

# Department of Chemistry

## B.Sc. (Hons.) with Specialization in Chemistry

Academic Year: 2025-2028

Total Credits: 148

Semester-I					Semester-II						
Code	Course Name	L	T	P	C	Code	Course Name	L	T	P	C
MAS1110	Fundamental of Calculus	3	1	0	4	MAS1211	Group Theory	3	1	0	4
CHY1106	States of Matter	3	1	0	4	PHY1204	Electricity and Magnetism	3	1	0	4
PHY1103	Oscillations and Wave Optics	3	1	0	4	PHY1232	Electricity and Magnetism Lab	0	0	4	2
CHY1134	Chemistry Lab 1	0	0	4	2	CHY1205	Stereochemistry and Reaction Mechanisms	3	1	0	4
PHY1132	Wave and Optics Lab	0	0	2	2	MAS1212	Ordinary Differential Equations (Minor)	3	1	0	4
LLC1110	Communicative English	2	0	0	2	CAP1203	Principles of Programming Languages (SEC)	2	1	0	3
CAP1104	Fundamentals of Computer	1	1	2	3	CHY1234	Chemistry Lab 2	0	0	4	2
CHY1003	Environmental Science (VAC)	3	0	0	3	MAS1213	Indian Knowledge System	1	0	0	1
<b>Total</b>		<b>15</b>	<b>4</b>	<b>8</b>	<b>24</b>	<b>Total</b>		<b>15</b>	<b>5</b>	<b>8</b>	<b>24</b>
<b>Total contact hours</b>		<b>27</b>				<b>Total contact hours</b>		<b>28</b>			
Semester-III					Semester-IV						
Code	Course Name	L	T	P	C	Code	Course Name	L	T	P	C
CHY2107	Structure and Properties of Atoms and Molecules	2	1	0	3	CHY2208	Structure and Bonding in Main Group	3	1	0	4
CHY2105	Hydrocarbons and Halogen Derivatives	2	1	0	3	CHY2205	Oxygen containing Derivatives	3	1	0	4
CHY2108	Equilibrium and Thermodynamics	2	1	0	3	CHY2206	Kinetics and Electrochemistry	3	1	0	4
CHY2133	Chemistry Lab-3	0	0	6	3	CHY2207	Nuclear and Analytical Chemistry	3	1	0	4
XXXXXXX	GE-III (A)	2	1	0	3	CHY2209	p-Block Elements, Noble Gases and Symmetry	3	1	0	4
XXXXXXX	GE-III (A) Lab	0	0	2	1	CHY2233	Chemistry Lab-4	0	0	8	4
XXXXXXX	GE-III (B)	2	1	0	3	XXXXXXX	Open Elective	2	1	0	3
XXXXXXX	GE-III (B) Lab	0	0	2	1						
XXXXXXX	SEC - I	2	0	0	2						
XXXXXXX	SEC - II	2	0	0	2						
<b>Total</b>		<b>14</b>	<b>5</b>	<b>10</b>	<b>24</b>	<b>Total</b>		<b>17</b>	<b>6</b>	<b>8</b>	<b>27</b>
<b>Total contact hours</b>		<b>29</b>				<b>Total contact hours</b>		<b>31</b>			
Semester-V					Semester-VI						
Code	Course Name	L	T	P	C	Code	Course Name	L	T	P	C
CHY3107	Organometallic Chemistry	3	1	0	4	CHY3205	Organic Spectroscopy	3	1	0	4
CHY3105	Advanced Stereo Chemistry and Heterocyclic Compounds	3	1	0	4	CHY3206	Quantum Chemistry and its Applications	3	1	0	4
CHY3133	Chemistry Lab-5	0	0	8	4	CHY3233	Chemistry Lab-6	0	0	8	4
CHY3106	Transition Metals and Coordination Chemistry	2	1	0	3	CHYXXXXX	DSE – I	2	1	0	3
CHY3107	Surface Phenomena and Phase Equilibria	2	1	0	3	CHYXXXXX	DSE – II	2	1	0	3
CHY3170	Project	0	0	12	6	XXXXXXX	GE-IV	2	1	0	3
						XXXXXXX	GE-IV Lab	0	0	2	1
						XXXXXXX	Open Elective	2	1	0	3
<b>Total</b>		<b>10</b>	<b>4</b>	<b>20</b>	<b>24</b>	<b>Total</b>		<b>14</b>	<b>6</b>	<b>10</b>	<b>25</b>
<b>Total contact hours</b>		<b>34</b>				<b>Total contact hours</b>		<b>30</b>			

### Discipline Specific Electives

Semester-VI			
Code	Course Name	Code	Course Name
CHY3241	Modern Electrochemistry	CHY3242	Statistical Thermodynamics
CHY3144	Mathematics for Chemists	CHY3243	Industrial Chemicals and Environment
CHY3246	Forensic Chemistry	CHY3247	Analytical Methods in Forensic Science

### Flexi Cores /Generic Electives

Semester-III		Semester-VI	
Code	Course Name	Code	Course Name
MAS2144	Real Analysis	MAS3244	Complex Analysis
PHY2160	Electronics	PHY3260	Modern Physics
BIO2150	Essentials of Molecular Biology	BIO3250	Physiology of Plants
BIO2136	Molecular Biology Laboratory	BIO3236	Plant Physiology Laboratory
MAS2145	Probability Theory and Numerical Analysis		
PHY2161	Heat and Thermodynamics		
BIO2152	Genetics and Genes		
BIO2138	Genetics and Genes Lab		
CHY2260	Fundamentals of Biochemistry		
		Semester-VI	
		Code	Course Name
		MAS3244	Complex Analysis
		PHY3260	Modern Physics
		BIO3250	Physiology of Plants
		BIO3236	Plant Physiology Laboratory

### Skill Enhancement Courses (SEC)

Semester-III			
Code	Course Name	Code	Course Name
CHY2150	Medicinal Chemistry		Chemistry of Natural Products
CHY2151	Cheminformatics	CHY2154	Polymer Chemistry
CHY2152	Fuel Chemistry	CHY2155	Chemistry of Cosmetics and Perfumes
CHY2157	Industrial Chemistry	CHY2156	Pesticide Chemistry

### THIRD SEMESTER

#### CHY2104: STRUCTURE AND PROPERTIES OF ATOMS AND MOLECULES [3 1 0 4]

Atomic Structure: Schrodinger's wave equation, significance of  $\Psi_1$  and  $\Psi_2$ , four quantum numbers and their significance, radial and angular probability, shapes of s, p, d and f orbitals, fundamental properties of atoms such as atomic volume, the sizes of atoms, ionization energy, electron affinity and their periodic trends. Electronegativity and Polarity of Bonds: Electronegativity, different scales and methods of determination, dipole moments, percentage of ionic character from dipole moment and electronegativity difference. Periodic Table and Chemical Periodicity: The relationship between chemical periodicity and electronic structure of the atom, the long form of the periodic table, classification of elements in s, p, d and f block of elements, diagonal behaviour between elements. Valence Bond Theory and Molecular Orbital Theory: Valence bond (VB) approach, molecular orbitals (MO) approach of bonding (LCAO Method) bonding in homo-nuclear and hetero-nuclear molecules. Acids-Bases: various definitions of acids and bases, a generalized acid-base concept, measurement of acid-base strength, Lewis interactions, Pearson's HSAB concept.

#### References:

1. J. D. Lee, Concise Inorganic Chemistry, Blackwell Science, 2008.
2. J. E. Huheey, E. A. Keiter & R. L. Keiter, Inorganic Chemistry: Principles of Structure and Reactivity, Pearson India, 2008.
3. D. Shriver & P. Atkins, Inorganic Chemistry, Oxford University Press, 2011.
4. F. A. Cotton, G. Wilkinson, C. A. Murillo & M. Bochmann, Advanced Inorganic Chemistry, Wiley India, 2007.
5. C. Housecroft & A. G. Sharpe, Inorganic Chemistry, Pearson India, 2012

#### CHY2105: HYDROCARBONS AND HALOGEN DERIVATIVES [2 1 0 3]

Alkanes and Cycloalkanes: IUPAC nomenclature of branched and unbranched alkanes, methods of synthesis of alkanes, physical properties and chemical reactions of alkanes, nomenclature of cycloalkanes, methods of synthesis of cycloalkanes, Baeyer's strain theory and its limitations. Alkenes: Nomenclature of alkenes, methods of formation, Saytzeff rule, Hoffmann elimination, physical properties and relative stabilities of alkenes, chemical reactions of alkenes, Markownikoff's rule, polymerization of alkenes, Methods of formation, conformation and chemical reactions of cycloalkenes, nomenclatures and classification of dienes, isolated conjugated and cumulated dienes. Structure of allenes and butadiene. Alkynes: Nomenclature, structure and bonding in alkynes, methods of formation, chemical reactions of alkynes, acidity of alkynes, mechanism of electrophilic and nucleophile addition reactions, hydroboration-oxidation and polymerization. Arenes and Aromaticity: Nomenclature of benzene and derivatives, Kekule structure, carbon-carbon bond lengths of benzene, resonance structure, MO picture, Aromatic electrophilic substitution, activating and deactivating substituents, orientation and ortho/para ratio. Alkyl Halides: Nomenclature and classes of alkyl halides, methods of formation, chemical reactions of alkyl halides, SN2, SN1, SN1 reactions mechanism with energy profile diagrams, polyhalogen compounds. Aryl Halides: Methods of formation of aryl halides, chemical reaction, addition-elimination and the elimination-addition mechanisms of nucleophile aromatic substitution reactions.

#### References:

1. R. T. Morrison, R. N. Boyd and S. K. Bhattacharjee, Organic Chemistry, Pearson India, 2011.
2. T. W. G. Solomons and C. B. Fryhle, Organic Chemistry, Wiley India, 2012.
3. P. Sykes, A Guidebook to Mechanism in Organic Chemistry, Pearson India, 2003.
4. F. A. Carey and R. J. Sundberg, Advanced Organic Chemistry: Structure and Mechanisms (Part A), Springer India Private Limited, 2007.
5. F. A. Carey and R. J. Sundberg, Advanced Organic Chemistry: Reaction and Synthesis (Part B), Springer India Private Limited, 2007.

