for polyatomic molecules, modes of vibration, concept of group frequencies.	15

	Vibration-rotation spectroscopy: diatomic vibrating rotator, P, Q, R branches.	
Unit-III	**Raman spectroscopy:** Qualitative treatment of Rotational Raman effect; Effect of nuclear spin, Vibrational Raman spectra, Stokes and anti-Stokes lines; their intensity difference, rule of mutual exclusion. **Electronic spectroscopy:** Franck-Condon principle, electronic transitions, singlet and triplet states, fluorescence and phosphorescence, dissociation and predissociation, calculation of electronic transitions of polyenes using free electron model.	15
Unit-IV	**Nuclear Magnetic Resonance (NMR) spectroscopy:** Principles of NMR spectroscopy, Larmor precession, chemical shift and low resolution spectra, different scales (δ and T), spin-spin coupling and high resolution spectra, interpretation of PMR spectra of organic molecules. **Electron Spin Resonance (ESR) spectroscopy**: Principle, hyperfine structure, ESR of simple radicals.	15

LEARNING OUTCOME:

1. Students should be able to describe the concepts behind different types of spectroscopy.
2. Students should be able to apply the concepts of spectroscopy in explaining the properties of molecules.
3. Students should be able to interpret various types of spectra and know about their application in structure elucidation.

Learning Resources	
Text Book	1. Banwell, C. N.; McCash, E. M. *Fundamentals of Molecular Spectroscopy 4th Ed.* Tata McGraw-Hill: New Delhi. 2. Chandra, A. K. *Introductory Quantum Chemistry* Tata McGraw-Hill. 3. Kakkar, R. *Atomic & Molecular Spectroscopy*, Cambridge University Press.
Reference Books	4. House, J. E. *Fundamentals of Quantum Chemistry 2nd Ed.* Elsevier: USA. 5. Lowe, J. P.; Peterson, K. *Quantum Chemistry*, Academic Press.

		L	T	P	C
Course Code-20CYH-218P	**Subject Name: Inorganic Chemistry Practical-IV**	**0**	**0**	**4**	**2**
Course Category-B	**Pre-requisite-**				
	Co-requisite-20CYH-218P				
	Designed –Department of Chemistry				

COURSE OBJECTIVE:

1. To understand the qualitative semi-micro analysis of acid and basic radicals.
2. To understand the working principle of paper chromatography.

UNIT	Course contents	Contact Hours
	1. Qualitative semimicro analysis of mixtures containing two anions and two cations. Acid radicals Basic radicals Group I, II, III, IV, V, VI **2**. Paper chromatographic separation of following metal ions: i. Ni (II) and Co (II) ii. Cu(II) and Cd(II)	30

LEARNING OUTCOME:

1. Students should be able to perform qualitative semi-micro analysis of acid and basic radicals.
2. Students should be able to describe the working principle of paper chromatography.

Learning Resources	
Text Books	1. Vogel, A.I. *Qualitative Inorganic Analysis*, Prentice Hall. 2. Vogel, A.I. *Quantitative Chemical Analysis*, Prentice Hall. 3. Ahluwalia, V. K.; Dhingra, S.; Dhingra, S. *College Practical Chemistry*, Universities Press. 4. Pandey, O.P.; Bajpai,D. N.; Giri,S. *Practical Chemistry*, S. Chand Limited.

		L	T	P	C
Course Code-	**Subject Name: Organic Chemistry Practical-IV**	**0**	**0**	**4**	**2**
Course Category-B	**Pre-requisite- No**				
	Co-requisite-20CYH-219P				
	Designed –Department of Chemistry				

COURSE OBJECTIVE:

1.Have idea about hoe to estimate of amino acids and their isoelectric point.
2. Have knowledge about how to characterize DNA from peas and cauliflower.

UNIT	Course contents	Contact Hours
	1. Estimation of glycine by Sorenson's formalin method. **2**. Determination of isoelectric point of glycine by titration. **3**. Estimation of proteins by Lowry's method. **4**. Study of the action of salivary amylase on starch at optimum conditions. **5**. Effect of temperature on the action of salivary amylase. **6**. Saponification value of an oil or a fat. **7**. Determination of Iodine number of an oil/ fat. **8**. Isolation and characterization of DNA from onion/ cauliflower/peas.	30

LEARNING OUTCOME:

1. Students should be able to estimate the amino acids and their isoelectric point.

2. Students should be able to execute isolation and characterization of DNA from peas and cauliflower.
3. Students should be able to explain the effect of temperature on enzyme and saponification value of oil or a fat.

Learning Resources	
Text Books	1. Arthur, I. V. *Quantitative Organic Analysis*, Pearson. 2. Damodaran Geetha K Practical Biochemistry 3. Joshi A. Rashmi A Textbook of Practical Biochemistry

		L	**T**	**P**	**C**
Course Code-20CYH-220P	**Subject Name: Physical Chemistry Practical-V**	**0**	**0**	**4**	**2**
Course Category-B	**Pre-requisite-**				
	Co-requisite-20CYH-220P				
	Designed –Department of Chemistry				

COURSE OBJECTIVE

1. To understand the working principle of Colorimetry.
2. To understand the adsorption by Freundlich and Langmuir isotherm.
3. To understand the working principle of UV-Visible spectrum.

UNIT	Course contents	Contact Hours
	1. Colorimetry: I. Verify Lambert-Beer's law and determine the concentration of $CuSO_4$/$KMnO_4$/$K_2Cr_2O_7$ in a solution of unknown concentration II. Determine the concentrations of $KMnO_4$ and $K_2Cr_2O_7$ in a mixture. III. Study the kinetics of iodination of propanone in acidic medium. IV. Determine the amount of iron present in a sample using 1, 10-phenathroline. V. Determine the dissociation constant of an indicator (phenolphthalein). VI. Study the kinetics of interaction of crystal violet/ phenolphthalein with sodium hydroxide.	30

	VII. Analysis of the given vibration-rotation spectrum of HCl(g). **2. UV/Visible spectroscopy:** I. Study the absorbance spectra of $KMnO_4$ and $K_2Cr_2O_7$ (in 0.1 M H_2SO_4) and determine the λmax values. Calculate the energies of the two transitions in different units (J molecule^{-1}, kJ mol^{-1}, cm^{-1}, eV). II. Study the pH-dependence of the UV-Vis spectrum of $K_2Cr_2O_7$. III. Record the UV spectra of the given compounds (acetone, acetaldehyde, 2-propanol, acetic acid) in water.	

LEARNING OUTCOME:

1. Students should be able to determine the concentration of unknown solution of $CuSO_4$/$KMnO_4$/$K_2Cr_2O_7$.
2. Students should be able to calculate λ^{max} values and J values.
3. Students should be able to calculate dissociation constant of indicators.

Learning Resources	
Text Book	1. Khosla, B. D.; Garg, V. C.; Gulati, A. *Senior Practical Physical Chemistry*, R. Chand & Co. 2. Garland, C. W.; Nibler, J. W.; Shoemaker, D. P. *Experiments in Physical Chemistry*, McGraw-Hill: New York. 3. Halpern, A. M.; McBane, G. C. *Experimental Physical Chemistry*, W.H. Freeman & Co.: New York.

Semester-VI

		L	T	P	C
Course Code-20CYH-222	**Subject Name: Organic Chemistry-V**	**4**	**0**	**0**	**4**
Course Category-B	**Pre-requisite-**				
	Co-requisite-20CYH-222				
	Designed –Department of Chemistry				

COURSE OBJECTIVE

1. Students should be able to describe the concept of various spectroscopies.
2. Students should be able to explain the different types of dyes and their preparations and structure elucidation.
3. Students should be able to discuss polymer classification, preparation and properties.

UNIT	Course contents	Contact Hours
Unit-I	**Organic Spectroscopy:** General principles Introduction to absorption and emission spectroscopy. **UV Spectroscopy:** Types of electronic transitions, λ_{max}, Chromophores and Auxochromes, Bathochromic and Hypsochromic shifts, Intensity of absorption; Application of Woodward Rules for calculation of λ_{max} for the following systems: α,β-unsaturated aldehydes, ketones, carboxylic acids and esters; Conjugated dienes: alicyclic, homoannular and heteroannular; Extended conjugated systems (aldehydes, ketones and dienes); distinction between cis and trans isomers.	15

Unit-II	**IR Spectroscopy:** Fundamental and non-fundamental molecular vibrations; IR absorption positions of O, N and S containing functional groups; Effect of H-bonding, conjugation, resonance and ring size on IR absorptions; Fingerprint region and its significance; application in functional group analysis. **NMR Spectroscopy:** Basic principles of Proton Magnetic Resonance, chemical shift and factors influencing it; Spin-Spin coupling and coupling constant; Anisotropic effects in alkene, alkyne, aldehydes and aromatics, Interpretation of NMR spectra of simple compounds. Applications of IR, UV and NMR for identification of simple organic molecules	15
Unit-III	**Dyes:** Classification, Color and constitution; Mordant and Vat Dyes; Chemistry of dyeing; Synthesis and applications of: Azo dyes – Methyl orange; Triphenyl methane dyes -Malachite green and Rosaniline; Phthalein Dyes- Phenolphthalein; Natural dyes –structure elucidation and synthesis of Alizarin and Indigotin; Edible Dyes with examples.	10
Unit-IV	**Polymers:** Introduction and classification including di-block, tri-block and amphiphilic polymers; Polymerisation reactions -Addition and condensation -Mechanism of cationic, anionic and free radical addition polymerization; Metallocene-based Ziegler-Natta polymerisation of alkenes; Preparation and applications of plastics – thermosetting (phenol-formaldehyde, Polyurethanes) and thermosoftening (PVC, polythene); Fabrics – natural and synthetic (acrylic, polyamido, polyester); Rubbers – natural and synthetic: Buna-S, Chloroprene and Neoprene; Vulcanization; Polymer additives; Introduction to Biodegradable and conducting polymers with examples.	20

LEARNING OUTCOME:

1. Students should be able to describe the basic principles of UV, IR and NMR spectroscopic techniques.
2. Students should be able to apply spectroscopic techniques to determine structure and stereochemistry of known and unknown compounds.

3. Students should be able to analyze the structure of Pharmaceutical Compounds. They will also understand the importance of different classes of drugs and their applications for treatment of various diseases.
4. Students should be able to explain the chemistry of natural and synthetic polymers including fabrics and rubbers.
5. Students should be able to discuss the chemistry of biodegradable and conducting polymers and appreciate the need of biodegradable polymers with emphasis on basic principles.
6. Students should be able to apply the theory of colour and constitution as well as the chemistry of dyeing and demonstrate the applications of various types of dyes including those in foods and textiles.

Learning Resources	
Text Books	1. Kalsi, P. S. *Textbook of Organic Chemistry 1st Ed.*, New Age International (P) Ltd. Pub. 2. Morrison, R. T.; Boyd, R. N. *Organic Chemistry*, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education). 3. Billmeyer, F. W. *Textbook of Polymer Science*, John Wiley & Sons, Inc. 4. Gowariker, V. R.; Viswanathan, N. V.; Sreedhar, J. *Polymer Science*, New Age International (P) Ltd. Pub. 5. Finar, I. L. *Organic Chemistry (Volume 2: Stereochemistry and the Chemistry of Natural Products)*, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
Reference Books	6. Solomons, G.*Organic Chemistry*, John Wiley & Sons, Inc. 7. Clayden, J.; Greeves, N.; Warren, S.; Wothers, P.; *Organic Chemistry*, Oxford University Press. 8. Singh, J.; Ali, S.M.; Singh, J. *Natural Product Chemistry*, PragatiPrakashan. 9. Kemp, W. *Organic Spectroscopy*, Palgrave.

		L	T	P	C
Course Code-20CYH-223	**Subject Name: Physical Chemistry-VI**	**4**	**0**	**0**	**4**
Course Category-B	**Pre-requisite-**				
	Co-requisite-20CYH-223				
	Designed –Department of Chemistry				

COURSE OBJECTIVE:

1. To understand the concept of quantum chemistry, setting up of Schrödinger equation for various systems.
2. To understand the concept of bonding and antibonding orbitals, Qualitative description of LCAO-MO treatment of homo-nuclear and heteronuclear diatomic molecules.