#### CHY2108: EQUILIBRIUM AND THERMODYNAMICS [3 1 0 4]

The First Law of Thermodynamics: Thermodynamic terms and basic concepts, intensive and extensive properties, state functions and differentials, thermodynamic processes, reversibility, irreversibility, various statements of first law, internal energy (U) and enthalpy (H). Thermochemistry: The reaction enthalpy, standard enthalpies, Hess's law and reaction enthalpies, Kirchoff's equation, relation between H and U for reactions, calorimetric measurements, varieties of enthalpy changes. The Second Law of Thermodynamics: Concept of entropy, entropy change in physical change; Clausius inequality, entropy as criteria of spontaneity and equilibrium. Entropy change in ideal gases and mixing of gases, Gibbs and Helmholtz functions; Gibbs function (G) and Helmholtz function (A) as thermodynamic quantities, criteria for thermodynamic equilibrium and spontaneity; Variation of G and A with P, V, and T. The Third Law of Thermodynamics: Nernst heat theorem, statement and concept of residual entropy, evaluation of absolute entropy from heat capacity data. Partial Molar Properties and Fugacity: Partial molar properties, chemical potential of a perfect gas, dependence of chemical potential on temperature and pressure, Gibbs-Duhem equation, real gases, fugacity, Clausius-Clapeyron equation and its application to solid-liquid, liquid-vapour and solid-vapour equilibria. Thermodynamics of Simple Mixtures: Thermodynamic functions for mixing of perfect gases, chemical potential of liquids. Raoult's law, Henry's law. Thermodynamics of Diffusion: Thermodynamic view of diffusion, relation between transport properties, Einstein relation, Nernst-Einstein relation, Stoke's Einstein relation. Chemical Equilibrium: Direction of spontaneous change in a chemical reaction, extent of reaction, stoichiometric coefficients, equilibrium constant in terms of G. temperature and pressure dependence of equilibrium constant, homogeneous and heterogeneous equilibria. Complex Equilibria – acid base equilibria, salt hydrolysis.

**References:**

1. P. Atkins and J. de Paula, Atkins's Physical Chemistry, Oxford University Press, NY, 2004.
2. B. R. Puri, L. R. Sharma and M. S. Pathania, Principal of Physical Chemistry, Vishal Publication Jalandhar, 2010.
3. P. C. Rakshit, Physical Chemistry, Sarat Book House, 2014.
4. D. A. McQuarrie and J. D. Simon, Physical Chemistry: A Molecular Approach, Viva books, 2011.
5. G. M. Barrow, Physical Chemistry (Special Indian Edition), Tata Mcgraw Hill Education Private Limited, 2006.
6. G. W. Castellan, Physical Chemistry, Narosa Publishing House, 2004.

**CHY2133: CHEMISTRY LABORATORY-3 [0 0 6 3]**

Treatment of Experimental Data: Accuracy, precision and error analysis. Liquids and Solutions: Determination of viscosity of different solvents and solutions. Physical Chemistry – Liquids and Solutions: (i) To determine surface tensions of solutions of alcohol in water at different concentrations and to calculate surface excess, (ii) To determine refractive index and molar refractivity of some organic liquids. Distribution Law: (i) Determination of partition coefficient of a solute in water and a non-aqueous solvent, (ii) determination of the equilibrium constant of the reaction  $I_2 + KI \rightleftharpoons KI_3$  by the partition method and the corresponding free energy change, Surface Phenomena: Adsorption of some organic acids on charcoal. Qualitative Organic Analysis: Qualitative organic analysis of functional groups.

**References:**

1. G. D. Christian, Analytical Chemistry, John Wiley, 2004.
2. J. Mendham, R. C. Denney, M. J. K Thomas and D. J. Barne, Vogel's Quantitative Chemical Analysis, Pearson India, 2009.
3. A. I. Vogel, Elementary Practical Organic Chemistry: Small Scale Preparations Part 1, Pearson India, 2010.

**FOURTH SEMESTER**

**CHY2208: STRUCTURE AND BONDING IN MAIN GROUP [3 1 0 4]**

Hydrogen: Position in the periodic table, isotopes, industrial production, properties, reactions and isotopes. The s-block Elements: Production and uses of alkali and alkaline earth metals, chemical reactivity, structure and properties of oxides, halides and hydroxides, coordination complexes. The p-block Elements - I: Chemical reactivity of B, Al, Ga, In and Tl, compounds of boron and aluminum, chemical reactivity and group trends of C, Si, Ge, Sn and Pb, allotropes

of carbon, compounds of Si, Ge, Sn and Pb. Ionic Bond: Factors affecting the stability of ionic compounds, lattice energy, Born Lande equation and its applications, Madelung constant, Born-Haber cycle, Fajan's rules, ionic radii, factors affecting the radii of ions, Structure of crystal lattices, predictive power of thermochemical calculations on ionic compounds. Intermolecular Forces and Metallic Bond: Van der Waals forces (Keesom, Debye & London Interactions). Structure of metals, valence bond and band model. Perfect and Imperfect Crystals: Intrinsic and extrinsic defects, point defects, line and plane defects, vacancies-Schottky and Frenkel defects, thermodynamics of Schottky and Frenkel defect, band theory, band structure of metals, insulators and semiconductors, intrinsic and extrinsic semiconductors, doping semiconductors, p-n junctions, high temperature super conductors.

**References:**

1. J. D. Lee, Concise Inorganic Chemistry, Blackwell Science, 2008.
2. J. E. Huheey, E. A. Keiter & R. L. Keiter, Inorganic Chemistry: Principles of Structure and Reactivity, Pearson India, 2008.
3. D. Shriver & P. Atkins, Inorganic Chemistry, Oxford University Press, 2011.
4. F. A. Cotton, G. Wilkinson, C. A. Murillo & M. Bochmann, Advanced Inorganic Chemistry, Wiley India, 2007.
5. C. Housecroft and A. G. Sharpe, Inorganic Chemistry, Pearson India, 2012.

**CHY2205: OXYGEN CONTAINING DERIVATIVES [3 1 0 4]**

Alcohols: Classification and nomenclature of monohydric, dihydric and trihydric alcohols, methods of formation and reactions of alcohols. Phenols: Nomenclature, structure and bonding of phenols, synthesis and reactions of phenols, physical properties and acidic character. Ethers and Epoxides: Nomenclature of ethers and methods of their preparation, physical properties, chemical reactions, cleavage and autoxidation, synthesis of epoxides, acid and base catalyzed ring opening of epoxides. Aldehydes and Ketones: Nomenclature and structure of the carbonyl group, synthesis of aldehydes and ketones, physical properties of aldehydes and ketones reactions of aldehydes and ketones with mechanism, introduction to  $\alpha$ ,  $\beta$ -unsaturated aldehydes and ketones. Carboxylic Acids: Nomenclature, structure and bonding, physical properties, acidity of carboxylic acids, effects of substituents on acid strength, preparation of carboxylic acids, reactions of carboxylic acids. Carboxylic Acid Derivatives: Structure and nomenclature of acid chlorides, esters, amides (urea) and acid anhydrides, relative stability of acyl derivatives.

**References:**

1. R. T. Morrison, R. N. Boyd and S. K. Bhattacharjee, Organic Chemistry, Pearson India, 2011.
2. T. W. G. Solomons and C. B. Fryhle, Organic Chemistry, Wiley India, 2012.
3. P. Sykes, A Guidebook to Mechanism in Organic Chemistry, Pearson India, 2003.
4. F. A. Carey and R. J. Sundberg, Advanced Organic Chemistry: Structure and Mechanisms (Part A), Springer India Private Limited, 2007.
5. F. A. Carey and R. J. Sundberg, Advanced Organic Chemistry: Reaction and Synthesis (Part B), Springer India Private Limited, 2007.

**CHY2206: KINETICS AND ELECTROCHEMISTRY [3 1 0 4]**

Chemical Kinetics: Rate of reaction, rate constant and rate laws, the order of reaction, first, second and third and zero order reactions, half-lives, determination of reaction order, temperature dependence of reaction rates, reaction mechanism, rate-determining step approximation, steady-state approximation, explosive/branched chain reactions. Catalysis: homogeneous catalysis, autocatalysis, oscillation reactions, bistability, enzyme catalysis, heterogeneous catalysis. Thermodynamics of Electrolytic Solutions: Activities of ions in solutions, model of ions in a solution, qualitative idea of Debye-Huckel theory, ionic strength, mean ionic activity coefficient and the Debye-Huckel limiting law for activity coefficients. Electrochemical Cells: Interfacial potential difference, the electrodes, potential at interfaces, electrode potentials, galvanic cells, EMF, direction of spontaneous reactions, measurements of solubility product, potentiometric titrations, pK and pH measurements. Equilibrium Electrochemistry: Transport of ions in solution, conductivity, Kohlrausch's law, Ostwald dilution law, mobility of ions, transport number and its

measurement, Arrhenius theory of Conductivity, Debye-Huckel-Onsager theory of conductivity. Dynamic Electrochemistry: Processes at electrodes, double layer at the interface.

**References:**

1. P. Atkins and J. de Paula, Atkins's Physical Chemistry, Oxford University Press, NY, 2004.
2. B. R. Puri, L. R. Sharma and M. S. Pathania, Principal of Physical Chemistry, Vishal Publication Jalandhar, 2010.
3. P. C. Rakshit, Physical Chemistry, Sarat Book House, 2014.
4. S. Glasstone, An Introduction to Electrochemistry, East-West Press (Pvt.) Ltd., 2006.
5. A. J. Bard and L. R. Faulkner, Electrochemical Methods: Fundamentals and Applications, John Wiley & Sons, 2001.
6. K. J. Laidler, Chemical Kinetics, Pearson Education India, 2003.
7. S. K. Upadhyay, Chemical Kinetics and Reaction Dynamics, Springer-Verlag New York Inc., 2006.
8. O. Levenspiel, Chemical Reaction Engineering, Wiley, 2006.

**CHY2207: NUCLEAR AND ANALYTICAL CHEMISTRY [3 1 0 4]**

Nuclear Chemistry: Atomic Nucleus, radioactive decay;  $\alpha$ ,  $\beta$  and  $\gamma$  particles, nuclear stability, liquid drop model, shell model, nuclear reactions, nuclear fission and fusion. Concepts of Analytical Chemistry: Qualitative and quantitative analysis – classifications, methods, sampling, sample preparation, calibration, equilibrium calculations. Volumetric and Gravimetric Analysis: Theory, equivalent points, standard solutions, end point detection, precipitation, washing and filtration of precipitates, determination of inorganic salts in mixtures, DSC, TGA, DTA. Acid-Base Equilibria: Preparation of standard solutions, mono and poly functional acids and bases, pH titration curves, applications. Precipitation Equilibria: Solubility, competing equilibria, separation of ions, effect of electrolyte concentration on solubility, solubility product. Complexation Equilibria: Complexation, formation constants, EDTA equilibria, indicators, applications. Principles of Automation: Instrumental parameters for automation. Atomic X-ray Spectrometry: Fundamentals, instrumentation, X-ray fluorescence, applications, coating and film thickness measurements, electron probe microanalysis, X-ray absorption spectrometry. Solvent Extraction and Ion-Exchange Separation: Principles, solvent extraction of metals, extraction process, separation efficiency, ion-exchange processes, techniques and applications. Atomic Spectrometric Methods: ES, FES, PES, AAS. Chromatography: the principles, instrumentation, and applications of chromatography methods, including gas chromatography (GC), liquid chromatography (LC), and thin-layer chromatography (TLC).

**References:**

1. H. J. Arnika, Essentials of Nuclear Chemistry, Wiley-Blackwell, 2011.
2. G. D. Christian, Analytical Chemistry, John Wiley, 2004.
3. D. A. Skoog, D.M. West, F.J. Holler, S.R. Crouch, Fundamentals of Analytical chemistry, Brooks/Cole, 2004.
4. G. Friedlander, J.W. Kennedy, E.S. Macias and J.M. Miller, Nuclear and Radiochemistry, Wiley India, 1981.
5. D. A. Skoog., Principles of Instrumental Analysis, Holt-Saunders International edition 2004.
6. R. A. Day & A. L. Underwood, Quantitative Analysis, Pearson, 1991.

**CHY2209: P-BLOCK ELEMENTS, NOBLE GASES AND SYMMETRY [3 1 0 4]**

The p-block Elements-II: Chemical reactivity and group trends of N, P, As, Sb & Bi, compounds of N, P, As, Sb & Bi, O, S, Se and Te Family: Chemical Reactivity, group trends and stereochemistry, dioxygen as a ligand, structure of O<sub>3</sub> and H<sub>2</sub>O<sub>2</sub>, clathrate hydrates allotropic forms of S & Se, structures of halides, oxides and oxyacids of S, Se & Te, liquid SO<sub>2</sub> and polyatomic cations of S, Se & Te. The Halogen Family: Chemical reactivity, group trends, chemistry of preparation of fluorine, hydrogen halides, HF as a solvent, inter-halogen compounds, polyhalide and polyhalonium ions, polyatomic cations of halogens, oxides and oxyacid of halogens. Noble Gases: Chemical reactivity and group trends, Clathrate compounds, preparation, structure and bonding of noble gas compounds. Introduction to Symmetry and Group Theory: Symmetry elements and symmetry operations, point groups, definitions of group.

**References:**

1. J. D. Lee, Concise Inorganic Chemistry, Blackwell Science, 2008.
2. J. E. Huheey, E. A. Keiter and R. L. Keiter, Inorganic Chemistry: Principles of Structure and Reactivity, Pearson India, 2008.
3. S. Swarnalakshmi, T. Saroja, & R. M. Ezhilarasi, Simple Approach to Group Theory in Chemistry, Universities Press, 2008.
4. F. A. Cotton, G. Wilkinson, C. A. Murillo and M. Bochmann, Advanced Inorganic Chemistry, Wiley India, 2007.
5. R. L. Carter, Molecular Symmetry and Group Theory, Wiley International, 2009.

#### **CHY2233: CHEMISTRY LABORATORY-4 [0 0 8 4]**

Physical Chemistry: Polarimetry - kinetics of inversion of cane sugar by means of polarimetry; Chemical Kinetics – determination of activation energy of a reaction by studying its temperature dependence, kinetics of the reactions of potassium iodide and ester hydrolysis; pH-metry – titrations, determination of ionization constant of the weak base. Colorimetry: (i) Verification of Lambert-Beer law, (ii) To determine the composition of a complex by Job's method of continuous variations (Ferric-salicylate Complex), (iii) To titrate copper with EDTA photometrically. Inorganic Chemistry: (i) Gravimetric Methods, Estimation of Ba<sup>2+</sup> as BaSO<sub>4</sub> and Ni<sup>2+</sup> as Nickel dimethylglyoxime Complex and Co<sup>2+</sup> gravimetrically. Determination of two metal ions, Cu-Ni and Cu-Fe. (ii) Preparation of anhydrous stannous chloride, (iii) Complexometric titrations involving EDTA for quantitative determination of individual cation/mixture of cations. Determination distribution coefficient between water and a non-aqueous solvent of a solute which associates or dissociates in one of the solvents. Chromatography: Thin Layer, Paper, and Column Chromatography, Determination of R<sub>f</sub> value and purity of organic compounds by use of thin layer chromatography, Separation of organic compound by column chromatography. Separation of cations and anions by paper chromatography.

#### **References:**

1. G. Svehla and B. Sivasankar, Vogel's Qualitative Inorganic Analysis, Pearson India, 2012.
2. A. K. Nad, B. Mahapatra, A. Ghoshal, An Advanced Course in Practical Chemistry, New Central Book Agency, 2011.

### **FIFTH SEMESTER**

#### **CHY3107: ORGANOMETALLIC CHEMISTRY [3 1 0 4]**

Organometallics: Definition, classification, EAN rule, Mg and Li-compounds, uses, importance in modern times, metal carbonyls, binary carbonyls, mixed metal polynuclear carbonyls, metal-olefin complexes, hapticity ( $\eta$ ), fluxional molecules, coordinative unsaturation, and homogeneous catalysis, Ziegler-Natta catalysis. Bonding and Structure: Molecular hydrogen compounds, metal-hydrogen interactions with C-H groups, carbonyl halides, metal nitrosyl compounds, nitrosyl carbonyls, dinitrogen and dioxygen complexes, tertiary phosphines as ligands. Organometallic Chemistry: Synthesis, structure and bonding of multi-electron cyclic and acyclic ligands, alkyl and aryls of transition metals, transition metal-carbon multiple bonds, alkylidene and alkylidyne complexes.

#### **References:**

1. B.D. Gupta and A. J. Elias, Basic Organometallic Chemistry, University Press, 2010.
2. R.C. Mehrotra, Organometallic Chemistry: A Unified Approach, New Age Publishers, 1991.
3. F. A. Cotton, G. Wilkinson, C. A. Murillo and M. Bochmann, Advanced Inorganic Chemistry, Wiley India, 2007.
4. D. Astruc, Organometallic Chemistry and Catalysis, Springer-Verlag, 2007.

#### **CHY3105: ADVANCED STEREO CHEMISTRY AND HETEROCYCLIC COMPOUNDS [3 1 0 4]**

Stereochemical Principles, Conformation, Steric and Stereo-electronic Effects: Enantiomeric relationships, diastereomeric relationships, dynamic stereochemistry, prochiral relationships, conformations of acyclic molecules, cyclohexane derivatives, rings other than six membered, conformational effects on reactivity. Free Radical Reactions:

Generation and characterization of free radicals, characteristics of reaction mechanisms involving electron transfer reactions. Carbanions and Other Nucleophilic Carbon Species: Acidity of hydrocarbons, carbanions stability by functional groups, generation of carbon nucleophiles by deprotonations, reactions involving carbanions. Heterocyclic Compounds: Introduction (pyrrole, furan, thiophene and pyridine), mechanism of electrophilic and nucleophilic substitution reactions, comparison of basicity, 5- and 6-membered heterocycles, preparation and reactions of indole, quinoline and isoquinoline with special reference to Fischer indole synthesis, Skraup synthesis and Bischler-Napieralski synthesis, mechanism of electrophilic substitution reactions of indole, quinoline and isoquinoline.

**References:**

1. R. T. Morrison, R. N. Boyd and S. K. Bhattacharjee, Organic Chemistry, Pearson India, 2011.
2. T. W. G. Solomons and C. B. Fryhle, Organic Chemistry, Wiley India, 2012.
3. P. Sykes, A Guidebook to Mechanism in Organic Chemistry, Pearson India, 2003.
4. E. L. Eliel, S. H. Wilen, Stereochemistry of Organic Compounds, Wiley, 2008.
5. P. S. Kalsi, Stereochemistry: Conformation and Mechanism, New Age International Private Limited, 2017.
6. D. Nasipuri, Stereochemistry of Organic Compounds: Principles and Applications, New Age, 2018.

**CHY3106: TRANSITION METALS AND COORDINATION CHEMISTRY [2 1 0 3]**

Chemistry of d-block Elements: Chemistry of transition metals, comparison of the chemistry of elements of second and third row series with that of elements of the first transition series. Mo-Mo and Re-Re quadrupole bonds, chemistry of complexes of Rh(III), Pt(II) and Pd(II). Chemistry of f-block Elements: Chemistry of lanthanide and actinide elements, their isolation from one another, their coordination chemistry. Coordination Compounds: Various definitions, types of ligands, chelate and macrocyclic effects, multidentate ligands, isomerism in coordination compounds, nomenclature, stability of coordination compounds, stability constants and chelate effect. Theories of Bonding in Complexes: Valence bond theory for bonding in coordination compounds, concept of multiple bonding and back bonding. Crystal Field Theory: The splitting of d-orbitals in different fields, consequences, factors affecting and applications of orbital splitting, crystal field stabilization energy (CFSE), magnetic properties, spectrochemical series and colour of transition metal complexes, John-Teller effect in octahedral and tetrahedral complexes, evidence of covalence and adjusted crystal field theory, molecular orbital treatment of octahedral, tetrahedral and square planar complexes.

**References:**

1. J. D. Lee, Concise Inorganic Chemistry, Blackwell Science, 2008.
2. J. E. Huheey, E. A. Keiter and R. L. Keiter, Inorganic Chemistry: Principles of Structure and Reactivity, Pearson India, 2008.
3. D. Shriver and P. Atkins, Inorganic Chemistry, Oxford University Press, 2011.
4. F. A. Cotton, G. Wilkinson, C. A. Murillo and M. Bochmann, Advanced Inorganic Chemistry, Wiley India, 2007.
5. C. Housecroft and A. G. Sharpe, Inorganic Chemistry, Pearson India, 2012.

**CHY3107: SURFACE PHENOMENA AND PHASE EQUILIBRIA [2 1 0 3]**

Surface Chemistry: Bulk phases and interfacial region, types of interfaces, surface tension and interfacial tension, surface tension of solutions, Gibbs adsorption equation and its thermodynamic derivation, surfactants, surface films on liquids. Colloids: The colloidal state, preparation of colloidal dispersions, dialysis, ultrafiltration, physical & optical properties, ultra-microscope, Electro kinetic phenomena, Zeta potential, Precipitation of sols by electrolytes, Hardy Schulz rules, other methods of precipitation, emulsions, association colloids/colloidal surfactants/micelle systems. Adsorption: Adsorption of gases on solids, chemisorption and physisorption, desorption, adsorption isotherms. Physical Transformation of Pure Materials: First and second order phase transitions, attainment of low temperature and energetics of refrigeration, adiabatic demagnetization. Phase Equilibria: Phase rule and its thermodynamic

derivation, one component systems, two component systems, eutectics, freezing mixtures, ultra-purity, zone refining.