UNIT	Course contents	Contact Hours
Unit-I	**Quantum Chemistry:** Postulates of quantum mechanics, quantum mechanical operators and commutation rules, Hermition operator, Hamiltonian operator, Schrödinger equation and its application to free particle and particle-in-a-box (rigorous treatment), quantization of energy levels, zero-point energy and Heisenberg Uncertainty principle; wave functions, probability distribution functions, nodal properties, Extension to two- and three-dimensional boxes, separation of variables, degeneracy.	15
Unit-II	**Qualitative treatment of simple harmonic oscillator model of vibrational motion:** Setting up of Schrödinger equation and discussion of solution and wave functions. Vibrational energy of diatomic molecules and zero-point	15

	energy. Angular momentum. Rigid rotator model of rotation of diatomic molecule. Schrödinger equation in Cartesian and spherical polar. Separation of variables. Spherical harmonics. Discussion of solution (Qualitative).	
Unit-III	**Qualitative treatment of hydrogen atom and hydrogen-like ions:** Setting up of Schrödinger equation in spherical polar coordinates, radial part, quantization of energy (only final energy expression). Average and most probable distances of electron from nucleus. Setting up of Schrödinger equation for many-electron atoms (He, Li). Need for approximation methods. Statement of variation theorem and application to simple systems (particle-in-a-box, harmonic oscillator, hydrogen atom).	15
Unit-IV	**Chemical bonding:** Covalent bonding, valence bond and molecular orbital approaches, LCAO-MO treatment of H_2^+. Bonding and anti-bonding orbitals. Qualitative extension to H_2. Comparison of LCAO-MO and VB treatments of H_2 (only wave functions, detailed solution not required) and their limitations. Refinements of the two approaches (Configuration Interaction for MO, ionic terms in VB). Qualitative description of LCAO-MO treatment of homonuclear and heteronuclear diatomic molecules (HF, LiH).	15

LEARNING OUTCOME:

1. Students should be able to describe the limitations of classical mechanics and solutions in terms of quantum mechanics for atomic/molecular systems.
2. Students should be able to explain the quantum mechanical operators, quantization, probability distribution, uncertainty principle and application of quantization to spectroscopy.
3. Students should be able to classify molecular orbitals and arrangement in chemical bonding.

Learning Resources

Text Books	1. Principles of Physical Chemistry, Puri, Sharma & Pathania, Vishal Pub. 2. Advanced Physical Chemistry, Gurtu &Gurtu, A Pragati Edition. 3. Physical Chemistry, P.W. Atkins, Oxford University Press. 4. Introductory Quantum Chemistry, A.K. Chandra, Tata McGraw Hill. 5. Quantum Chemistry, I.M. Levine, Prentice Hall.
Reference Books	6. Quantum Mechanics, M.L. Strause, Prentice – Hall 7. Quantum Chemistry, J. P. Lowe & K. Peterson, Academic Press (2005). 8. Molecular Quantum Mechanics, P.W. Atkins & R.S. Friedman, 3rd Ed. Oxford University Press (1997).

		L	T	P	C
Course Code-20CYH-222P	**Subject Name: Organic Chemistry Practical-V**	**0**	**0**	**4**	**2**
Course Category-B	**Pre-requisite-**				
	Co-requisite-20CYH-222P				
	Designed –Department of Chemistry				

COURSE OBJECTIVE:

1. To understand the extraction of caffeine and preparation of polymer.
2. To understand the interpretation of IR spectra and NMR spectra.

UNIT	Course contents	Contact Hours
	1. Extraction of caffeine from tea leaves. 2. Preparation of urea formaldehyde resin. 3.Qualitative analysis of unknown organic compounds containing mono-functional groups (carbohydrates, aryl halides, aromatic hydrocarbons, nitro compounds, amines and amides) and simple bifunctional groups, e.g. salicylic acid, cinnamic acid, nitrophenols etc. 4. Interpretation of IR spectra and NMR spectra (Spectra to be provided). 5. Preparation of methyl orange.	30

LEARNING OUTCOME:

1. Students should be able to demonstrate the practical knowledge about how to extract of caffeine from tea leaves and how to prepare of polymer.
2. Students should be able to interpret IR spectra and NMR spectra of various molecules.

Learning Resources	
Text Books	1. Vogel, A.I. *Quantitative Organic Analysis*, Part 3, Pearson. 2. Mann, F.G.; Saunders, B.C. *Practical Organic Chemistry*, Pearson Education. 3. Ahluwalia, V.K.; Aggarwal, R. *Comprehensive Practical Organic Chemistry: Preparation and Quantitative Analysis*, University Press. 4. Ahluwalia, V.K.; Dhingra, S. *Comprehensive Practical Organic Chemistry: Qualitative Analysis*, Universities Press.

		L	**T**	**P**	**C**
Course Code-20CYH-223P	**Subject Name: PHYSICAL CHEMISTRY PRACTICAL-VI**	**0**	**0**	**4**	**2**
Course Category-B	**Pre-requisite-**				
	Co-requisite-20CYH-223P				
	Designed –Department of Chemistry				

COURSE OBJECTIVE:

1. To understand basic concept about how to prepare nanoparticles by different approaches.
2. To learn the how to synthesize of micelles and inverse micelles.

UNIT	Course contents	Contact Hours
	1. To prepare metallic nanoparticles using chemical reduction method using stabilizer. 2. To prepare metallic nanoparticles using greener approaches. 3. To prepare bimetallic nanoparticles using chemical	30

	reduction method using stabilizer. 4. To prepare metallic nanoparticles of different sizes using reducing agents of different strengths. 5. To prepare metallic nanoparticles of different colours by varing concentration of reducing agents 6. Absorption study of nano particles using UV-Vis spectroscopy. 7. Synthesis of micelles and inverse micelles. 8. To prepare metallic nanoparticles using reverse micelles method.	

LEARNING OUTCOME:

1. Students should be able to synthesize nanoparticles by applying different methods.
2. Students should be able to demonstrate the preparation of micelles and inverse micelles and metallic nanoparticles using reverse micelles method.

Learning Resources	
Text Books	1. Edelstein A S and Cammarata R C, Taylor and Francis, 2012, Nanomaterials: Synthesis, Properties and Applictions" 2. T. Pradeep, McGraw Hill Education (India) Private Limited:, 2012, Textbook of Nanoscience and Nanotechnology

General Elective courses

20CYH-203A	**Subject Name-GE-I (THERMAL PHYSICS)**	**4**	**0**	**0**	**4**
Course Category-B	**Pre-requisite-**				
	Co-requisite-20CYH-203A				
	Designed –Department of Physics				

COURSE OBJECTIVE

To make the student familiar with

1. The concepts of thermal physics
2. The zeroth, first and second laws of thermodynamics
3. Heat engines
4. The kinetic theory of gasses
5. Entropy
6. The basis of statistical mechanics

UNIT	Course contents	Contact Hours

Unit-I	**Kinetic Theory of Gases:** Maxwell-Boltzmann distribution Law of distribution of velocities in an ideal gas and its experimental verification, Mean, RMS and Most Probable Speeds. Degrees of Freedom. Law of Equipartition of Energy (No proof required). Specific heats of Gases; mono-atomic and diatomic gases. Mean Free Path. Collision Probability. Transport Phenomenon in Ideal Gases: (1) Viscosity, (2) Thermal Conductivity and (3) Diffusion. Brownian Motion and its Significance.	10
Unit-II	**Real Gas:** Behavior of Real Gases; Deviations from the Ideal Gas Equation. The Virial Equation. Andrew's Experiments on CO_2 Gas. Critical Constants. Continuity of Liquid and Gaseous State. Vapour and Gas. Boyle Temperature. Van der Waal's Equation of State for Real Gases. Values of Critical Constants. Law of Corresponding States. Comparison with Experimental Curves. P-V Diagrams. Joule's Experiment. Free Adiabatic Expansion of a Perfect Gas. Joule-Thomson Porous Plug Experiment. Joule-Thomson Effect for Real and Van der Waal Gases. Temperature of Inversion. Joule-Thomson Cooling.	10
Unit-III	**Laws of Thermodynamic:** Thermodynamic Description of system: Zeroth Law of thermodynamics and temperature. First law and internal energy. Conversion of Heat into Work, Various Thermodynamic Processes, Applications of First Law: General Relation between C_P and C_V, Work Done during Isothermal and Adiabatic Processes. Compressibility and Expansion Coefficients. Second law: Reversible and Irreversible process with examples. Conversion of Work into Heat and Heat into Work. Heat Engines. Carnot's Cycle, Carnot engine & efficiency. Kelvin-Planck and Clausius Statements and their Equivalence. Carnot's Theorem. Applications of Second Law of Thermodynamics: Thermodynamic Scale of Temperature and its Equivalence to Perfect Gas Scale.	20
Unit-IV	**Entropy**: Concept of Entropy, Clausius Theorem. Clausius Inequality, Second Law of Thermodynamics in terms of Entropy. Entropy of a perfect gas. Principle of Increase of Entropy. Entropy Changes in Reversible and Irreversible processes with examples. Entropy of the Universe. Temperature–Entropy diagrams for Carnot's Cycle. Third Law of Thermodynamics. Unattainability of Absolute	10

	Zero.	
Unit-V	**Maxwell Equations:** Thermodynamic functions: Internal Energy, Enthalpy, Helmholtz function, Gibb's function, Derivation of Maxwell Relations and applications: Joule-Thompson Effect, First and second order Phase Transitions with examples, Clausius-Clapeyron Equation and Ehrenfest equations, Expression for (CP and CV). T-dS equations.	10

LEARNING OUTCOME:

To calculate the heat flow into and work done by a system and how that is constrained by the first law of thermodynamics

1. Students should be able to corelate the second law of thermodynamics to the operation of heat engines, particularly the carnot engine
2. Students should be able to explain the kinetic theory of gases and calculate properties of gases including the heat capacity and mean free path
3. Students should be able to apply the theory of equi-partition to relate the structure of the molecules to the measured heat capacity
4. Students should be able to describe the basis of entropy and relate this to the second law of thermodynamics and calculate entropy changes

Learning Resources	
Text Books	1. Heat Thermodynamics &Statistical Physics: Brijlal & Subrahmanyam 2. Thermal Physics: A B Gupta & H. P. Roy 3. Introduction to Statistical Physics, K Huang 4. Heat and Thermodynamics, M.W. Zemansky and R. Dittman, 1981, McGraw-Hill
Reference Books	5. Fundamental of Statistical Mechanics: B.B. Laud 6. A primer of Statistical Mechanics: R.B. Singh 7. Statistical Mechanics: Gupta, Kumar

Course Code-20CYH-203PA	Subject Name-PHYSICS PRACTICALS THERMAL PHYSICS	0	0	4	2
Course Category-B	**Pre-requisite-**				
	Co-requisite-20CYH-203PA				
	Designed –Department of Physics				

COURSE OBJECTIVE:

1. To understand how to determine resistance, thermal conductivity of material.
2. To impart knowledge about mechanical equivalent heat, RTD.

COURSE CONTENTS:

1. Determination of Stefan's constant
2. Determination of temperature coefficient of resistance.
3. Determination of thermal conductivity of a card-board by Lee's disc method.
4. Measurement of Planck's constant using black body radiation.
5. To study the variation of thermo emf across two junctions of a thermocouple with temperature.
6. To determine Mechanical Equivalent of Heat, J, by Callender and Barne's constant flow method.
7. To determine the coefficient of thermal conductivity of copper by Searle's Apparatus.
8. To calibrate Resistance Temperature Device (RTD) using Null Method/Off-Balance Bridge

LEARNING OUTCOME:

1. Students should be able to determine Stefan's constant, temperature coefficient of resistance, thermal conductivity of a card-board by Lee's disc method etc.
2. Students should be able to calibrate Resistance Temperature Device (RTD) using Null Method/Off-Balance Bridge.