**References:**

1. P. Atkins and J. de Paula, Atkins's Physical Chemistry, Oxford University Press, NY, 2004.
2. B. R. Puri, L. R. Sharma and M. S. Pathania, Principal of Physical Chemistry, Vishal Publication Jalandhar, 2010.
3. P. C. Rakshit, Physical Chemistry, Sarat Book House, 2014.
4. D. A. McQuarrie and J. D. Simon, Physical Chemistry: A Molecular Approach, Viva books, 2011.
5. I. N. Levine, Physical Chemistry, McGraw Hill, 2008.

**CHY3133: CHEMISTRY LABORATORY-5 [0 0 8 4]**

Physical Chemistry: Potentiometry, determination of molecular masses by cryoscopy, pH-metric titrations. Inorganic Chemistry: Preparation and characterization of inorganic compounds and their characterization by conductivity, conductometric/ potentiometric methods, study of reactions of the elements of first transition series: Ti, V, Cr, Mn, synthesis and characterization of inorganic/organometallic compounds, ion exchange separation of oxidation states of vanadium. Organic Chemistry - Multistep Preparations and Estimations: Protection, aromatic electrophilic substitution and deprotection, nucleophilic addition of Hoffman degradation, diazotization and Sandmeyer reaction, photoreduction, pinacol – pinacolone rearrangement, nucleophilic cleavage of C-C bond, free radical bromination by use of NBS, cross aldol condensation, Perkin reaction, diazotization, aromatic electrophilic substitution and deamination, Fries reaction, Fehling method, To estimate acid value, iodine value and saponification.

**References:**

1. J. Bassett, R.C Denney, G.H Jeffery, J. Mendham, Vogel's Textbook of Quantitative Inorganic Analysis (revised), Orient Longman, 2003.
2. S. K. Maity & N. K. Ghosh, Physical Chemistry Practical, New Central Book Agency, 2012.
3. O. P. Pamdey, D. N. Bajpai, S. Giri, Practical Chemistry, S Chand, 2010.

**SIXTH SEMESTER**

**CHY3205: ORGANIC SPECTROSCOPY [3 1 0 4]**

Electromagnetic Spectrum & Absorption Spectroscopy: Ultraviolet (UV) absorption spectroscopy—absorption laws (Beer-Lambert law), chromophore and auxochrome, bathochromic, hypsochromic, hyperchromic and hypochromic shifts, UV spectra of conjugated enes and enones. Infrared (IR) absorption spectroscopy: Molecular vibrations, Hooke's law, selection rules, intensity and position of IR bands, measurement of IR spectrum, fingerprint region, characteristic absorptions of various functional groups and interpretation of IR spectra of simple organic compounds. NMR Spectroscopy: Nuclear magnetic resonance (NMR) spectroscopy. Proton magnetic resonance,  $^1\text{H}$  ( $^1\text{H}$  NMR) spectroscopy, nuclear shielding and deshielding, chemical shift and molecular structure, spin-spin splitting and coupling constants, areas of signals, interpretation of  $^1\text{H}$  NMR spectra of simple organic molecules such as ethyl bromide, ethanol, acetaldehyde, 1,1,2-tribromoethane, ethyl acetate, toluene and acetophenone basics of  $^{13}\text{C}$  NMR. Mass Spectroscopy: Introduction, instrumentation, methods of ionization, separation, fragmentation, McLafferty rearrangement, problems pertaining to the structure elucidation of simple organic compounds using UV, IR and  $^1\text{H}$  NMR spectroscopic techniques.

**References:**

1. W. Kemp, Organic Spectroscopy, Palgrave Macmillan, 2008.
2. R.M. Silverstein, F.X. Webster, D. Kiemle, Spectrometric Identification of Organic Compounds, John Wiley & Sons, 2005.
3. D.L. Pavia, G.M. Lampman, G.S. Kriz, J.A. Vyvyan, Introduction to Spectroscopy, Cengage Learning, 2008.

**CHY3206: QUANTUM CHEMISTRY AND ITS APPLICATIONS [3 1 0 4]**

lementary Quantum Chemistry: Historical background, classical ideas of energy and particles, blackbody radiation and Planck's hypothesis of quantization of energy, photoelectric effect, de Broglie's hypothesis, Heisenberg's uncertainty principle, Schrödinger-wave equation, concept of wave function ( $\psi$ ); physical significance of  $\psi$  and  $\psi^2$ , normalization. Operators, postulates of quantum mechanics. Free particle: particle in a one and three dimensional box, translational energy, energy levels, quantization of energy, wave functions for particle in a box. Tunelling, basic concepts of STM. Time dependent Schrödinger equation, expectation values, and applications of particle in a box model, vibrational motion, classical one-dimensional harmonic oscillator, quantum mechanical harmonic oscillator, rotational motion, spherical harmonics, applications to diatomic molecule (rigid rotator), Schrödinger equation for hydrogen-like atoms, elementary discussion of its solution, wave functions for hydrogen atom, electron spin, concept of spin orbitals, spectral selection rules for one-electron atoms, spectrum of hydrogen atom. Molecular Spectroscopy: Microwave absorption, rotational spectra, rotational Raman spectra, Electronic spectra, electronic energy levels of molecules, selection rules for electronic spectra of molecules, Frank-Condon principle, photoelectron spectroscopy. Statistical thermodynamics: Distribution of Molecular States: Types of statistics, Molecular energy levels and the Boltzmann distribution, Maxwell distribution, configurations and weights, most probable configuration, Partition Function and Ensemble: the molecular partition function, physical interpretation of the partition function. The canonical ensemble, canonical partition function and its relation to molecular partition function for independent particles.

**References:**

1. I. N. Levine, Quantum Chemistry, Oxford University Press, 2000.
2. P. Atkins and J. De Paula, Atkins' Physical Chemistry, Oxford University Press, 2011.
3. C.N. Banwell and E. M. McCash, Fundamentals of Molecular Spectroscopy, McGraw Hill Education (India) Pvt. Ltd., 2013.
4. D. C. McQuarrie, Quantum Chemistry, Viva Books, 2018.
5. D. C. McQuarrie, Physical Chemistry, University Science Books, 2005.
6. A. Chandra, Introductory Quantum Chemistry, McGraw Hill Education, 2018.

**CHY3233: CHEMISTRY LABORATORY-6 [0 0 8 4]**

Inorganic Chemistry: Reactions of the elements of first transition series: a) Iron, b) Cobalt, c) Nickel, d) Copper, Preparation of chromium (II) acetate, use of inert atmosphere technique, and measurement of magnetic susceptibility; preparation and identification organometallic compounds. Qualitative Analysis: Qualitative analysis of binary mixtures, separation by ether, sodium hydroxide, sodium bicarbonate and dil. hydrochloric acid. Organic chemistry: Test for elements – N, S, X (Cl, Br, I), functional group determination, melting point, derivative preparation TLC for checking the purity and effectiveness of separation.

**References:**

1. G. Svehla and B. Sivasankar, Vogel's Qualitative Inorganic Analysis, Pearson India, 2012
2. J. Mendham, R.C. Denney, M.J.K Thomas and D. J. Barne, Vogel's Quantitative Chemical Analysis, Pearson India, 2009.
3. P. T. Kissinger and W. R. Heineman, Laboratory Techniques in Electroanalytical Chemistry, Marcel and Dekker Publisher, 1984.
4. K. Zutshi, Polarography and allied techniques, New Age International, 2006.
5. J. G. Speight, The Chemistry and Technology of Petroleum, CRC Press, New York, 2014.
6. V. Simanzhenkov & R. Idem, Crude Oil Chemistry, Marcel Dekker, New York 2003.
7. J. G. Speight, Natural Gas, Gulf Publishing Company, Houston, Texas, 2007.

**DISCIPLINE SPECIFIC ELECTIVES (DSE)**

**DSE - I**

**CHY3241: MODERN ELECTROCHEMISTRY [2 1 0 3]**

Photoelectrochemistry: Photoexcitation of electrons by absorption of light, p-type photocathodes, n-type photoanode, surface effects in photoelectrochemistry, surface states, effects of surface state on distribution of potential across the interface, Photoelectrocatalysis. Organoelectrochemistry: electrochemical route of synthesis, electro-organic synthesis, Chiral electrode, electrically conducting polymers. Electrochemistry in Material Science: charge transfer, surface, a corroding metal is analogous to a short-circuited, mechanism, cathodic reaction, thermodynamics and stability of metals, Pourbaix diagram, corrosion current and potential, electrochemicals of metal in absence of oxide films, Evans diagram, corrosion rate measurements, Stern-Gary approach, passivation. Conversion and Storage of Electrochemical Energy: Fuel cell, efficiency, kinetics, porous electrode, types of fuel cell, batteries, classical of batteries, modern batteries, electrochemical capacitor for energy storage. Bioelectrochemistry: Bioelectrochemicals, membrane potential, electrical conduction in biological organism, electrochemical mechanism of nervous system, enzyme electrochemicals. Environmental Oriented Electrochemistry: The Solar-Hydrogen solution, large scale solar-hydrogen productions, Fixing of CO<sub>2</sub>, removal of wastes.

**References:**

1. J. O. Bockris, A. K. N. Reddy, Modern Electrochemistry 2B, Kluwer Academic/Plenum Publishers, 2018.
2. P.W. Atkins, J. De Paula, Physical Chemistry, W.H. Freeman, 2012.
3. J. Koryta, J. Dvorak, L. Kavan. Principles of Electrochemistry, Wiley, 1993.

**CHY3244 MATHEMATICS FOR CHEMISTS [2 1 0 3]**

Vectors: Vectors, vector products, gradient, divergence & curl, vector calculus. Applications: Two body problem, centre of mass and relative coordinates, Potentials. Matrix Algebra: addition, multiplication, inverse, adjoint and transpose of matrices, special matrices and their properties, matrix equations and their solutions, matrix eigenvalues and eigenvectors, diagonalization, determinants, introduction to tensors. Applications: Slater determinants, Hückel Molecular Orbital Theory, Polarizability and Magnetic Susceptibility. Functions, Continuity, and Differential Calculus: rules for differentiation, applications of differential calculus including maxima and minima, exact and inexact differentials with their applications to thermodynamic properties. Applications: Maximally populated rotational energy levels, Bohr's radius, and most probable velocity from Maxwell distribution. Integral Calculus: integration by parts, partial fraction and substitution, reduction formulae, applications of integral calculus, functions of several variables, partial differentiation, co-ordinate transformations Applications: Cartesian to spherical polar, curve sketching. Differential Equations: variables-separable and exact first-order differential equations, homogeneous, exact, and linear equations, solutions of differential equations by the power series method, Fourier series, solutions of harmonic oscillator and Legendre equation etc, spherical harmonics, second order differential equations and their solutions. Applications: chemical kinetics, secular equilibria, quantum chemistry etc.

**References:**

1. The chemistry Mathematics Book, E.Steiner, Oxford University Press (2008).
2. Mathematical for Physical Chemistry : F. Daniels, Mc. Graw Hill (1959).
3. Chemical Mathematics D.M. Hirst, Longman (1979).
4. Applied Mathematics for Physical Chemistry, J.R. Barante, Prentice Hall (1974).
5. Advance Engineering Mathematics, E. Kreyszig and E. J. Norminton, Wiley (2011).

**CHY3246: FORENSIC CHEMISTRY [2 1 0 3]**

Alcohols and alcoholic beverages, Analysis of alcohols, country made liquor, illicit liquor and medicinal preparations, Analysis of various denaturants of alcohol, detection and determination of ethanol, methanol, aldehyde, ester by colour test and instrumental technique, Relevant sections of Excise Act. Metals and alloys their composition; Importance of analysis, purity of metals, trace elements, asht dhatu and their analysis. Analysis of trap case:- Mechanism of colour reaction, factor affecting the colour, detection of phenolphthalein and alkali used, method of detection of degraded product on conversion of pink colour to colourless solution by TLC and UV visible spectrophotometer. Photo and videography and voice recording as supporting evidence. Dyes: Role of dyes in crime investigation, comparison of dyes in fibres and different inks by TLC and UV-VIS Spectrophotometer. Pesticides:

Different types of pesticide, formulation, identification of pesticide, standard or sub-standard or substituted pesticides. Determination of purity by analysis by chemical test, thin layer chromatography, ultra violet - visible spectrophotometry and gas liquid chromatography. Determination of level of pesticide in water, cold drinks, milk, food materials. Analysis of Drugs: Narcotic drugs, Depressants, Barbiturates, methaqualone, Benzodiazepines, Stimulants, Hallucinogens, Designer Drugs, Club drugs, date rape drugs and precursors by Field test kits for drugs and precursors using colour test, thin layer chromatography and further confirmation by HPTLC, UV-Vis spectrophotometry, Gas Chromatography, HPLC, GC-Mass Spectrometry and LC-Mass Spectrometry, Raman Spectroscopy and FTIR after extraction of drug from the seized sample. Detection of common adulterants and determination of percentage purity in seized sample

**Reference:**

1. Barry Levine. Principles of Forensic Toxicology, 4th Edition, AACC Press, 2013.
2. Connors, K.: A text book of Pharmaceuticals analysis, Interscience, New York, 1975.
3. G. Svehla, B. Sivasankar. Vogel's Qualitative Inorganic Analysis, 2012 11.
4. Gail Cooper, Adam Negrusz. Clarke's Analytical Forensic Toxicology, Pharmaceutical Press, 2013.

**DSE - II**

**CHY3242: STATISTICAL THERMODYNAMICS [2 1 0 3]**

Partition Function and Ensemble: the molecular partition function, physical interpretation of the partition function. The canonical ensemble, canonical partition function and its relation to molecular partition function for independent particles, the statistical entropy, entropy and partition function, entropy of a monoatomic gas, Factorization of partition function, calculation of translational, rotational vibrational and electronic contributions, the overall partition function. Fermi-Dirac statistics; Bose Einstein statistics. Debye equation of states.

**References:**

1. T. Engel and P. Reid, Thermodynamics, Statistical Thermodynamics, & Kinetics, Pearson India, 2007.
2. B.R. Puri, L.R. Sharma and M.S. Pathania, Principles of Physical Chemistry, Vishal Publishing Co., 2013.
3. P. Atkins and J. De Paula, Atkins' Physical Chemistry, Oxford University Press, 2011.
4. R. J. Silbey, R. A. Albert and M. G. Bawendi, Physical Chemistry, Wiley India, 2006.
5. N. O. Smith, Elementary Statistical Thermodynamics: A Problems Approach, Kluwer Academic/Plenum Publishers, 1982.

**CHY3243: INDUSTRIAL CHEMICALS AND ENVIRONMENT [2 1 0 3]**

Industrial Gases and Inorganic Chemicals: Large scale production, uses, storage and hazards in handling of gases, i.e. oxygen, nitrogen, argon, neon, helium, hydrogen, acetylene, carbon monoxide, chlorine, fluorine, sulfur dioxide and phosgene. Manufacture, application, analysis and hazards in handling of hydrochloric acid, sulfuric acid, nitric acid, caustic soda, hydrogen peroxide, potash alum, chrome alum and potassium dichromate. Environment and its segments: Biogeochemical cycle of Carbon. Major regions of atmosphere, chemical and photochemical reactions in atmosphere, type, sources, particle size, effects and chemical nature of air pollutants, photochemical smog: its constituents and photochemistry. Environmental effects of ozone, ozone layer depletion, greenhouse effects and global warming, removal of sulphur from coal and control of particulates. Sources, nature and effect of water pollutants. Water purification methods, effluent treatment plants. Industrial effluents and their treatment of electroplating, textile, tannery, dairy, petroleum and petrochemical, agro and fertilizers, sludge disposal, industrial waste management, water quality parameter of waste water, industrial water and domestic water. Energy and environment: Sources of energy: Coal, petrol and natural gas. Nuclear fusion/fission, solar energy, hydrogen, geothermal, tidal and hydel. Disposal of nuclear waste, nuclear disaster and its management.

**References:**

1. S. E. Manahan, Environmental Chemistry, CRC Press, 2005.
2. G. T. Miller, Environmental Science, Brooks/Cole, 2006.

3. A. Mishra, Environmental Studies, Selective and Scientific books, New Delhi, 2005.
4. R. Carson, Silent Spring. Houghton Mifflin Harcourt, 2002.
5. A. K. De, Environmental Chemistry, New Age International Publishers, New Delhi, 2007.

### **CHY3247: ANALYTICAL METHODS IN FORENSIC SCIENCE [2 1 0 3]**

Basic Ideas in Forensic Science, Application of Forensic Science, Limits of Forensic Science; Locard's Exchange Principle, Forensic Laboratories, Reconstruction & Re-enactment; Elemental Analysis, Analysis of Microscopic Objects; Introduction to Chromatography, GC & HPLC; Infrared Spectroscopy; Mass Spectrometry. Introduction to DNA, Techniques used in DNA Profiling, Polymerase Chain Reaction (PCR), Short Tandem Repeats (STR), Early Uses of DNA Profiling, Mitochondrial DNA, DNA Profiling of Other Species; Introduction to Polymers & Fibres, Natural Polymers, Hair; Internal Ballistics, Gun Shot Residue. Types of Illegal Drugs, Cocaine, Opium, Morphine & Heroin, Synthetic Drugs, Detection and Identification of Drugs. Introduction to Toxicology, Deliberate & Accidental Poisoning, Toxins & Biological Poisons, Forensic Toxicology, Alcohol, Inorganic Poisons - Arsenic, Thallium, Barium; Nerve Agents.

Reference:

1. Barry Levine. Principles of Forensic Toxicology, 4th Edition, AACC Press, 2013.
2. Connors, K.: A text book of Pharmaceuticals analysis, Interscience, New York, 1975.
3. G. Svehla, B. Sivasankar. Vogel's Qualitative Inorganic Analysis, 2012 11.
4. Gail Cooper, Adam Negrusz. Clarke's Analytical Forensic Toxicology, Pharmaceutical Press, 2013.

## **SKILL ENHANCEMENT ELECTIVES (SEC)**

### **SEC – I**

### **CHY2150: MEDICINAL CHEMISTRY [2 0 0 2]**

Drugs & Pharmaceuticals: Drug discovery, design and development, Basic Retrosynthetic approach, Synthesis of the representative drugs of the following classes: analgesics agents, antipyretic agents, anti-inflammatory agents (Aspirin, paracetamol, ibuprofen), antibiotics (Chloramphenicol); antibacterial and antifungal agents (sulphonamides, sulphamethoxazol, sulphacetamide, Trimethoprim), antiviral agents (Acyclovir), Central Nervous System agents (Phenobarbital, Diazepam), Cardiovascular (Glyceryl trinitrate), antilaprosy (Dapsone), HIV-AIDS related drugs (AZT- Zidovudine). Fermentation: Aerobic and anaerobic fermentation, 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.

References:

1. G. L. Patrick, An Introduction to Medicinal Chemistry, Oxford University Press, UK, 2018.
2. V. Alagarsamy, Textbook of Medicinal Chemistry, Vallabh Prakashan, Pitampura, New Delhi.
3. T. L. Lemke, Essentials of Foye's Principles of Medicinal Chemistry, CBS Publishers and Distributors, 2005.

### **CHY2151: CHEMINFORMATICS [2 0 0 2]**

Introduction to Cheminformatics: History and evolution, Molecular Modelling and Structure elucidation. Representation of Molecules and Chemical Reactions: Nomenclature, Different types of notations: SMILES coding, Matrix representations, Structure of Molfiles and Sdfiles, Libraries and toolkits, Different electronic effects, Reaction classification. Searching Chemical Structures: Full structure search, sub-structure search, similarity search, three dimensional search methods, basics of computation of physical and chemical data and structure descriptors, data visualization. Applications: Prediction of Properties of Compounds. Linear Free Energy Relations, Quantitative Structure-Property Relations, Descriptor Analysis, Model Building, Modeling Toxicity, Structure-Spectra correlations, Application of cheminformatics in Drug Design.

References:

1. A. R. Leach & V. J. Gillet, An Introduction to Chemoinformatics. Springer: The Netherlands, 2007.

2. J. Gasteiger & T. Engel, Chemoinformatics: A Textbook, Wiley-VCH, 2003.
3. S. P. Gupta, QSAR & Molecular Modeling, Anamaya Pub.: New Delhi, 2011.