Learning Resources	
Text Books	1. Flint, B. L.; Worsnop, H. T.; *Advanced Practical Physics for students*,1971, Asia Publishing House. 2. Prakash, I.; and Ramakrishna, *A Text Book of Practical Physics,11th Edition*, 2011, KitabMahal, 3. New Delhi. 4. Khandelwal, D. P. *A Laboratory Manual of Physics for Undergraduate Classes*, 1985, Vani Publication.

Course Code-20CYH-203B	**Subject Name- MODERN PHYSICS**	**4**	**0**	**0**	**4**
Course Category-B	**Pre-requisite-**				
	Co-requisite-20CYH-203B				
	Designed –Department of Physics				

COURSE OBJECTIVE:

1. To understand the Planck's quantum theory, photoelectric effect.
2. To understand the concept of uncertainty relation.
3. To impart the knowledge about wave mechanics and operators and nuclear physics.

UNIT	Course contents	Contact Hours
Unit-I	**Matter waves & light:** Planck's quantum theory, Light as a collection of photons; Photo-electric effect and Compton scattering. De Broglie wavelength and matter waves; Davisson Germer experiment. Bohr's quantization rule and atomic stability; calculation of energy levels for hydrogen like atoms and their spectra.	12
Unit-II	**Uncertainity relation:** Position measurement- gamma ray microscope thought experiment; Wave-particle duality, Heisenberg uncertainty principle- impossibility of a particle following a trajectory; estimating minimum energy of a confined particle using uncertainty principle; Energy-time uncertainty principle.	12

Unit-III	**Wave mechanics & operators:** Schrodinger equation for non-relativistic particles; Momentum and Energy operators; stationary states; physical interpretation of wave function, probabilities and normalization; Probability and probability current densities in one dimension.	12
Unit-IV	**Application of Schrodinger equation:** One dimensional infinitely rigid box- energy eigen values and eigen functions, normalization; Quantum dot as an example; Quantum Mechanical Scattering and Tunnelling in one Dimension - across a step potential and across a rectangular potential barrier, Tunnelling Effect, Alpha Decay	12
Unit-V	**Nuclear physics:** Radioactivity: stability of nucleus; Law of radioactive decay; Mean life & half-life; α decay; β-decay - energy released, γ-ray emission. Fission and Fusion - mass deficit, relativity and generation of energy; Fission - nature of fragments and emission of neutrons; Fusion and thermonuclear reactions.	12

LEARNING OUTCOME:

1. Students should be able to describe the dual nature of matter.
2. Students should be able to explain about wave mechanics & operators.
3. Students should be able to discuss the concept of radioactivity.

Learning Resources	
Text Books	1. Beiser, A. *Concepts of Modern Physics*, 2002, McGraw-Hill. 2. Meyer, R.; Kennard, Coop, *Introduction to Modern Physics,* 2002, Tata McGraw Hill. 3. Griffith, D. J. *Introduction to Quantum Mechanics*, 2005, Pearson Education.
Reference Book	4. N. Zettili, Quantum Mechanics-Concepts & Applications.

Course Code-20CYH-203PB	**Subject Name-PHYSICS PRACTICAL-ELEMENTS OF MODERN PHYSICS**	**0**	**0**	**4**	**2**
Course Category-B	**Pre-requisite-**				
	Co-requisite-20CYH-203PB				
	Designed –Department of Physics				

COURSE OBJECTIVE:

1. To understand the Planck's constant using LED.
2. To understand the value of e/m by magnetic focusing.
3. To setup the Millikan oil drop apparatus.

COURSE CONTENTS

1. To determine value of Planck's constant using LEDs of at least 4 different colors.
2. To determine the ionization potential of mercury.
3. To determine the wavelength of laser light by diffraction Grating
4. To determine the absorption lines in the rotational spectrum of Iodine vapor.
5. To study the diffraction patterns of single and double slits using laser source and measure its intensity variation using Photo-sensor and compare with incoherent source – Na light.
6. Photo-electric effect: photo current versus intensity and wavelength of light; maximum energy of photo-electrons versus frequency of light
7. To determine the value of e/m by magnetic focusing.

8. To setup the Millikan oil drop apparatus and determine the charge of an electron.

LEARNING OUTCOME:

Students should be able to demonstrate the hands on experience of elements of modern physics related listed practical.

Learning Resources	
Text Books	1. Flint, B. L.; Worsnop, H. T. *Advanced Practical Physics for students*, 1971, Asia Publishing House. 2. Nelson, M.; Ogborn, J. M. *Advanced level Physics Practicals, 4th Edition*, reprinted 1985, Heinemann Educational Publishers. 3. Prakash, I.; Ramakrishna, *A Text Book of Practical Physics, 11th Edition*, 2011, KitabMahal.

20CYH-207A	**Subject Name-MATHEMATICS I – ALGEBRA & CALCULUS (GE-II)**	**4**	**0**	**0**	**4**
Course Category-B	**Pre-requisite-**				
	Co-requisite-20CYH-207A				
	Designed –Department of Mathematics				

COURSE OBJECTIVE:

1. To understand the fundamentals of recapitulation, uncertainty in experimental techniques.
2. To get knowledge about the solution of mathematical series, process of integration, methods of integration etc.

UNIT	Course contents	Contact Hours
Unit-I	**Recapitulation:** Fundamentals. Mathematical functions, polynomial expressions, logarithms, the exponential function, units of a measurement, interconversion of units, constants and variables, equation of a straight line, plotting graphs. **Uncertainty in experimental techniques:** Displaying uncertainties, measurements in chemistry, decimal places, significant figures, combining quantities. Uncertainty in measurement: types of uncertainties, combining uncertainties. Statistical treatment. Mean, standard deviation, relative error. Data reduction and the propagation of errors. Graphical and numerical data reduction. Numerical curve fitting: the method of least squares (regression).	15
Unit-II	**Algebraic operations** on real scalar variables (e.g. manipulation of van der Waals equation in different forms). Roots of quadratic equations analytically and iteratively (e.g. pH of a weak acid). Numerical methods of finding roots (Newton-Raphson, binary –bisection, e.g. pH of a weak acid not ignoring the ionization of water, volume of a van der Waals gas, equilibrium constant expressions). **Mathematical series:** Power series, Maclaurin, Taylor series, convergence (e.g. pressure virial equation of state, colligative properties). Pythagoras theorem in three dimensions. Trigonometric functions, identities.	10

Unit-III	**Differential calculus:** The tangent line and the derivative of a function, numerical differentiation (e.g., change in pressure for small change in volume of a van der Waals gas, potentiometric titrations), differentials, higher order derivatives, discontinuities, stationary points, maximum minimum problems, inflexion points, limiting values of functions: L'Hôpital's rule, combining limits.	20
Unit-IV	**Integral calculus:** The process of integration, odd and even functions, indefinite integrals, standard integrals, methods of integration (e.g. integrated rate law for second order reaction), numerical integration (Trapezoidal and Simpson's rule, e.g. entropy/enthalpy change from heat capacity data), probability distributions (gas kinetic theory) and mean values. Calculus of the trigonometric functions. Calculus with several independent variables: Functions of several independent variables, change of variables, relations between partial derivatives (e.g. change in pressure for small changes in volume and temperature), total differentials, chain rules for partial differentiation, Euler's theorem, exact and inexact differentials (thermodynamics), line integrals.	15

LEARNING OUTCOME:

1. Students should be able to recapitulate, uncertainty in experimental techniques.
2. Students should be able to apply solution of mathematical series, process of integration, methods of integration etc. and their use in Chemistry.

Learning Resources	
Text Books	1. McQuarrie, D. A. *Mathematics for Physical Chemistry* University Science Books (2008). 2. Mortimer, R. *Mathematics for Physical Chemistry. 3 rd Ed.* Elsevier (2005). 3. Steiner, E. *The Chemical Maths Book* Oxford University Press (1996).
Reference Book	4. Yates, P. *Chemical Calculations. 2 nd Ed.* CRC Press (2007).

Course Code-19BMH0203	Subject Name-MATHEMATICS-I PROGRAMMING IN MATLAB	4	0	0	4
Course Category-P	**Pre-requisite-**				
	Co-requisite-19BMH0203				
	Designed –Department of Mathematics				

COURSE OBJECTIVE:

1. To provides a gentle introduction to the MATLAB computing environment, and is intended for beginning users and those looking for a review.
2. To give students a basic understanding of MATLAB, including popular toolboxes.

UNIT	Course contents	Contact Hours
Unit-I	Practicing MATLAB environment with simple exercises to familiarize Command Window, History, Workspace, Current Directory, Figure window, Edit window, Shortcuts, Help files.	15
Unit-II	Data types, Constants and Variables, Character constants, operators, Assignment statements. Control Structures: For loops, While, If control structures, Switch, Break, Continue statements.	10
Unit-III	Input-Output functions, Reading and Storing Data, Vectors and Matrices, commands to operate on vectors and matrices, matrix Manipulations.	20
Unit-IV	Arithmetic operations on Matrices, Relational operations on Matrices, Logical operations on Matrices.	15

LEARNING OUTCOME:

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

1. Find importance of this software for Lab Experimentation.
2. Write basic mathematical problems in Matlab.
3. Design and conduct experiments, as well as to analyze and interpret data.

Learning Resources	
Text Books	1. Bansal R. K, Goel A. K., Sharma M. K., "MATLAB and its Applications in Engineering", Pearson Education, 2012. 2. Amos Gilat, "MATLAB-An Introduction with Applications", Wiley India, 2009. 3. Stephen. J. Chapman, "Programming in MATLAB for

	Engineers", Cengage Learning, 2011. 4. Pratap R., Getting started with MATLAB: A Quick introduction for Scientists & Engineers, Oxford University Press, 2010.

Course Code-20CYH-207B	Subject Name-MATHEMATICS-II DIFFERENTIAL EQUATIONS & DETERMINANTS	3	1	0	4
Course Category-B	**Pre-requisite-**				
	Co-requisite-20CYH-207B				
	Designed –Department of Mathematics				

COURSE OBJECTIVE:

1. To understand the concept of solutions of differential equations, eigen functions.
2. To understand the eigen values, unit vectors, matrix and functions of variables.

UNIT	Course contents	Contact Hours
Unit-I	**Differential equations:** Introduction to Differential equations, Linear equations of second order with constant coefficients, Homogeneous equation of second order with variable, Method of variation of parameters.	10
Unit-II	**Multiple integrals:** Introduction to Double and Triple integration, Evaluation of Double integration in Cartesian coordinates, Evaluation of Double integration in Polar coordinates, Area as double integral, triple integration in Cartesian coordinates only.	15
Unit-III	**Matrices:** Rank of matrix, Consistency of a system of 'm' linear equations in 'n', Inconsistency of a system of 'm' linear equations in 'n' unknowns, Cayley- Hamilton theorem & it's applications, eigen values, eigen vectors for a matrices, properties of eigen values and eigen vectors.	15
Unit-IV	**Functions of several variables:** Functions of two variables – partial derivatives, total differentiation-euler's theorem, taylor's expansion, maxima and minima of functions of two variables, lagrange's multiplier method, jacobians.	10
Unit-V	**Vector calculus:** Gradient, directional derivatives, divergence and curl, solenoidal field, irrotational field, line, surface and volume integrals, green's theorem (without proof) and its applications.	10

LEARNING OUTCOME:

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

4. Find importance of this software for Lab Experimentation.
5. Construct the basic mathematical problems in Matlab.
6. Design and conduct experiments, as well as to analyze and interpret data.

Learning Resources	
Text Books	1. McQuarrie, D. A. *Mathematics for Physical Chemistry* University Science Books (2008). 2. Mortimer, R. *Mathematics for Physical Chemistry. 3 rd Ed.* Elsevier (2005). 3. Steiner, E. *The Chemical Maths Book* Oxford University Press (1996).
Reference Book	**4.** Yates, P. *Chemical calculations. 2nd Ed.* CRC Press (2007).

Course Code-19BMH0203L	Subject Name-MATHEMATICS-II PROGRAMMING IN MATLAB	0	0	2	1
Course Category-P	**Pre-requisite-**				
	Co-requisite-19BMH0203L				
	Designed –Department of Mathematics				

COURSE OBJECTIVE:

1**.** To become familiar with fundamental operations in Matlab.