### **CHY2152: FUEL CHEMISTRY [2 0 0 2]**

Review of energy sources (renewable and non-renewable). Classification of Fuels, Calorific value. Coal: Uses (fuel and nonfuel), composition, carbonization of coal. Coal gas, Producer Gas and Water Gas: Composition and uses, fractionation of coal tar, uses of coal tar based chemicals, requisites of a good metallurgical coke, coal gasification (hydro gasification and catalytic gasification), coal liquefaction and solvent refining. Petroleum and Petrochemical Industry: Composition of crude petroleum, refining and different types of petroleum products and their applications, fractional distillation (principle and process), cracking (thermal and catalytic cracking), reforming petroleum and non-petroleum fuels (LPG, CNG, LNG, bio-gas, fuels derived from biomass), fuel from waste, synthetic fuels (gaseous and liquids), clean fuels. Petrochemicals: Vinyl acetate, propylene oxide, isoprene, butadiene, toluene and its derivatives xylene. Lubricants: Classification, lubricating oils (conducting and non-conducting) solid and semisolid lubricants, synthetic lubricants, properties of lubricants (viscosity index, cloud point, pore point) and their determination.

#### **References:**

1. P. C. Jain & M. Jain, Engineering Chemistry, Dhanpat Rai & Sons, 2019.
2. B. K. Sharma, Industrial Chemistry, Goel Publishing House, Meerut, 2016.
3. J. H. Gary, G. E. Handwerk, Mark J. Kaiser, Petroleum Refining – Technology and Economics, Marcel Dekker Inc., 1984.

### **CHY2157: INDUSTRIAL CHEMISTRY [2 0 0 2]**

Water Treatment: Sources, impurities, hardness and removal. Plastics and Rubber: Classification, manufacture, properties and uses, natural rubber, synthetic rubbers. Sugar Industry: Extraction, manufacture and refining, molasses and bagasse. Cellulose Industry: Manufacture – paper, wood pulp, multistage bleaching, Fourdrinier machine. Paints: Introduction, classification, manufacture, and requirements. Metallurgy and alloys: Principles, processes, and applications of metallurgy, the behavior and properties of alloys.

#### **References:**

1. J. A. Kent, Riegel's Handbook of Industrial Chemistry, CBS, 1997.
2. P. C. Jain and M. Jain, Engineering Chemistry, Dhanpat Rai Publishing Company (P) Ltd, 2019.

## **SEC - II**

### **CHY2153: CHEMISTRY OF NATURAL PRODUCTS [2 0 0 2]**

Structure, stereochemistry and Biogenesis: Morphine, tamiflu and Podophyllotoxin. Synthesis of Some Natural Products: i) Reserpine (Woodward synthesis) ii) Taxol iii) Estrone and Mifepristone iv) Strychnine (Overman's synthesis) v) Fredericamycin A. Secondary Metabolism: Natural Products, Primary and Secondary Metabolism, Enzymes and Coenzymes. Secondary Metabolites Derived from Acetates, Fatty acids and Polyketides, Metabolites derived from Shikimic acid Secondary Metabolism of Amino acids, Chemistry of Natural Products such as Carbohydrates, proteins and peptides, fatty acids, nucleic acids and Lipids.

#### **References:**

1. I. L. Finar, Organic Chemistry (Volume 2: Stereochemistry and the Chemistry of Natural Products), Pearson Education India, 2002.
2. J. Singh, S. M. Ali, & J. Singh, Natural Product Chemistry, Prajati Parakashan, 2010.
3. G. R. Chatwal, Organic Chemistry of Natural Products: Vol. I, Himalaya Publishing House, 2010.

### **CHY2154: POLYMER CHEMISTRY [2 0 0 2]**

Introduction and History: Classifications, nomenclature, molecular forces and chemical bonding in polymers, texture. Functionality: Criteria, polymerization processes, relationships between functionality, extent of reaction and degree of polymerization, bifunctional systems, poly-functional systems. Kinetics of Polymerization: Step growth, radical

chain growth, ionic and coordination polymerizations, copolymerization, polymerization techniques. Molecular Weight of Polymers: Distribution, significance, determination by end group analysis, viscometry, light scattering and osmotic pressure methods, Polydispersity index. Glass Transition Temperature (T<sub>g</sub>): Determination of T<sub>g</sub>, Free volume theory, WLF equation, Factors affecting glass transition temperature (T<sub>g</sub>). Properties of Polymers: Physical, thermal, flow & mechanical properties. Case studies: Preparation, structure, properties and application of important polymers. Conducting polymers and biopolymers synthesis, properties, applications, and emerging trends in these fields, with a focus on their role in modern materials science and technology.

**References:**

1. F. W. Billmeyer, Text Book of Polymer Science, John Wiley, 2007.
2. C. E. Carraher Jr., Introduction to Polymer Chemistry, CRC Press, 2013.
3. G. Odian, Principles of Polymerization, John Wiley, 1981.

**CHY2155: CHEMISTRY OF COSMETICS AND PERFUMES [2 0 0 2]**

A general study including preparation and uses of 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: Eugenol, Geraniol, sandalwood oil, eucalyptus, rose oil, 2-phenyl ethyl alcohol, Jasmine, Civetone, Muscone. Preparations: Preparation of talcum powder, Preparation of shampoo, Preparation of enamels, Preparation of hair remover, Preparation of face cream, Preparation of nail polish and nail polish remover.

**References:**

1. R. Kumari, Chemistry of Cosmetics, Prestige Publishers, 2018.
2. R. Bushby, Cosmetics and How to Make Them, White Press, 2016.

**CHY2156: PESTICIDE CHEMISTRY [2 0 0 2]**

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 (DDT, Gammexene,); Organophosphates (Malathion, Parathion); Carbamates (Carbofuran and carbaryl); Quinones (Chloranil), Anilides (Alachlor and Butachlor).

**References:**

1. R. Cremlyn, Pesticides: Preparation and Mode of Action, John Wiley, 1979.
2. A. Rakshit, Manures Fertilizers and Pesticides, CBS Publishing, 2015.
3. H. Panda, The Complete Technology Book On Pesticides, Insecticides, Fungicides and Herbicides with Formulae & Processes, National Institute of Industrial Research, 2003.

**GENERIC ELECTIVES**

**GE – III (A) & LAB**

**MAS2144: REAL ANALYSIS [3 1 0 4]**

Real Numbers as a Complete Ordered Field: Field structure and order structure, Order properties of R and Q, Characterization of intervals, bounded and unbounded sets, Supremum and Infimum, Order completeness property, Archimedean property, Characterization of intervals, Neighborhoods, Open sets, Closed sets, Union and intersection of such sets, Limit points of a set, Bolzano-Weierstrass theorem, Isolated points, Closure, Idea of countable sets, uncountable sets and uncountability of R; Real Sequences: Sequences, Bounded sequences, Convergence of sequences, Limit point of a sequence, Bolzano-Weierstrass theorem for sequences, Limits superior and limits inferior, Cauchy's general principle of convergence, Cauchy sequences and their convergence criterion, Algebra of sequences, Cauchy's first and second theorems and other related theorems, monotonic sequences, Subsequences; Infinite Series: Definition of infinite series, sequence of partial sums, convergence and divergence of infinite series, Cauchy's general principle of convergence for series, positive term series, geometric series, comparison series, comparison tests; Cauchy's n<sup>th</sup> root test, Ratio test, Raabe's test, Logarithmic test, alternating series and Leibnitz's

theorem, absolute and conditional convergence; Improper Integrals: Convergence of unbounded functions with finite limit of integration, Comparison tests at upper and lower limits, comparison Integrals, convergence of Beta and Gamma functions, absolute convergence for finite limit, comparison tests for convergence at infinity, absolute convergence for infinite limit.

**References:**

1. S. Narayan, Elements of Real Analysis, S. Chand & Co., New Delhi, 2017.
2. S. C. Malik and S. Arora, Mathematical Analysis, New Age Int. Pub., New Delhi, 2015.
3. W. Rudin, Principles of Mathematical Analysis, 3<sup>rd</sup> Edition, McGraw Hill, New York, 2013.
4. R. G. Bartle and D. R. Sherbert, Introduction to Real Analysis, 3<sup>rd</sup> Edition, John Wiley & Sons, 2011.
5. T. M. Apostol, Mathematical Analysis, Addison-Wesley, 2008.
6. H. L. Royden and P. M. Fitzpatrick, Real Analysis, 3<sup>rd</sup> Edition, Macmillan, New York, 2010.

**PHY2160: ELECTRONICS [3 1 0 4]**

Semiconductor Diodes: P and N type semiconductors, energy level diagram, conductivity and mobility, drift velocity, p-n junction, barrier formation in p-n junction diode, static and dynamic resistance. Two-terminal Devices and their Applications: Rectifiers, half wave, full wave and bridge, ripple factor, zener diode and voltage regulation, principle and structure of LEDs, photodiode, tunnel diode, solar cell. Solid State Batteries Bipolar Junction transistors: n-p-n and p-n-p transistors, characteristics of CB, CE and CC configurations, current gains  $\alpha$  and  $\beta$ , relations between  $\alpha$  and  $\beta$ , load line analysis, DC load line and Q-point, active, cutoff, saturation region. Amplifiers: Transistor biasing and stabilization circuits, fixed Bias and voltage divider bias, Feedback in Amplifiers: Effects of positive and negative feedback on input impedance, output impedance, gain, stability, distortion and noise; Operational Amplifiers and its Applications: characteristics of an ideal and practical Op-Amp, open-loop and closed-loop gain inverting and non-inverting amplifiers, adder, subtractor, differentiator, integrator. Digital electronics: Boolean algebra and basic logic gates and De-Morgan's theorem. Three-terminal Devices (FETs): Characteristics of JFET, advantages of JFET, MOSFET.

**References:**

1. B. G. Streetman, S. Banerjee, Solid state electronic devices, Pearson Prentice Hall, 2015.
2. R. Boylestad, Louis Nashelsky, Electronic Devices and Circuit Theory, Pearson Education, India, 2014.
3. A B Gupta, N Islam, Solid State Physics and Electronics, Books & Allied Ltd, 2012
4. D Chattopadhyay, P C Rakshit, Electronics: Fundamentals and Applications, New Age international (P) Ltd, 2018.
5. J. Millman, C. C. Halkias, Integrated Electronics, Tata McGraw-Hill, 2017
6. A. P. Malvino, Electronic Principals, McGraw-Hill, 2015.
7. Mottershead, Electronic Circuits and Devices, PHI, 1997.
8. S M Sze, Physics of Semiconductor Devices, Wiley, 2008. 3 ed.