2. To perform statistical data analysis, data interpolation by Matlab, solve differentiation equation with Matlab.

3. To acquire a reasonable level of competence in designing optimization algorithms, solve linear programming, constrained and unconstrained optimization problems by Matlab.

COURSE CONTENT

PRACTICAL

Programs based on MATLAB.

LEARNING OUTCOME:

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

1. Execute the fundamental operations in Matlab.
2. Perform statistical data analysis, data interpolation by Matlab, solve differentiation equation with Matlab.
3. Acquire a reasonable level of competence in designing optimization algorithms; solve linear programming, constrained and unconstrained optimization problems by Matlab.

Reference Books: Laboratory Manual

Course Code-20CYH-211A	Subject Name-COMPUTER FOR CHEMISTS (GE-III)	4	0	0	4
Course Category-P	**Pre-requisite-**				
	Co-requisite-20CYH-211A				
	Designed –Department of Chemistry				

COURSE OBJECTIVE:

1To understand the concept of solutions of differential equations, eigen functions.

2. To understand the eigen values, unit vectors, matrix and functions of variables.

UNIT	Course contents	Contact Hours
Unit-I	**Basic Computer system (in brief):** Hardware and software; input devices, storage devices, output devices, central processing unit (control unit and arithmetic logic unit); number system (binary, octal and hexadecimal operating system); computer codes (BCD and ASCII); numeric/string constants and variables. Operating systems (DOS, WINDOWS, and Linux); Software languages: low level and high level languages (machine language, assembly language; QBASIC, FORTRAN and C++); internet application.	15
Unit-II	**Use of Programming Language for solving problems in Chemistry:** Computer Programming Language- QBASIC, (for solving some of the basic and in turn complicated chemistry problems). QB4 version of QBASIC can be used. **Programming Language–QBASIC; Commands:** INPUT and PRINT Commands; GOTO, If, ELSEIF, THEN and END IF Commands; FOR and NEXT Commands; Library Functions (ABS, ASC, CHR$, EXP, INT, LOG, RND, SQR, TAB and trigonometric Functions), DIM, READ, DATA, REM, RESTORE, DEF FNR, GOSUB, RETURN, SCREEN, VIEW, WINDOW, LINE, CIRCLE. LOCATE, PSET Commands.	15
Unit-III	Simple programs using above mentioned commands. QBASIC programs for chemistry problems - example: plotting van der Waal Isotherms (simple problem, available in general text books) and observe whether van der Waal	20

	gas equation is valid at temperatures lower than critical temperature where we require to solve a cubic equation and calculation of area under the curves (complicated problem, not available in general text books). Solution of quadratic equation, polynomial equations (formula, iteration and Newton Raphson methods, binary bisection and Regula Falsi); Numerical differential, Numerical integration (Trapezoidal rule), Simultaneous equations, Matrix addition and multiplication, Statistical analysis	
Unit-IV	**Use of Software Products:** Computer software like scilab, excel, etc to solve some of the plotting or calculation problems. Basic idea of molecular modelling using software like chemsketc or JDrawetc for geometry optimization and potential energy surface (local and global minima).	10

LEARNING OUTCOME:

1. Students should be able to describe most commonly used commands and library functions used in QBASIC programming.
2. Students should be able to develop algorithm to solve problems and write corresponding programs in BASIC for performing calculations involved in laboratory experiments and research work.

3. Students should be able to apply various spreadsheet software to perform theoretical calculations and plot graphs.

Learning Resources	
Text Book	1. Grewal B. S, *Higher Engineering Mathematics*, Khanna Publications, 44th Edition, 2017. 2. Bali N.P., Goyal M, Watkins C, Advanced Engineering Mathematics: A Complete Approach., *Advanced Engineering Mathematics*, Laxmi Publications, New, Delhi.2018 3. Kandasamy P et al. Engineering Mathematics, Vol. I (4th revised edition), S. Chand & Co., New Delhi, 2000.
Reference Books	4. Kreyszig E., "Advanced Engineering Mathematics", 8th edition, John Wiley & Sons, Singapore, 2012 5. Venkataraman M.K., Engineering Mathematics – I Year

	(2nd edition), National Publishing Co., Chennai, 2000. 6. Dass H. K., Advanced engineering Mathematics, Sultan Chand Publication, Delhi, 2013.

Course Code-20CYH-211PA	Subject Name-COMPUTER FOR CHEMISTS PRACTICALS	0	0	4	2
Course Category-P	**Pre-requisite-**				
	Co-requisite-20CYH-211PA				
	Designed –Department of Chemistry				

COURSE OBJECTIVE:

1. To understand the basic of computer, computer codes, operating systems etc.
2. To know QBASIC programs for Chemistry problems, computer software like Sci-lab, Excel etc. to solve some of the plotting or calculation problems.

COURSE CONTENT:

Computer programs using QBASIC based on numerical methods

1. Roots of equations: (e.g. volume of gas using van der Waals equation and comparison with ideal gas, pH of a weak acid).

2. Numerical differentiation (e.g., change in pressure for small change in volume of a van der Waals gas, potentiometric titrations).

3. Numerical integration (e.g. entropy/ enthalpy changes from heat capacity data).

4. Probability distributions (gas kinetic theory) and mean values.

5. Matrix operations.

6. Graphic programs related to Chemistry problems. *e.g.* van der Waals isotherm, Compressibility versus pressure curves, Maxwell distribution curves, concentration-time graph, pH metric titration curve, conductometric titration curves, Lambert Beer's law graph, s, p, d orbital shapes, radial distribution curves, etc.

Use of Software Products

1. Computer Software Scilab for data handling and manipulation.
2. Simple exercises using molecular visualization software like JDraw, geometry optimization and potential energy surface of molecules like carbon dioxide, water, ethane, cyclohexane and benzene (local and global minima)

LEARNING OUTCOME:

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

1. Students should be able to demonstrate the practical knowledge of Chemistry problems, computer software like Sci-lab,
2. Students should be able to practice chemistry related software.

Learning Resources	
Text Books	1. McQuarrie, D. A. *Mathematics for Physical Chemistry* University Science Books (2008). 2. Mortimer, R. *Mathematics for Physical Chemistry. 3 rd Ed.* Elsevier (2005). 3. Steiner, E. *The Chemical Maths Book* Oxford University Press (1996). 4. Yates, P. *Chemical calculations. 2nd Ed.* CRC Press (2007).

Course Code-20CYH-211B	Subject Name-MOLECULAR MODELLING & DRUG DESIGN	4	0	0	4
Course Category-P	**Pre-requisite-**				
	Co-requisite-20CYH-211B				
	Designed –Department of Chemistry				

COURSE OBJECTIVE:

1. To understand basic concept of Molecular modeling.
2. To impart the knowledge about force field, simulation, Monte Carlo simulation energy minimization concept.
3. To understand Molecular dynamics, structure prediction and drug design.

UNIT	Course contents	Contact Hours
Unit-I	**Introduction to Molecular Modelling:** Useful Concepts in Molecular Modelling: Coordinate Systems. Potential Energy Surfaces. Molecular Graphics. Surfaces. Computer Hardware and Software. The Molecular Modelling Literature. **Force Fields:** Fields. Bond Stretching. Angle bending. Introduction to non-bonding interactions. Electrostatic interactions. Van der Waals interactions. Hydrogen bonding in molecular mechanics. Force field models for the simulation of liquid water.	15
Unit-II	**Energy Minimization and Computer Simulation:** Minimization and related methods for exploring the energy surface. Non-derivative method, first and second order minimization methods. Computer simulation methods. Simple thermodynamic properties and phase space. Boundaries, analyzing the results of a simulation and estimating Errors.	15
Unit-III	**Molecular Dynamics & Monte Carlo Simulation:** Molecular dynamics simulation methods. Molecular dynamics using simple models. Molecular dynamics with continuous potentials. Molecular dynamics at constant temperature and pressure. Metropolis method. Monte Carlo simulation of molecules. Models used in Monte Carlo simulations of polymers.	15
Unit-IV	**Structure Prediction and Drug Design:** Structure prediction - Introduction to comparative modeling. Sequence alignment. Constructing and evaluating a	15

	comparative model. Predicting protein structures by 'Threading', Molecular docking. Structure based de novo ligand design, Drug discovery-Chemoinformatics – QSAR.	

LEARNING OUTCOME:

1. Students should be able to apply theoretical background of computational techniques and selective application to various molecular systems.
2. Students should be able to explain Energy minimization methods through use of different force fields.
3. Students should be able to describe the ESP Plots by suitable soft wares, electron rich and electron deficient sites,
4. Students should be able to compare computational and experimental results and explain deviations.
5. Students should be able to execute Molecular dynamics (MD) and Monte Carlo (MC) simulations on several molecules and polymers.
6. Students should be able to explain QSAR properties and their role in molecular modelling, cheminformatics and drug discovery.
7. Students should be able to perform Optimization of geometry parameters of a molecule (such as shape, bond length and bond angle) through use of software like Chem Sketch and Argus Lab in interesting hands-on exercises.

Learning Resources	
Text Books	1. A.R. Leach, Molecular Modelling Principles and Application, Longman, 2001. 2. J.M. Haile, Molecular Dynamics Simulation Elementary Methods, John Wiley and Sons, 1997. 3. Satya Prakash Gupta, QSAR and Molecular Modeling, Springer - Anamaya Publishers, 2008.

Course Code-20CYH-211PB	Subject Name-MOLECULAR MODELLING & DRUG DESIGN PRACTICAL	0	0	4	2
Course Category-P	**Pre-requisite-**				
	Co-requisite-20CYH-211PB				
	Designed –Department of Chemistry				

COURSE OBJECTIVE:

1. To understand the bond length concepts in different molecules.
2. To impart knowledge about the energy minimization concept.

COURSE CONTENT:

i. Compare the optimized C-C bond lengths in ethane, ethene, ethyne and benzene.

ii. Visualize the molecular orbitals of the ethane ζ bonds and ethene, ethyne, benzene and pyridine π bonds.

a) Perform a conformational analysis of butane.

(b) Determine the enthalpy of isomerization of *cis* and *trans*-2-butene.

iii. Visualize the electron density and electrostatic potential maps for LiH, HF, N_2, NO and CO and comment. Relate to the dipole moments. Animate the vibrations of these molecules.

iv. (a) Relate the charge on the hydrogen atom in hydrogen halides with their acid character.

(b) Compare the basicities of the nitrogen atoms in ammonia, methylamine, dimethylamine and trimethylamine.

v. (a) Compare the shapes of the molecules: 1-butanol, 2-butanol, 2-methyl-1-propanol, and 2-methyl-2-propanol. Note the dipole moment of each molecule.

(b) Show how the shapes affect the trend in boiling points: (118 ºC, 100 ºC, 108 ºC, 82 ºC, respectively).

vi. Build and minimize organic compounds of your choice containing the following functional groups. Note the dipole moment of each compound: (a) alkyl halide (b) aldehyde (c) ketone (d) amine (e) ether (f) nitrile (g) thiol (h) carboxylic acid (i) ester (j) amide.

vii. (a) Determine the heat of hydration of ethylene. (b) Compute the resonance energy of benzene by comparison of its enthalpy of hydrogenation with that of cyclohexene.

viii. Arrange 1-hexene, 2-methyl-2-pentene, (E)-3-methyl-2-pentene, (Z)-3-methyl-2-pentene, and 2,3-dimethyl-2-butene in order of increasing stability.

ix. (a) Compare the optimized bond angles H_2O, H_2S, H_2Se. (b) Compare the HAH bond angles

for the second row dihydrides and compare with the results from qualitative MO theory.

Note: Software: ChemSketch, ArgusLab (www.planaria-software.com)

LEARNING OUTCOME:

1. Students should be able to determine enthalpy of isomerization of *cis*, *trans* compounds.
2. Students should be able to explain electron density and electrostatic potential maps of diatomic molecules.
3. Students should be able to demonstrate the knowledge and practical experiences of about molecular modelling.

Learning Resources	
Text Books	1. A.R. Leach, Molecular Modelling Principles and Application, Longman, 2001. 2. J.M. Haile, Molecular Dynamics Simulation Elementary Methods, John Wiley and Sons, 1997. 3. Satya Prakash Gupta, QSAR and Molecular Modeling, Springer - Anamaya Publishers, 2008.

Course Code-20CYH-216A	**Subject Name-PHARMACEUTICAL CHEMISTRY (GE-IV)**	**4**	**0**	**0**	**4**
Course Category-P	**Pre-requisite-**				
	Co-requisite-20CYH-216A				
	Designed –Department of Chemistry				

COURSE OBJECTIVE:

1. To understand retro-synthesis approach in relation to drug design and drug discovery.
2. To understand synthetic pathways of major drug classes.
3. To understand the fermentation process and production of ethanol, citric acids, antibiotics and some classes of vitamins.

UNIT	Course contents	Contact Hours
Unit-I	Synthesis of the representative drugs of the following classes: analgesics agents, antipyretic agents, anti-inflammatory agents (Aspirin, paracetamol, lbuprofen); antibiotics (Chloramphenicol); antibacterial and antifungal agents (Sulphonamides; Sulphanethoxazol, Sulphacetamide, Trimethoprim); antiviral agents (Acyclovir, Remdesivir).	15
Unit-II	Central Nervous System agents (Phenobarbital, Diazepam), Cardiovascular (Glyceryltrinitrate), antilaprosy (Dapsone), HIV-AIDS related drugs (AZT- Zidovudine). Fermentation: Aerobic and anaerobic. Production of (i) Ethyl alcohol and citric acid, (ii) Antibiotics; Penicillin, Cephalosporin, Chloromycetin and Streptomycin, (iii) Lysine, Glutamic acid, Vitamin B2, Vitamin B12 and Vitamin C.	15
Unit-III	Drug discovery, design and development. Stages of drug discovery, lead discovery, identification, validation and diversity of drug targets. Some novel molecular targets along with their pharmacodynamic agents: Polyketide synthase (Pks13), signal transducer and activator of transcription-3 (STAT-3) and sodium glucose cotransporter-2 (SGLT-2).	15

	Stereochemistry and drug action: Pharmacodynamic, pharmacokinetic (drug adsorption, metabolism, distribution and elimination) and toxicological aspects of stereoisomers (Geometrical, optical and conformational).	
Unit-IV	Basic concepts, prodrugs of functional group, rationale and practical consideration of prodrug design. Rational versus analog approach of drug design. Combating drug resistance: Causes for drugresistance, strategies to combat drug resistance in antibiotics therapy, Genetic principles of drug resistance.	15

LEARNING OUTCOME:

1. Students should be able to explain the retro-synthesis approach in relation to drug design and drug discovery.
2. Students should be able to describe the synthetic pathways of major drug classes.
3. Students should be able to illustrate the fermentation process and production of ethanol, citric acids, antibiotics and some classes of vitamins.

Learning Resources	
Text Books	1. Abraham D. J., Burger's Medicinal Chemistry and Drug Discovery, John Wiley and Sons Inc., New York. 2. Block J. H. and Beale J. M., Wilson and Gisvold's Textbook of Organic Medicinal and Pharmaceutical Chemistry, Lippincott Williams and Wilkins, Philadelphia.
Reference Books	3. Lemke T. L., Williams D. A., Roche V. F. and Zito S. W., Foye's Principles of Medicinal Chemistry, Lippincott Williams and Wilkins, Philadelphia. 4. Vardanyan R. S. and Hruby V. J., Synthesis of Essential Drugs, Elsevier, Philadelphia.

Course Code-20CYH-216AP	Subject Name-PHARMACEUTICAL CHEMISTRY PRACTICAL	0	0	4	2
Course Category-P	**Pre-requisite-**				
	Co-requisite-20CYH-216AP				
	Designed –Department of Chemistry				

COURSE OBJECTIVE:

1. To Prepare some drugs
2. To determine content of alcohol, Vitamin C.

COURSE CONTENT:

1. Preparation of aspirin and its analysis.
2. Preparation of paracetamol and its analysis.
3. Preparation of sulphacetamide of sulphonamide and its analysis.
4. Determination of alcohol contents in liquid drugs/galenical.
5. Determination of ascorbic acid in vitamin C tablets by iodometric or coulometric titrations.
6. Synthesis of ibuprofen.
7. Analysis of commercial vitamin C tablets by iodometric and coulometric titrimetry.

LEARNING OUTCOME:

1. Students should be able to analyze the properties of drugs.
2. Students should be able to estimate the content of alcohol and vitamins

Learning Resources	
Text Books	1. Kjonaas, R. A.; Williams, P. E.; Counce, D. A.; Crawley, L. R. Synthesis of Ibuprofen. J. Chem. Educ., 2011, 88 (6), pp 825–828. DOI: 10.1021/ed100892p. 2. Marsh, D.G.; Jacobs, D.L.; Veening, H. Analysis of commercial vitamin C tablets by iodometric and coulometric titrimetry. J. Chem. Educ., 1973, 50 (9), p 626. DOI: 10.1021/ed050p626

Course Code-20CYH-216B	**Subject Name-CHEMICAL TECHNOLOGY & SOCIETY BUSINESS SKILLS FOR CHEMISTS**	**4**	**0**	**0**	**4**
Course Category-P	**Pre-requisite-**				
	Co-requisite-20CYH-216B				
	Designed –Department of Chemistry				

COURSE OBJECTIVE:

1. To understand Chemical Technology.
2. To impart the knowledge about business skills for Chemists.
3. To understand the challenges and opportunity in Chemical Technology.

UNIT	Course contents	Contact Hours
Unit-I	Chemical Technology, Basic principles of distillation, solvent extraction, solid-liquid leaching and liquid-liquid extraction, separation by absorption and adsorption. An introduction into the scope of different types of equipment needed in chemical technology, including reactors, distillation columns, extruders, pumps, mills, emulgators. Scaling up operations in chemical industry. Introduction to clean technology.	20
Unit-II	Society Exploration of societal and technological issues from a chemical perspective. Chemical and scientific literacy as a means to better understand topics like air and water (and the trace materials found in them that are referred to as pollutants); energy from natural sources (i.e. solar and renewable forms), from fossil fuels and from nuclear fission; materials like plastics and polymers and their natural analogues, proteins and nucleic acids, and molecular reactivity and interconversions from simple examples like combustion to complex instances like genetic engineering and the manufacture of drugs.	20

Unit-III	Business Basics Key business concepts: Business plans, market need, project management and routes to market. Chemistry in Industry Current challenges and opportunities for the chemistry-using industries, role of chemistry in India and global economies. Making money Financial aspects of business with case studies Intellectual property Concept of intellectual property, patents.	20

LEARNING OUTCOME:

1. Students should be able to apply the concepts of basic chemistry to chemical engineering
2. Students should be able to practice various chemical technology used in industries
3. Students should be able to apply the scientific solutions for societal needs.

Learning Resources	
Text Books	1. John W. Hill, Terry W. McCreary & Doris K. Kolb, Chemistry for changing times 13th Ed 2. www.rsc.org

SKILL ENHANCEMENT COURSE (SEC)

Course Code-20CYH-212A	**Subject Name-Intellectual Property Rights (SEC-I)**	**2**	**0**	**0**	**2**
Course Category-P	**Pre-requisite-**				
	Co-requisite-20CYH-212A				
	Designed –Department of Chemistry				

COURSE OBJECTIVE:

1. To get knowledge about different types of intellectual property, trademarks, WIPO and PCT system etc.
2. To know about different international agreements, role of law enforcement agencies etc.

UNIT	Course contents	Contact Hours
Unit-I	Introduction to Intellectual Property: Historical Perspective, Different Types of IP, Importance of protecting IP. Copyrights Introduction, how to write &file a patent, difference between Indian and US patent, Differences from Patents. 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. Geographical Indications Definition, rules for registration, prevention of illegal exploitation, importance to India.	15
Unit-II	Industrial Designs Definition, features, International design registration. Layout design of integrated circuits Circuit Boards, Integrated Chips, Importance for electronic industry. Trade Secrets Introduction and Historical Perspectives, Scope of Protection, Risks involved and legal aspects of Trade Secret Protection.	15

	Different International agreements (a) 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, IP Infringement issue and enforcement – Role of Judiciary, cyber laws, plagiarism, 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.	

LEARNING OUTCOME:

Students should be able to describe the theoretical concepts of evolution of Intellectual Property Laws, and to differentiate between the different kinds of IP.

Learning Resources	
Text Books	1. Acharya, N.K. *Textbook on intellectual property rights*, Asia Law House (2001). 2. Guru, M.; Rao, M.B. *Understanding Trips: Managing Knowledge in Developing Countries*, Sage Publications (2003). 3. Ganguli, P. *Intellectual Property Rights: Unleashing the Knowledge Economy*, Tata McGraw Hill (2001).

		L	T	P	C
Course Code-20CYH-212B	**Subject Name: PESTICIDE CHEMISTRY**	**2**	**0**	**0**	**2**
Course Category-P	**Pre-requisite-**				
	Co-requisite-20CYH-212B				
	Designed –Department of Chemistry				

COURSE OBJECTIVE

1. To get knowledge about pesticides, their benefits and effects and uses.
2. To understand the pesticide formulations.

UNIT	Course contents	Contact Hours
Unit-I	General introduction to pesticides (natural and synthetic), benefits and adverse effects, changing concepts of pesticides, structure activity relationship, synthesis and technical manufacture and uses of representative pesticides in the following classes: organochlorines (Gammexene); organophosphates (Malathion, Parathion); carbamates (Carbofuran and carbaryl); quinines (Chloranil), anilides (Alachlor and Butachlor). Natural pesticides, green pesticides and pheromones.	15
Unit-II	**Practical** To calculate acidity/alkalinity in given sample of pesticide formulations as per BIS specifications. Preparation of simple organophosphates, phosphonates and thiophosphates ***Note: There is no external practical examination for this paper. The questions will be asked in the internal and external examination from the theory as well as practical.***	15

LEARNING OUTCOME:

1. Students should be able to describe the basic role of pesticide in everyday life, various ingredients and their role in controlling the pest.
2. Students should be able to advise the farmers/gardeners to choose the appropriate pesticides for their crop production.

Learning Resources

Text Books	1. Cremlyn,R. *Pesticides*, John Wiley. 2. Perry, A.S.; Yamamoto, I.; Ishaaya, I.; Perry,R.Y.(1998),Insecticides in Agriculture and Environment, Springer-Verlag Berlin Heidelberg. 3. Kuhr, R. J.; Derough, H.W.(1976),Carbamate Insecticides: Chemistry, Biochemistry and Toxicology, CRC Press,USA.

		L	T	P	C
Course Code-20CYH-217A	**Subject Name: CHEMISTRY OF COSMETICS & PERFUMES (SEC-II)**	**2**	**0**	**0**	**2**
Course Category-P	**Pre-requisite-**				
	Co-requisite-20CYH-217A				
	Designed –Department of Chemistry				

COURSE OBJECTIVE:

1. To know about cosmetics, their preparation and uses.
2. To get knowledge about essential oils and their importance in cosmetic industries.

UNIT	Course contents	Contact Hours
Unit-I	A general study including preparation and uses of the following: Hair dye, hair spray, shampoo, suntan lotions, face powder, lipsticks, talcum powder, nail enamel, creams (cold, vanishing and shaving creams), antiperspirants and artificial flavours. Essential oils and their importance in cosmetic industries with Reference Books to Eugenol, Geraniol, sandalwood oil, eucalyptus, rose oil, 2-phenyl ethyl alcohol, Jasmone, Civetone, Muscone.	15
Unit-II	**Practicals:** **1**. Preparation of talcum powder. **2**. Preparation of shampoo. **3**. Preparation of enamels. **4**. Preparation of hair remover. **5**. Preparation of face cream. **6**. Preparation of nail polish and nail polish remover. **7**. Preparation of green perfumes. ****There is no external practical examination for this paper. The questions will be asked in the internal and external examination from the theory of practical.***	15

LEARNING OUTCOME:

1. Students should be able to describe the basic of cosmetics, various cosmetic formulation, ingredients and their roles in cosmetic products.
2. Students should be able to learn the use of safe, economic and body-friendly cosmetics

Prepare new innovative formulations.