**BIO2150: ESSENTIALS OF MOLECULAR BIOLOGY [2 1 0 3]**

Introduction and History of Molecular Genetics: Basis of life, Genetics and Biology, molecular structure of nucleic acids, packaging of DNA into chromosomes, DNA as the genetic material, classical experiments of Hershey Chase, Avery McLeod etc. Central dogma: Concept of replication in prokaryotes and eukaryotes along with enzymes involved in DNA replication: DNA polymerases, DNA ligase, Primase, Telomerase and other accessory proteins. Transcription in Prokaryotes and Eukaryotes: Enzymes & proteins. Fine structure of genes: Concept of promoter, regulator, enhancer, operator & structural genes, intron and exons, gene expression and regulation, inducible and repressible gene expressions. Gene silencing technology.

**References:**

1. B.N. Pandey. Cytology, Genetics and Molecular Genetics. Mc Graw Hill Publications, New Delhi, India. 2012.
2. B.D. Singh. Biotechnology. Kalyani Publishers, New Delhi, India. 2015.
3. B. Lewin. Genes XII, Oxford University Press, Oxford, New York. 2013.

4. L. Synder and W. Champness. Molecular Genetics of Bacteria, ASM Press, Washington. 2011.
5. E. J. Gardner. Genetics, John Wiley and Sones Inc., USA, 2012.

#### **BIO2136: MOLECULAR BIOLOGY LABORATORY [0 0 2 1]**

Isolation and purification of DNA from microbial cell (Bacteria) and plant. Agarose gel electrophoresis of isolated DNA, Native and denature electrophoresis of protein using PAGE. Elution of DNA from agarose gel. Determination of plasmid in given bacterial strain. Perform Southern Blot Hybridization and Western Blot. Demonstration of DNA amplification by PCR.

#### **GE – III (B) & LAB**

#### **MAS2145: PROBABILITY THEORY AND NUMERICAL ANALYSIS [3 1 0 4]**

Probability Theory: Dependent, independent and compound events, definitions of probability, addition and multiplication theorems of probability, conditional probability, Bayes theorem and its applications; Random Variable: Definition with illustrations, probability mass function, probability density function, distribution function and its properties, expectation and its properties, definition of variance and covariance and properties, raw and central moments, moment generating functions (m.g.f.) and cumulates generating functions (c.g.f.); Discrete Distributions: Binomial, Poisson and Geometric distributions and their properties; Continuous Distributions: Rectangular, Normal distributions and Exponential and their properties; Numerical Solution of Algebraic and Transcendental Equations: Bisection method, Regula Falsi method, Secant method, Newton-Raphson Method; Interpolation: Difference operators and relations between them, Newton's formulae for forward and backward interpolation, Lagrange's interpolation formula. Stirling's interpolation formulae; Numerical Differentiation and Integration: Numerical differentiation; Numerical integration by Trapezoidal rule, Simpson's one-third rule, Simpson's three-eighth rule; Numerical Solution of Initial Value Problems: Picard's Method, Euler's and modified Euler's method, Runge-Kutta method.

#### **References:**

1. S. C. Gupta and V. K. Kapoor, Fundamentals of Mathematical Statistics, Sultan Chand & Sons, New Delhi, 2014.
2. A. M. Mood, F. A. Graybill and D. C. Bose, Introduction to the Theory of Statistics, McGraw Hill, 2001.
3. B. S. Grewal, Numerical Methods, Khanna Publishers, 2006.
4. P. G. Hoel, Introduction to Mathematical Statistics, John Wiley & sons, 2000.
5. S. S. Shastri, An Introductory Methods in Numerical Analysis, PHI, 2005.
6. M. R. Spiegel, Theory and Problem of Statistics, Schaum's Publishing Series, 2008.
7. A. M. Goon, A. K. Gupta and B. D. Gupta, Fundamental of Statistics, Vol. I, World Press, Calcutta, 2016.

#### **PHY2161: HEAT AND THERMODYNAMICS [3 1 0 4]**

Thermodynamics: Thermodynamic equilibrium, zeroth law of thermodynamics and concept of temperature, work and heat energy, state functions. Laws of Thermodynamics: First law of thermodynamics, differential form of first law, internal energy, first law and various processes, applications of first law, heat engines, Carnot cycle, Carnot engine, second law of Thermodynamics-Kelvin-Planck and Clausius Statements and their equivalence, Carnot theorem; Applications of Second Law of Thermodynamics: Thermodynamic scale of temperature and its equivalence to perfect gas scale. Entropy: Change in entropy, entropy of a state, Clausius theorem, second law of thermodynamics in terms of entropy, entropy of a perfect gas, entropy of the universe, entropy changes in reversible and irreversible processes, principle of increase of entropy. Impossibility of Attainability of Absolute Zero: Third law of thermodynamics, temperature-entropy diagrams, first and second order phase transitions. Thermodynamic Potentials: extensive and intensive thermodynamic variables, thermodynamic potentials U, H, F and G, their definitions, properties and applications, surface films and variation of surface tension with temperature, magnetic work, cooling due to adiabatic demagnetization, approach to absolute zero. Maxwell's Thermodynamic Relations:

Derivations of Maxwell's relations, applications of Maxwell's relation, Clausius-Clapeyron equation, Joule-Kelvin Coefficient for Ideal and Van der Waal Gases; Kinetic Theory of Gases: Distribution of velocities, Maxwell-Boltzmann 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, specific heats of gases, molecular collisions, mean free path, collision probability, estimates of mean free path. Transport Phenomenon in Ideal Gases: Viscosity, thermal conductivity and diffusion, Brownian motion and its significance; Real gases: Behavior of real gases, Van der Waal's equation of state for real gases, values of critical constants, 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.

**References:**

1. M. W. Zemansky, R. Dittman, Heat and Thermodynamics, McGraw-Hill, 2017.
2. S. C. Garg, R. M. Bansal, C. K. Ghosh, Thermal Physics: with Kinetic Theory, Thermodynamics and Statistical Mechanics, McGraw-Hill, 2017.
3. E. Fermi, Thermodynamics, Snow Ball Publications, 2010.
4. F. W. Sears, G. L. Salinger, Thermodynamics Kinetic Theory and Statistical Thermodynamics, Narosa Publications, 1998.
5. M. Alonso, E. Finn, Physics, Addison-Wesley, 2000.

**BIO2152: GENETICS AND GENES [2 1 0 3]**

History of genetics, Genes, genome, chromosome, Principles of Inheritance, Chromosome theory, Non-Mendelian inheritance, Linkage, Crossing Over and Chromosomal Mapping Linkage maps, Sex-linked, sex-limited, and sex influenced characters. Chromosomal mutations: deletion, duplication, inversion, translocation, aneuploidy and polyploidy, genetic disorders, single gene inheritance, multifactorial inheritance, chromosomal abnormalities, mitochondrial inheritance. Genetic testing for mental health conditions. Genes and human behavior.

**References:**

1. W.S. Klug, M.R. Cummings, C. A. Spencer. Concepts of genetics. Pearson Education Limited, 2016.
2. C.H, Waddington. Introduction to modern genetics Taylor and Francis Ltd., 2017

**BIO2138: GENETICS AND GENES LAB [0 0 2 1]**

Study of linkage, recombination, gene mapping using marker-based data from Drosophila. Study of Human and Phlox/ Allium Karyotype (normal and abnormal). Pedigree analysis of some human inherited traits. Study of Hardy-Weinberg Law using simulations (seeds). Isolation and purification of DNA from microbial cell. Agarose gel electrophoresis of isolated DNA.

**GE – IV & LAB**

**MAS3244: COMPLEX ANALYSIS [3 1 0 4]**

Complex Numbers and Functions: Limit, continuity and differentiability of complex functions, analytic functions, Cauchy-Riemann equations, harmonic functions, contours, line integrals, Cauchy's integral theorem and its direct consequences, Cauchy's integral formula for the functions and derivatives, Morera's theorem, applications to the evaluation of simple line integrals, Cauchy's inequality, Liouville's theorem, fundamental theorem of algebra. Power Series: Taylors series, Laurent's series, circle and radius of convergence, sum functions; Singularities and Residues: Isolated singularities (removable singularity, pole and essential singularity), residues, residue theorem; Real definite integrals: Evaluation using the calculus of residues, integration on the unit circle; Transformations: Definition of conformal mapping, bilinear transformation, cross-ratio, properties, inverse points, elementary transformations e.g. the function.

**References:**

1. A. R. Vashishtha, Complex Analysis, Krishna Prakashan, Meerut, 2013.
2. R. V. Churchill and J. W. Brown, Complex Variables and Applications, 5th Edition, McGraw Hill Co., 2013.

3. L. V. Ahlfors, Complex Analysis, Tata McGraw Hill, 3rd Edition, 2013.
4. S. Ponnusamy, Foundation of Complex Analysis, Narosa Pub. House, 2nd Edition, 2010.

**PHY3260: MODERN PHYSICS [3 1 0 4]**

Particles and Waves: Inadequacies in classical physics, blackbody radiation, photoelectric effect, Compton Effect, Franck-Hertz experiment, wave nature of matter, wave packets, group and phase velocities, two-slit experiment with electrons, probability, wave functions, Heisenberg's uncertainty principle, derivation from wave packets,  $\gamma$ -ray microscope. quantum mechanics: basic postulates and formalism: energy, momentum and Hamiltonian Operators, time-independent Schrödinger wave equation for stationary states, conditions for physical acceptability of wave functions, expectation values, wave function of a free particle. Applications of Schrödinger Wave Equation: Eigen functions and eigenvalues for a particle in a one dimensional box: bound state problems, general features of a bound particle system, (1) one dimensional simple harmonic oscillator, scattering problems in one dimension: (1) finite potential step: reflection and transmission, stationary solutions, probability current, attractive and repulsive potential barriers (2) quantum phenomenon of tunneling: tunnel effect, tunnel diode (qualitative description) (3) finite potential well (square well). Operators in Quantum Mechanics: Hermitian operator, commutator brackets, simultaneous eigen functions, commutator algebra, commutator brackets using position, momentum and angular momentum operator, concept of parity, parity operator and its eigen values.

**References:**

1. Ghatak, S. Lokanathan, Quantum Mechanics: Theory and Applications, Laxmi Publications, 2016.
2. D. J. Griffith, Introduction to Quantum Mechanics, Pearson Education, 2015.
3. L. I. Schiff, J. Bandhyopadhyay, Quantum Mechanics, McGraw-Hill Book, 2010.
4. E. Merzbacher, Quantum Mechanics, John Wiley & Sons, Inc, 2007.
5. J. L. Powell, B. Crasemann, Quantum Mechanics, Addison-Wesley Pubs.Co., 2010.
6. E. M. Lifshitz, L. D. Landau, Quantum Mechanics: Non-Relativistic Theory, Butterworth-Heinemann, 2009.