Learning Resources	
Text Books	1. Barel, A. O.; Paye, M.; Maibach, H.I.(2014),Handbook of Cosmetic Science and Technology, CRC Press. 2. Garud, A.; Sharma, P.K.; Garud, N. (2012), Text Book of Cosmetics, Pragati Prakashan. 3. Gupta, P.K.; Gupta, S.K.(2011),Pharmaceutics and Cosmetics, Pragati Prakashan
Reference Books	4. Butler, H. (2000), Poucher's Perfumes, Cosmetic and Soap, Springer 5. Kumari, R. (2018), Chemistry of Cosmetics, Prestige Publisher.

		L	T	P	C
Course Code-20CYH-217B	**Subject Name: BIOLOGY FOR CHEMISTS**	**2**	**0**	**0**	**2**
Course Category-P	**Pre-requisite-**				
	Co-requisite-20CYH-217B				
	Designed –Department of Chemistry				

COURSE OBJECTIVE:

1. To understand the structure of prokaryotic and eukaryotic cells, catabolism and anabolism.
2. To get the knowledge about essential fatty acids, their structures and functions and structure of proteins.
3. To know the structure of nucleic acids and genetic codes.

UNIT	Course contents	Contact Hours
Unit-I	**Cell Structure and Metabolism:** Structure of prokaryotic and eukaryotic cells, intracellular organelles and their functions, comparison of plant and animal cells. Overview of metabolic processes - catabolism and anabolism. ATP - the biological energy currency.	10
Unit-II	**Nucleic Acids and Genetic Code:** Structure of nucleotides, nucleosides, DNA (Watson - Crick model) RNA structure and conformation, Replication of DNA, transcription, translation of genetic material, genetic code, universality of the code, codon, anticodon pairing, RNA, protein biosynthesis (initiation, elongation, termination and processing of the peptide chain)	20

LEARNING OUTCOME:

1. Students should be able to describe the structure of prokaryotic and eukaryotic cells, catabolism and anabolism.
2. Students should be able to discuss the essential fatty acids, their structures and functions and structure of proteins.
3. Students should be able to explain the structure of nucleic acids and genetic codes.

Learning Resources	
Text Books	1. Karp, G. *Cell and Molecular Biology: Concepts and Experiments*, *6th Ed.*, John Wiley & Sons. 2. Robertis, EDP D.; Robertis, RE D.*Inc.2010 Cell and Molecular Biology*, *8th Ed.*, Lippincott Williams and Wilkins, Philadelphia. 2009 3. 3. Cooper, G. M.; Hausman, R. E. *The Cell: A Molecular Approach*, *5th Ed.*, Sinnauer Associates Inc. 2009 4. Finar, I. L. *Organic Chemistry* (*Volume 1*), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
Reference Books	5. Finar, I. L. *Organic Chemistry* (*Volume 2)*, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education). 6. Nelson, D. L. & Cox, M. M. *Lehninger's Principles of Bioch*emistry, W. H. Freeman. 7. Berg, J. M., Tymoczko, J.L. & Stryer, L. *Biochemistry*, W.H. Freeman.

DISCIPLINE SEPECIFIC ELECTIVE

		L	T	P	C
Course Code-20CYH-221A	**Subject Name: ENVIRONMENT & INDUSTRIAL CHEMISTRY (DSE-I)**	**4**	**0**	**0**	**4**
Course Category-P	**Pre-requisite-**				
	Co-requisite-20CYH-221A				
	Designed –Department of Chemistry				

COURSE OBJECTIVE:

1. To know about the storage and handling of industrial gases and inorganic chemicals.
2. To understand the methods for the metal preparation, major regions of atmosphere and reactions in atmosphere.
3. To understand water resources, aquatic ecosystems, sources and nature of water pollutants, techniques for measuring water pollution etc.
4. To know about high energy materials like RDX, Dynamite, Solar energy etc.

UNIT	Course contents	Contact Hours
Unit-I	**Industrial Gases and Inorganic Chemicals** *Industrial Gases:* Storage and hazards in handling of the following gases: oxygen, nitrogen, argon, neon, helium, hydrogen, acetylene, carbon monoxide, chlorine, fluorine, sulfur dioxide and phosgene. *Inorganic Chemicals:* Manufacture, application, analysis and hazards in handling the following chemicals: hydrochloric acid, nitric acid, sulfuric acid, caustic soda, common salt, borax, bleaching powder, sodium thiosulfate, hydrogen peroxide, potash alum, chrome alum, potassium dichromate and potassium permanganate.	15
Unit-II	**Air Pollution:** Major regions of atmosphere. Chemical and photochemical reactions in atmosphere. Air pollutants: types, sources, particle size and chemical nature; Photochemical smog: its constituents and photochemistry. Environmental effects of ozone, Major sources of air pollution. Pollution by MIC, SO_2, CO_2, CO, NO_x, H_2S and other foul smelling gases. Methods of estimation of CO, NO_x, SO_x and control procedures. Effects of air pollution on living organisms and	15

	vegetation. Greenhouse effect and Global warming, Ozone depletion by oxides of nitrogen, chlorofluorocarbons and Halogens, removal of sulfur from coal. Control of particulates.	
Unit-III	**Water Pollution**: Hydrological cycle, water resources, aquatic ecosystems, Sources and nature of water pollutants, Techniques for measuring water pollution, Impacts of water pollution on hydrological and ecosystems. Water purification methods. Effluent treatment plants (primary, secondary and tertiary treatment). Industrial effluents from the industries and their treatment. Sludge disposal. Industrial waste management, incineration of waste. Water treatment and purification (reverse osmosis, electro dialysis, ion exchange). Water quality parameters for waste water, industrial water and domestic water.	15
Unit-IV	**High Energy Materials:** Sources of Energy: Coal, Petrol and Natural gas. Nuclear Fusion / Fission, Solar Energy, Hydrogen, Geothermal, Tidal and Hydel etc. RDX, picric acid, dynamite **Nuclear Pollution:** Disposal of Nuclear waste, Nuclear Disaster and its Management. **Biocatalysis:** Introduction to biocatalysis: Importance in ―Green Chemistry and Chemical Industry.	15

LEARNING OUTCOME:

1. Students should be able to describe the toxicity hazards of toxic gases, safe design systems for large scale production of industrial gases, manufacturing processes handling and storage of inorganic chemicals.
2. Students should be able to discuss the hazardous effects of the inorganic chemicals on human beings and vegetation, the requirement of ultra-pure metals for the semiconducting technologies.
3. Students should be able to analyze the composition of air, various air pollutants, effects and control measures of air pollutants, different sources of water, water quality parameters, impacts of water pollution, water treatment, different industrial effluents and their treatment methods will also be taught.

Learning Resources	
Text Books	1. E. Stocchi: *Industrial Chemistry*, Vol-I, Ellis Horwood Ltd. UK. 2. R.M. Felder, R.W. Rousseau: *Elementary Principles of Chemical Processes*, Wiley Publishers, New Delhi. 3. J. A. Kent: Riegel's *Handbook of Industrial Chemistry*, CBS Publishers, New Delhi. 4. S. S. Dara: *A Textbook of Engineering Chemistry*, S. Chand & Company Ltd. New Delhi.
Reference Books	5. K. De, *Environmental Chemistry*: New Age International Pvt., Ltd, New Delhi. 6. S. M. Khopkar, *Environmental Pollution Analysis*: Wiley Eastern Ltd, New Delhi. 7. S.E. Manahan, Environmental Chemistry, CRC Press. 8. G.T. Miller, Environmental Science 11th edition. Brooks/ Cole (2006). 9. A. Mishra, Environmental Studies. Selective and Scientific Books, New Delhi (2005).

		L	T	P	C
Course Code-20CYH-221PA	**Subject Name: INDUSTRIAL CHEMICALS & ENVIRONMENT PRACTICALS**	**0**	**0**	**2**	**2**
Course Category-P	**Pre-requisite-**				
	Co-requisite-20CYH-221PA				
	Designed –Department of Chemistry				

COURSE OBJECTIVE

1. To understand the analysis of water like BOD, COD.
2. To understand the estimation of total alkalinity of water samples and common bio-indicators of pollution.
3. To study the preparation of boric acid.

UNIT	Course contents	Contact Hours
	1. Determination of dissolved oxygen in water. **2**. Determination of Chemical Oxygen Demand (COD) **3**. Determination of Biological Oxygen Demand (BOD) **4**. Percentage of available chlorine in bleaching powder. **5**. Measurement of chloride, sulfate and salinity of water samples by simple titration method ($AgNO_3$ and potassium chromate). **6**. Estimation of total alkalinity of water samples (CO_3^{2-}, HCO_3^-) using double titration method. **7**. Measurement of dissolved CO_2. **8**. Study of some of the common bio-indicators of pollution. **9**. Preparation of borax/ boric acid	30

LEARNING OUTCOME:

1. Students should be able to explain the toxicity hazards of toxic gases, safe design systems for large scale production of industrial gases, manufacturing processes handling and storage of inorganic chemicals.
2. Students should be able to describe the hazardous effects of the inorganic chemicals on human beings and vegetation, the requirement of ultra-pure metals for the semiconducting technologies.

3. Students should be able to explain the composition of air, various air pollutants, effects and control measures of air pollutants, different sources of water, water quality parameters, impacts of water pollution, water treatment, different industrial effluents and their treatment methods.

Learning Resources	
Text Books	1. Stocchi, E. *Industrial Chemistry*, Vol-I, Ellis Horwood Ltd. UK. 2. Felder, R. M.; Rousseau, R.W. *Elementary Principles of Chemical Processes*, Wiley Publishers, New Delhi. 3. Kent, J. A. Riegel's *Handbook of Industrial Chemistry*, CBS Publishers, New Delhi.

		L	T	P	C
Course Code-20CYH-221B	**Subject Name: GREEN CHEMISTRY**	**4**	**0**	**0**	**4**
Course Category-P	**Pre-requisite-**				
	Co-requisite-20CYH-221B				
	Designed –Department of Chemistry				

COURSE OBJECTIVE:

1.To understand basic concept Green Chemistry
2. To understand the importance of Green Chemistry in today's world.
3. To understand the role of green solvent for the preparation of different molecules.

UNIT	Course contents	Contact Hours
	Introduction to Green Chemistry, What is Green Chemistry? Need for Green Chemistry. Goals of Green Chemistry. Limitations/ Obstacles in the pursuit of the goals of Green Chemistry Principles of Green Chemistry and Designing a Chemical synthesis. Twelve principles of Green Chemistry with their explanations and special emphasis on the following with examples: Designing a Green Synthesis using these principles; Prevention of Waste/ byproducts; maximum incorporation of the materials used in the process into the final products, Atom Economy, calculation of atom economy of the rearrangement, addition, substitution and elimination reactions. Prevention/ minimization of hazardous/ toxic products reducing toxicity risk = (function) hazard x exposure; waste or pollution prevention hierarchy Green solvents– super critical fluids, water as a solvent for organic reactions, ionic liquids, fluorous biphasic solvent, PEG, solventless processes, immobilized solvents and how to	60

	compare greenness of solvents Energy requirements for reactions – alternative sources of energy: use of microwaves and ultrasonic energy Selection of starting materials; avoidance of unnecessary derivatization-careful use of blocking/protecting groups; Use of catalytic reagents (wherever possible), stoichiometric reagents; catalysis and green chemistry, comparison of heterogeneous and homogeneous catalysis, bio catalysis, asymmetric catalysis and photo catalysis. Prevention of chemical accidents designing greener processes, inherent safer design, principle of ISD -What you don't have cannot harm you, greener alternative to Bhopal Gas Tragedy (safer route to carbaryl) and Flixiborough accident (safer route to cyclohexanol) subdivision of ISD, minimization, simplification, substitution, moderation and limitation. Strengthening/ development of analytical techniques to prevent and minimize the generation of hazardous substances in chemical processes. Examples of Green Synthesis/ Reactions and some real world cases 1. Green Synthesis of the following compounds: adipic acid, catechol, disodium iminodiacetate (alternative to Strecker synthesis) 2. 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 3. Ultrasound assisted reactions: sonochemical Simmons-Smith Reaction (Ultrasonic alternative to Iodine) 4. Surfactants for Carbon Dioxide – replacing smog	

	producing and ozone depleting solvents with CO_2 for precision cleaning and dry cleaning of garments. 5. Designing of Environmentally safe marine antifoulant. 6. Rightfit pigment: synthetic azopigments to replace toxic organic and inorganic pigments. 7. An efficient, green synthesis of a compostable and widely applicable plastic (poly lactic acid) made from corn. 8. Healthier Fats and oil by Green Chemistry: Enzymatic Inter esterification for production of no Trans-Fats and Oils 9. Development of Fully Recyclable Carpet: Cradle to Cradle Carpeting Future Trends in Green Chemistry Oxidation reagents and catalysts; Biomimetic, multifunctional reagents; combinatorial green chemistry; Proliferation of solventless reactions;	

LEARNING OUTCOME:

1. Students should be able to describe the twelve principles of green chemistry and will build the basic understanding of toxicity, hazard and risk of chemical substances.
2. Students should be able to perform stoichiometric calculations and relate them to green chemistry metrics. Understand benefits of use of catalyst and bio catalyst, use of renewable feed stock which helps in energy efficiency and protection of the environment, renewable energy sources.
3. Students should be able to learn to design safer chemical, products and processes that are less toxic, than current alternatives. Lastly they will be able to appreciate the use of green chemistry in problem solving skills, critical thinking and valuable skills to innovate and find out solution to environmental problems.
4. Students should be able to realize that chemistry can be used to solve rather than cause environmental problems.

Learning Resources

Text Books	1. Ahluwalia, V. K. and Kidwai, M. R. New Trends in Green Chemistry, Anamalaya Publishers, 2005 2. Anastas, P. T. and Warner, J. K. Oxford Green Chemistry -Theory and Practical, University Press, 1998 3. Matlack, A. S. Introduction to Green Chemistry, Marcel Dekker, 2001
Reference Books	4. Cann, M. C. and Connely, M.E. Real-World Cases in Green Chemistry, American Chemical Society, Washington, 2000 5. Ryan, M.A. and Tinnes and, M., Introduction to Green Chemistry, American Chemical Washington, 2002.

		L	T	P	C
Course Code-20CYH-221PB	**Subject Name: GREEN CHEMISTRY PRACTICAL**	**0**	**0**	**4**	**2**
Course Category-P	**Pre-requisite-**				
	Co-requisite-20CYH-221PB				
	Designed –Department of Chemistry				

COURSE OBJECTIVE:

1. To learn and understand the preparation, characterization of starting materials.
2. To understand the property of green solvent for the preparation of different compounds**.**

UNIT	Course contents	Contact Hours
	Practical: Green chemistry 1. Preparation and characterization of nanoparticles of gold using tea leaves/silver using plant extracts. 2. Extraction of D-limonene from orange peel using liquid CO_2 prepared form dry ice. 3. Preparation of biodiesel from waste cooking oil and its characterization (TLC, pH, Solubility, Combustion Test, Density, Viscosity, Gel Formation at Low Temperature and IR can be provided). 4. Solvent free, microwave assisted one pot synthesis of phthalocyanine complex of copper (II). 5. Benzoin condensation using Thiamine Hydrochloride as a catalyst instead of cyanide. Alternative green solvents 6. Mechanochemical solvent free, solid–solid synthesis of azomethine using p- toluidine and o-vanillin/pvanillin (various other combinations of primary amine and aldehyde can also be tried). Alternative sources of energy 7. Photoreduction of benzophenone to benzopinacol in the presence of sunlight.	30

LEARNING OUTCOME:

1. Students should be able to demonstrate the preparation and characterization of nanoparticle by using plant extract.
2. Students should be able to prepare biodiesel from waste cooking oil.
3. Have the knowledge about microwave assisted one port synthesis.

Learning Resources	
Text Books	1. Anastas, P. T and Warner, J. C. Green Chemistry: Theory and Practice, Oxford University Press, 1998 2. Kirchoff, M. and Ryan, M.A. Greener approaches to undergraduate chemistry experiment. American Chemical Society, Washington DC, 2002 3. Ryan, M. A. Introduction to Green Chemistry, Tinnesand; (Ed), American Chemical Society, Washington DC, 2002 4. Sharma, R. K.; Sidhwani, I. T. and Chaudhari, M. K. Green Chemistry Experiments: A monograph, I.K. International Publishing House Pvt Ltd. New Delhi, Bangalore ISBN 978-93-81141-55-7, 2013
Reference Books	5. Cann, M. C. and Connelly, M. E. Real world cases in Green Chemistry, American Chemical Society, 2008

		L	T	P	C
Course Code-20CYH-224A	**Subject Name: ANALYTICAL METHODS IN CHEMISTRY (DSC-II)**	**4**	**0**	**0**	**4**
Course Category-P	**Pre-requisite-**				
	Co-requisite-20CYH-224A				
	Designed –Department of Chemistry				

COURSE OBJECTIVE:

1. To understand basic concept Analytical Chemistry.
2. To understand the importance of Spectroscopy.

UNIT	Course contents	Contact Hours
Unit-I	**Qualitative and quantitative aspects of analysis:** Sampling, evaluation of analytical data, errors, accuracy and precision, methods of their expression, normal law of distribution of indeterminate errors, statistical test of data; F, Q and t test, rejection of data, and confidence intervals.	15
Unit-II	**Optical methods of analysis:** Origin of spectra, interaction of radiation with matter, fundamental laws of spectroscopy and selection rules, validity of Beer-Lambert's law. **UV-Visible Spectrometry:** Basic principles of instrumentation (choice of source, monochromator and detector) for single and double beam instrument; **Basic principles of quantitative analysis:** Estimation of metal ions from aqueous solution, geometrical isomers, keto-enol tautomers. **Flame Atomic Absorption and Emission Spectrometry:** Basic principles of instrumentation (choice of source, monochromator, detector, choice of flame and Burner designs.	20

Unit-III	**Thermal methods of analysis:** Theory of thermogravimetry (TG), basic principle of instrumentation. Techniques for quantitative estimation of Ca and Mg from their mixture.	10
Unit-IV	**Separation techniques:** Solvent extraction: Classification, principle and efficiency of the technique. Mechanism of extraction: extraction by solvation and chelation. Technique of extraction: batch, continuous and counter current extractions. Qualitative and quantitative aspects of solvent extraction: extraction of metal ions from aqueous solution, extraction of organic species from the aqueous and non-aqueous media.	15

LEARNING OUTCOME:

1. Students should be able to perform experiment with accuracy and precision and develop methods of analysis for different samples independently. Understand basic principle and working of instrument like Flame Photometer, UV-vis spectrophotometer.
2. Students should be able to learn separation of analytes by chromatography and test contaminated water samples.
3. Students should be able to determine composition of soil and estimate its macronutrients using Flame photometry.

Learning Resources	
Text Books	1. Vogel, Arthur I: *A Text book of Quantitative Inorganic Analysis (Rev. by G.H. Jeffery and others) 5th Ed.* The English Language Book Society of Longman. 2. Willard, Hobart H. et al.: *Instrumental Methods of Analysis, 7th Ed*. Wardsworth Publishing Company, Belmont, California, USA. 3. Christian, Gary D; *Analytical Chemistry, 6th Ed*. John Wiley & Sons, New York. 4. Harris, Daniel C: *Exploring Chemical Analysis, Ed*. New York, W.H. Freeman. 5. Khopkar, S.M. *Basic Concepts of Analytical Chemistry*. New Age, International Publisher.

Reference Books	6. Skoog, D.A., Holler F.J. and Nieman, T.A. *Principles of Instrumental Analysis,*Thomson Asia Pvt. Ltd. Singapore. 7. Mikes, O. and Chalmers, R.A. Ed. *Laboratory Hand Book of Chromatographic andAllied Methods*, EllesHorwood Ltd. London. 8. Dilts, R.V. *Analytical Chemistry – Methods of separation* Van Nostrand.

		L	T	P	C
Course Code-20CYH-224PA	**Subject Name: ANALYTICAL METHODS IN CHEMISTRY PRACTICAL**	**0**	**0**	**2**	**2**
Course Category-P	**Pre-requisite-**				
	Co-requisite-20CYH-224PA				
	Designed –Department of Chemistry				

COURSE OBJECTIVE:

1. To understand separation techniques
2. To understand the basic concept of solvent extraction.

UNIT	Course contents	Contact Hours
	1. Solvent Extractions: (i) To separate a mixture of Ni^{2+} & Fe^{2+} by complexation with DMG and extracting the Ni^{2+} DMG complex in chloroform. Analysis of soil: (i) Determination of pH of soil. (ii) Total soluble salt (iii) Estimation of calcium, magnesium (iv) Qualitative detection of nitrate, phosphate Ion exchange: (i) Determination of exchange capacity of cation exchange resins and anion exchange resins. **2**. Spectrophotometry Verification of Lambert-Beer's law and determination of	30

	concentration of a coloured species	

LEARNING OUTCOME:

1. Students should be able to execute the solvent extraction and separation of mixtures.
2. Students should be able to determine exchange capacity of different resins.

Learning Resources	
Text Books	1. Ahluwalia, V. K. & Dhingra, S. Comprehensive Practical Organic Chemistry: Qualitative Analysis, University Press. 2. Mann, F.G. & Saunders, B.C. *Practical Organic Chemistry* Orient-Longman. 3. Vogel, A. I., Tatchell, A. R., Furnis, B. S., Hannaford, A. J. & Smith, P.W.G., *Textbook of Practical Organic Chemistry*, Prentice-Hall

		L	**T**	**P**	**C**
Course Code-20CYH-224B	**Subject Name: INDUSTRIAL METHODS OF ANALYSIS**	**4**	**0**	**0**	**4**
Course Category-P	**Pre-requisite-**				
	Co-requisite-20CYH-224B				
	Designed –Department of Chemistry				

COURSE OBJECTIVE

1. To understand basic concept of spectroscopic method of analysis.
2. To understand the basic concept of chromatography and its application for purification/isolation, identifications.

UNIT	Course contents	Contact Hours
Unit-I	Introduction to spectroscopic methods of analysis: Recap of the spectroscopic methods covered in detail in the core chemistry syllabus: Treatment of analytical data, including error analysis. Classification of analytical methods and the types of instrumental methods. Consideration of electromagnetic radiation.	10

Unit-II	**Molecular spectroscopy:** Infrared spectroscopy: Interactions with molecules: absorption and scattering. Means of excitation (light sources), separation of spectrum (wavelength dispersion, time resolution), detection of the signal (heat, differential detection), interpretation of spectrum (qualitative, mixtures, resolution), advantages of Fourier Transform (FTIR). Samples and results expected. Applications: Issues of quality assurance and quality control, Special problems for portable instrumentation and rapid detection. UV-Visible/ Near IR – emission, absorption, fluorescence and photoaccoustic. Excitation sources (lasers, time resolution), wavelength dispersion (gratings, prisms, interference filters, laser, placement of sample relative to dispersion, resolution), Detection of signal (photocells, photomultipliers, diode arrays, sensitivity and S/N), Single and Double Beam instruments, Interpretation (quantification, mixtures, absorption vs. fluorescence and the use of time, photoaccoustic, fluorescent tags).	20
Unit-III	**Separation techniques Chromatography:** Gas chromatography, liquid chromatography, supercritical fluids, Importance of column technology (packing, capillaries), Separation based on increasing number of factors (volatility, solubility, interactions with stationary phase, size, electrical field), Detection: simple vs. specific (gas and liquid), Detection as a means of further analysis (use of tags and coupling to IR and MS), Electrophoresis (plates and capillary) and use with DNA analysis. Immunoassays and DNA techniques Mass spectroscopy: Making the gaseous molecule into an ion (electron impact, chemical ionization), Making liquids and solids into ions (electro spray, electrical discharge, laser desorption, fast atom bombardment), Separation of ions on basis of mass to charge ratio, Magnetic,	15

	Time of flight, Electric quadruple. Resolution, time and multiple separations.	
Unit-IV	**Elemental analysis:** Mass spectrometry (electrical discharges). Atomic spectroscopy: Atomic absorption, Atomic emission, and Atomic fluorescence. Excitation and getting sample into gas phase (flames, electrical discharges, plasmas), Wavelength separation and resolution (dependence on technique), Detection of radiation (simultaneous/scanning, signal noise), Interpretation (errors due to molecular and ionic species, matrix effects, other interferences). **NMR spectroscopy:** Principle, Instrumentation, Factors affecting chemical shift, Spincoupling, applications. **Electroanalytical Methods:** Potentiometry & Voltammetry, Radiochemical Methods, X-ray analysis and electron spectroscopy (surface analysis)	15

LEARNING OUTCOME:

Student will be able to analyze toxic substances using different techniques that are used in industries.