**BIO3250: PHYSIOLOGY OF PLANTS [2 1 0 3]**

Plant cell-water relations, water and mineral absorption, transpiration, guttation, mineral nutrition- essential micro and macro nutrients, deficiency of minerals; nitrogen metabolism. Photosynthesis: photosynthetic pigments, photosystems, photophosphorylation, Calvin cycle, C4 pathway, CAM, photorespiration. Respiration: RQ, ATP- the biological energy currency, glycolysis, Krebs's cycle, Electron transport mechanism, oxidative phosphorylation, pentose phosphate pathway. Growth and development: Physiology of flowering: photoperiodism and vernalization, growth movements. Abscission and senescence.

**References:**

1. S.K. Verma. Plant Physiology and Biochemistry, S. Chand & Sons, New Delhi, 2012.
2. R.M. Devlin. Plant Physiology, East-West Press Pvt. Ltd. New Delhi, 1997.
3. W.G. Hopkins. Introduction to Plant Physiology, John Wiley & Sons Inc. New York, USA, 1995.
4. L. Taiz and E. Zieger. Plant Physiology, Sinauer Associates, Inc., Publishers, Massachusetts, USA, 2010.

**BIO3236: PLANT PHYSIOLOGY LABORATORY [0 0 2 1]**

Demonstration of phenomenon of osmosis by potato osmometer. Demonstration of phenomenon of transpiration in dorsiventral leaves using cobalt chloride paper. Study of the rate of transpiration using photometers. Demonstrate the use of light, CO<sub>2</sub> and chlorophyll are necessary for photosynthesis. Demonstrate that O<sub>2</sub> is evolved during photosynthesis by Bell Jar experiment. Determine the value of RQ of different respiratory substrates by Ganong's respirometer.

## SKILL ENHANCEMENT ELECTIVES (SEC)

### SEC – I

#### **CHY2150: MEDICINAL CHEMISTRY [2 0 0 2]**

Drugs & Pharmaceuticals: Drug discovery, design and development, Basic Retrosynthetic approach, Synthesis of the representative drugs of the following classes: analgesics agents, antipyretic agents, anti-inflammatory agents (Aspirin, paracetamol, ibuprofen), antibiotics (Chloramphenicol); antibacterial and antifungal agents (sulphonamides, sulphanethoxazol, sulphacetamide, Trimethoprim), antiviral agents (Acyclovir), Central Nervous System agents (Phenobarbital, Diazepam), Cardiovascular (Glyceryl trinitrate), antilaprosy (Dapsone), HIV-AIDS related drugs (AZT- Zidovudine). Fermentation: Aerobic and anaerobic fermentation, 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.

#### **References:**

1. G. L. Patrick, An Introduction to Medicinal Chemistry, Oxford University Press, UK, 2018.
2. V. Alagarsamy, Textbook of Medicinal Chemistry, Vallabh Prakashan, Pitampura, New Delhi.
3. T. L. Lemke, Essentials of Foye's Principles of Medicinal Chemistry, CBS Publishers and Distributors, 2005.

#### **CHY2151: CHEMINFORMATICS [2 0 0 2]**

Introduction to Cheminformatics: History and evolution, Molecular Modelling and Structure elucidation. Representation of Molecules and Chemical Reactions: Nomenclature, Different types of notations: SMILES coding, Matrix representations, Structure of Molfiles and Sdfiles, Libraries and toolkits, Different electronic effects, Reaction classification. Searching Chemical Structures: Full structure search, sub-structure search, similarity search, three dimensional search methods, basics of computation of physical and chemical data and structure descriptors, data visualization. Applications: Prediction of Properties of Compounds. Linear Free Energy Relations, Quantitative Structure-Property Relations, Descriptor Analysis, Model Building, Modeling Toxicity, Structure-Spectra correlations, Application of cheminformatics in Drug Design.

#### **References:**

1. A. R. Leach & V. J. Gillet, An Introduction to Chemoinformatics. Springer: The Netherlands, 2007.
2. J. Gasteiger & T. Engel, Chemoinformatics: A Textbook, Wiley-VCH, 2003.
3. S. P. Gupta, QSAR & Molecular Modeling, Anamaya Pub.: New Delhi, 2011.

#### **CHY2152: FUEL CHEMISTRY [2 0 0 2]**

Review of energy sources (renewable and non-renewable). Classification of Fuels, Calorific value. Coal: Uses (fuel and nonfuel), composition, carbonization of coal. Coal gas, Producer Gas and Water Gas: Composition and uses, fractionation of coal tar, uses of coal tar based chemicals, requisites of a good metallurgical coke, coal gasification (hydro gasification and catalytic gasification), coal liquefaction and solvent refining. Petroleum and Petrochemical Industry: Composition of crude petroleum, refining and different types of petroleum products and their applications, fractional distillation (principle and process), cracking (thermal and catalytic cracking), reforming petroleum and non-petroleum fuels (LPG, CNG, LNG, bio-gas, fuels derived from biomass), fuel from waste, synthetic fuels (gaseous and liquids), clean fuels. Petrochemicals: Vinyl acetate, propylene oxide, isoprene, butadiene, toluene and its derivatives xylene. Lubricants: Classification, lubricating oils (conducting and non-conducting) solid and semisolid lubricants, synthetic lubricants, properties of lubricants (viscosity index, cloud point, pore point) and their determination.

#### **References:**

1. P. C. Jain & M. Jain, Engineering Chemistry, Dhanpat Rai & Sons, 2019.
2. B. K. Sharma, Industrial Chemistry, Goel Publishing House, Meerut, 2016.
3. J. H. Gary, G. E. Handwerk, Mark J. Kaiser, Petroleum Refining – Technology and Economics, Marcel Dekker Inc., 1984.

**CHY2157: INDUSTRIAL CHEMISTRY [2 0 0 2]**

Water Treatment: Sources, impurities, hardness and removal. Plastics and Rubber: Classification, manufacture, properties and uses, natural rubber, synthetic rubbers. Sugar Industry: Extraction, manufacture and refining, molasses and bagasse. Cellulose Industry: Manufacture – paper, wood pulp, multistage bleaching, Fourdrinier machine. Paints: Introduction, classification, manufacture, and requirements. Metallurgy and alloys: Principles, processes, and applications of metallurgy, the behavior and properties of alloys.

**References:**

1. J. A. Kent, Riegel's Handbook of Industrial Chemistry, CBS, 1997.
2. P. C. Jain and M. Jain, Engineering Chemistry, Dhanpat Rai Publishing Company (P) Ltd, 2019.

**SEC - II****CHY2153: CHEMISTRY OF NATURAL PRODUCTS [2 0 0 2]**

Structure, stereochemistry and Biogenesis: Morphine, tamiflu and Podophyllotoxin. Synthesis of Some Natural Products: i) Reserpine (Woodward synthesis) ii) Taxol iii) Estrone and Mifepristone iv) Strychnine (Overman's synthesis) v) Fredericamycin A. Secondary Metabolism: Natural Products, Primary and Secondary Metabolism, Enzymes and Coenzymes. Secondary Metabolites Derived from Acetates, Fatty acids and Polyketides, Metabolites derived from Shikimic acid Secondary Metabolism of Amino acids, Chemistry of Natural Products such as Carbohydrates, proteins and peptides, fatty acids, nucleic acids and Lipids.

**References:**

1. I. L. Finar, Organic Chemistry (Volume 2: Stereochemistry and the Chemistry of Natural Products), Pearson Education India, 2002.
2. J. Singh, S. M. Ali, & J. Singh, Natural Product Chemistry, Prajati Parakashan, 2010.
3. G. R. Chatwal, Organic Chemistry of Natural Products: Vol. I, Himalaya Publishing House, 2010.

**CHY2154: POLYMER CHEMISTRY [2 0 0 2]**

Introduction and History: Classifications, nomenclature, molecular forces and chemical bonding in polymers, texture. Functionality: Criteria, polymerization processes, relationships between functionality, extent of reaction and degree of polymerization, bifunctional systems, poly-functional systems. Kinetics of Polymerization: Step growth, radical chain growth, ionic and coordination polymerizations, copolymerization, polymerization techniques. Molecular Weight of Polymers: Distribution, significance, determination by end group analysis, viscometry, light scattering and osmotic pressure methods, Polydispersity index. Glass Transition Temperature (T<sub>g</sub>): Determination of T<sub>g</sub>, Free volume theory, WLF equation, Factors affecting glass transition temperature (T<sub>g</sub>). Properties of Polymers: Physical, thermal, flow & mechanical properties. Case studies: Preparation, structure, properties and application of important polymers. Conducting polymers and biopolymers synthesis, properties, applications, and emerging trends in these fields, with a focus on their role in modern materials science and technology.

**References:**

1. F. W. Billmeyer, Text Book of Polymer Science, John Wiley, 2007.
2. C. E. Carraher Jr., Introduction to Polymer Chemistry, CRC Press, 2013.
3. G. Odian, Principles of Polymerization, John Wiley, 1981.

**CHY2155: CHEMISTRY OF COSMETICS AND PERFUMES [2 0 0 2]**

A general study including preparation and uses of 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: Eugenol, Geraniol, sandalwood oil, eucalyptus, rose oil, 2-phenyl ethyl alcohol, Jasmane, Civetone, Muscone. Preparations: Preparation of talcum powder, Preparation of shampoo, Preparation of enamels, Preparation of hair remover, Preparation of face cream, Preparation of nail polish and nail polish remover.

**References:**

1. R. Kumari, Chemistry of Cosmetics, Prestige Publishers, 2018.
2. R. Bushby, Cosmetics and How to Make Them, White Press, 2016.

**CHY2156: PESTICIDE CHEMISTRY [2 0 0 2]**

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 (DDT, Gammexene,); Organophosphates (Malathion, Parathion); Carbamates (Carbofuran and carbaryl); Quinones (Chloranil), Anilides (Alachlor and Butachlor).

**References:**

1. R. Cremlyn, Pesticides: Preparation and Mode of Action, John Wiley, 1979.
2. A. Rakshit, Manures Fertilizers and Pesticides, CBS Publishing, 2015.
3. H. Panda, The Complete Technology Book On Pesticides, Insecticides, Fungicides and Herbicides with Formulae & Processes, National Institute of Industrial Research, 2003.