Learning Resources	
Text Books	1. Principles of Instrumental Analysis - 6th Edition by Douglas A. Skoog, F. James Holler, and Stanley Crouch (ISBN 0-495-01201-7). 2. Instrumental Methods of Analysis, 7th ed, Willard, Merritt, Dean, Settle. 3. P.W. Atkins: Physical Chemistry.

Reference Books	4. G.W. Castellan: Physical Chemistry. 5. C. N. Banwell: Fundamentals of Molecular Spectroscopy. 6. Brian Smith: Infrared Spectral Interpretations: A Systematic Approach.

		L	T	P	C
Course Code-20CYH-221PB	**Subject Name: INDUSTRIAL METHODS OF ANALYSIS PRATICAL**	**0**	**0**	**4**	**2**
Course Category-P	**Pre-requisite-**				
	Co-requisite-20CYH-221PB				
	Designed –Department of Chemistry				

COURSE OBJECTIVE:

1. To understand safety practices in the Chemistry Laboratory.
2. To understand the separation method of different natural as well as synthetic chemicals by different methods.

UNIT	Course contents	Contact Hours

	1. Safety Practices in the Chemistry Laboratory 2. Analysis of industrial effluents. 3. Determination of the isoelectric point and pH of a protein. 4. Titration curve of an amino acid. 5. Determination of the void volume of a gel filtration column. 6. Determination of a Mixture of Cobalt and Nickel (UV/Vis spec.) 7. Study of Electronic Transitions in Organic Molecules (i.e., acetone in water) 8. IR Absorption Spectra (Study of Aldehydes and Ketones) 9. Determination of Calcium, Iron, and Copper in Food by Atomic Absorption 10. Potentiometric Titration of a Chloride-Iodide Mixture 11. Cyclic Voltammetry of the Ferrocyanide/Ferricyanide Couple 12. Use of fluorescence to do presumptive tests to identify blood or other body fluids	30

LEARNING OUTCOME:

1. Students should be able to analyze amino acids.
2. Students should be able to estimate different element in food.
3. Students should be able to study of IR Absorption Spectra.

Learning Resources	
Text Books	1. Principles of Instrumental Analysis - 6th Edition by Douglas A. Skoog, F. James Holler, and Stanley Crouch (ISBN 0-495-01201-7). **2.** Instrumental Methods of Analysis, 7th ed, Willard,

	Merritt, Dean, Settle.

		L	T	P	C
Course Code-20AEC0102	**Subject Name: ABILITY ENHANCEMENT COURSES ENVIRONMENTAL STUDIES**	**2**	**1**	**0**	**3**
Course Category-P	**Pre-requisite-**				
	Co-requisite-20AEC0102				
	Designed –Department of Chemistry				

COURSE OBJECTIVE:

1. To get knowledge about the multidisciplinary nature of environmental studies, concept of ecosystem, renewable and non-renewable resources.
2. To understand the biodiversity patterns and global biodiversity hot spots, etc.

UNIT	Course contents	Contact Hours

Unit-I	**Introduction** • Introduction to environmental studies • Multidisciplinary nature of environmental studies • Scope and importance • Need for public awareness.	5
Unit-II	**Ecosystems** • Concept of an ecosystem. • Structure and function of an ecosystem. • Energy flow in an ecosystem: food chains, food webs and ecological pyramids. • Ecological succession. • Case studies of the following ecosystems: a) Forest ecosystem b) Grassland ecosystem c) Desert ecosystem d) Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries)	10
Unit III	**Natural resources: renewable & non-renewable resources:** • Land resources and land use change: Land as a resource, land degradation, landslides (natural &man-induced), soil erosion and desertification. • Forests & forest resources: Use and over-exploitation, deforestation, case studies. • Impacts of deforestation, mining, dam building on environment, forests, biodiversity and tribalpopulations. • Resettlement and rehabilitation of project affected persons; problems and concerns, case studies • Water resources: Use and over-exploitation of surface and ground water, floods, drought, conflictsover water (international & inter-state).	15

	• Food resources: World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity, case studies. • Energy resources: Renewable and non-renewable energy sources, use of alternate energy sources, growing energy needs, case studies.	
Unit-IV	**Biodiversity & conservation** • Levels of biological diversity: genetic, species and ecosystem diversity. • Biogeographic zones of India • Ecosystem and biodiversity services: Ecological, economic, social, ethical, aesthetic and Informational values • Biodiversity patterns and global biodiversity hot spots • India as a mega-biodiversity nation; Endangered and endemic species of India • Threats to biodiversity: Habitat loss, poaching of wildlife, man-wildlife conflicts, biological invasions. • Conservation of biodiversity: In-situ and Ex-situ conservation of biodiversity.	10
Unit-V	**Environmental pollution** * Definition * Types of pollutants * Causes, effects and control measures of (a) Air pollution (b) Water pollution * Solid waste management	5

LEARNING OUTCOME:

1. Students should be able to describe of environment and its importance.
2. Students should be able to discuss the basic concept of ecosystem, natural resources, renewable & non-renewable resources.

Learning Resources	
Text Books	1. Environmental Studies from crisis to cure, by R. Rajagopalan, 3rd edition, Oxford Higher Education 2. Kurian Joseph & R. Nagendran, "Essential of Environmental Studies, Pearson Education, 2004. 3. Dara S.S., A Text Book of Environmental Chemistry and pollution control, S. Chand & Company Ltd., New Delhi, 2004. 4. Jeyalakshmi, R., Principles of Environmental Science, 1st Edition, Devi Publications, Chennai 2006.
Reference Books	5. Kamaraj. P & Arthanareeswari. M, Environmental Science – Challenges andChanges, 1st Edition, Sudhandhira Publications, 2007. 6. Arivalagan. K, Ramar. P & Kamatchi. P, Principles of Environmental Science, 1st Edition, Suji Publications, 2007.

		L	T	P	C
Course Code- 20AEC0101	**Subject Name: COMMUNICATIVE ENGLISH**	**3**	**0**	**0**	**3**
Course Category-P	**Pre-requisite-**				
	Co-requisite-20AEC0101				
	Designed –Department of Chemistry				

COURSE OBJECTIVE

This course enhances and strengthens communication skills in English language facilitating the holistic and integrated development of LSRW skills – Listening, Speaking, Reading Writing. The course will expose the learners to a wide range of lexical and grammatical skills, critical reading and writing and professional communicative skills to meet the demands at workplace.

UNIT	Course contents	Contact Hours

Unit-I	**Grammar & Vocabulary Building:** Introduction - Basic English Grammar – Tenses – Active Voice - Passive Voice Phrasal verbs – Prepositions - Building Vocabulary - Prefixes and Suffixes – Simple and complex sentences	5
Unit-II	**Technical Writing Skills** Report Writing: Scientific documents/observations/experiments Discipline specific writing techniques, vocabulary and practices Curriculum Vitae – Resume Writing Abstract and Synopsis Writing Reviewing – Editing Effective Language - Formal Letters Memos & Email letters to the editor - Writing letters, informal and official Art of Condensation – Article Writing - Writing Proposals - Research Papers – Preparing Minutes of Meeting.	10
Unit-III	**Communication** English Communication - Aims & Objectives - Basics of Communication - Barriers to Communication - Non-Verbal Communication – Listening Skills - Active Listening - Effective Speaking – Speech - Art of Public Speaking – Pronunciation - Stress & Intonation in English – Debate – Conversations	10
Unit-IV	**Effective Reading** Reading strategies (Skimming, Scanning, Inferring) – Predicting and responding to content – Speed Reading – Note Making – Use of Extensive reading texts – Vocabulary Extension - Guessing from Context - Use of Extensive Reading Texts.	10
Unit-VI	**Language Through Literature** The Overcoat (Nikolai Gogol) The Open Window (H.H. Munro) To a Skylark (P.B. Shelley) The Raven (Edgar Allan Poe)	10

LEARNING OUTCOME:

Students should be able to read, write and talk English without error..

Learning Resources	
Text Book	1. Koneru, Aruna. *Professional Speaking Skills*. New Delhi: Oxford University Press, 2015. 2. Sanjay Kumar and Pushp Lata. *Technical Communication*, New Delhi: Oxford University Press, 2008. 3. Koneru, Anuna. *Professional Communication*, New Delhi: McGraw Hill Pvt. Ltd, 2008. 4. Murphy, Herta A. *Effective Business Communication*, New Delhi: McGraw Hill, 2008.
Reference Book	5. Swan, Michael. *Practical English Usage*. New Delhi: Oxford University Press, 2005. 6. Rizvi, M. Ashraf. *Effective Technical Communication*, New Delhi: McGraw Hill, 2018. 7. Barun K. Mitra, Personality Development and Soft Skills, Oxford University Press, New Delhi, 2011.

Value Added Course

Course Code: 20GE0107	**Subject Name: NSS/NCC / NSO /YOGA**	**L**	**T**	**P**	**C**
		0	0	2	1
Course Category-G	**Pre-requisite- No**				
	Co-requisite-yes				
	Designed –Department of Chemistry				

Unit	Lecture	Practical
1	**Yoga**- History, Classification and importance	Practice of **Relaxing asanas** (Savasana, Shashankasana, Makarasana & its Variations)
2	**Asanas**- Meaning, Classifications of Asanas	Practice of **Meditative Asanas** (Padmasana, Swastrikasana, Sukhasana, Vajrasana, Siddhasana)
3	**Asanas**- General Benefits of Asanas	Practice of **Cultural Asanas** (Bhujangasana, Sarvangasana, Salabhasana, Ardha Matsyendrasana, Matsyasana, Dhanurasana, Setubandhasana, Chakrasana, Ardha Halasana,

		Purna Halasana)
4	**Suryanamaskar**- Meaning, Steps & Benefits	Practice of **Suryanakaskar**
5	**Pranayam** – Meaning,Types, Steps & Benefits	Practice of **Pranayam** (Purak, Rechak, Khumbhak, anulom-Vilom, Kapal-Bhathi, Bhramri, Shitli & Shitkari)
6	**Meditation**- Meaning, Rules & General Benefits	Practice of **Meditation**
		Contac Hours = 15

NSO Curriculum

	Lecture	**Practical**
1	**Basketball-** History, Measurements, rules & regulations, basic skills, Awardees, Important Tournaments, Standard Venues	Practise of basic skills with the implementation of basic rules of **Basketball**
2	**Cricket-** History, Measurements, rules & regulations, basic skills, Awardees, Important Tournaments, Standard Venues	Practise of basic skills with the implementation of basic rules of **Cricket**
3	**Football-** History, Measurements, rules & regulations, basic skills, Awardees, Important Tournaments, Standard Venues	Practise of basic skills with the implementation of basic rules of **Football**
4	**Volleyball-** History, Measurements, rules & regulations, basic skills, Awardees, Important Tournaments, Standard Venues	Practise of basic skills with the implementation of basic rules of **Volleyball**
		Contact Hours = 8

Assessment of Student Learnings: Students will be assessed for their ability to focus, participate, make effort, and search alignment. Continual progress, the desire to improve, use of breath, posturing, and focus are the primary things the instructor will look for. Project file also has to be maintained for record keeping.

	Grading based upon	**Percentage of grade**
#1	Skill Performance	40%
#2	Project (Practical File)	30%
#3	Viva	30%
TOTAL		**100%**