B.Sc. (Hons.) Chemistry

Year	FIRST SEMESTER						SECOND SEMESTER					
	Course Code	Course Name	L	T	P	C	Course Code	Course Name	L	T	P	C
I	CY1104	Structure, Bonding and Periodicity	3	1	0	4	CY1204	Main group elements-I and Ionic structures	3	1	0	4
	CY1106	States of Matter	3	1	0	4	CY1205	Stereochemistry and Reaction Mechanisms	3	1	0	4
	CY1133	Chemistry Lab-1	0	0	8	4	CY1206	Thermodynamics and Equilibrium	3	1	0	4
	CA1170	Fundamental of Computers	1	1	0	2	CY1233	Chemistry Lab-2	0	0	8	4
	CA1175	Fundamental of Computers Lab	0	0	2	1	******	**GE-II (A)	2	1	0	3
	CY1003	Environmental Science	3	0	0	3	******	**GE-II (A) Lab	0	0	2	1
	LN1106	Communicative English	2	0	0	2	******	**GE-II (B)	2	1	0	3
	******	**GE-I	2	1	0	3	******	**GE-II (B) Lab	0	0	2	1
	******	**GE-I Lab	-	-	2	1						
			14	4	12	24			13	5	12	24
	Total Contact Hours (L + T + P)		**30**				**Total Contact Hours (L + T + P)**		**30**			
	THIRD SEMESTER						**FOURTH SEMESTER**					
II	CY2104	Main group elements-II and Introduction to Group theory	2	1	0	3	CY2204	Chemistry of transition and inner-transition Metals	3	1	0	4
	CY2105	Hydrocarbons and Halogen Derivatives	2	1	0	3	CY2205	Oxygen containing Derivatives	3	1	0	4
	CY2106	Surface, Solutions, and Mixtures	2	1	0	3	CY2206	Kinetics and Electrochemistry	3	1	0	4
	CY2133	Chemistry Lab-3	0	0	6	3	CY2207	Nuclear and Analytical Chemistry	3	1	0	4
	******	**GE-III (A)	2	1	0	3	CY2233	Chemistry Lab-4	0	0	8	4
	******	**GE-III (A) Lab	0	0	2	1	CY224X	**DSE - I	2	1	0	3
	******	**GE-III (B)	2	1	0	3	CY223X	**DSE - I Lab	0	0	2	1
	******	**GE-III (B) Lab	0	0	2	1	******	Open Elective	2	1	0	3
	CY215*	**SEC - I	2	0	0	2						
	CY215*	**SEC - II	2	0	0	2						
			14	5	10	24			16	6	10	31
	Total Contact Hours (L + T + P)		**29**				**Total Contact Hours (L + T + P) + OE**		**32**			
III	**FIFTH SEMESTER**						**SIXTH SEMESTER**					
	CY3104	Organometallic and Industrial Chemistry	3	1	0	4	CY3205	Organic Spectroscopy	3	1	0	4
	CY3105	Advanced Stereo Chemistry and Heterocyclic Compounds	3	1	0	4	CY3206	Quantum Chemistry and its Applications	3	1	0	4
	CY3133	Chemistry Lab-5	0	0	8	4	CY3233	Chemistry Lab-6	0	0	8	4
	******	**DSE - II	2	1	0	3	******	**DSE - IV	2	1	0	3
	******	**DSE - III	2	1	0	3	******	**DSE - V	2	1	0	3
	CY3170	Project	0	0	12	6	******	**GE-IV	2	1	0	3
							******	**GE-IV Lab	0	0	2	1
							******	Open Elective	2	1	0	3
			10	4	20	24			14	6	10	25
	Total Contact Hours (L + T + P)		**34**				**Total Contact Hours (L + T + P) + OE**		**30**			

Discipline Specific Electives (DSE)

DSE-I

1. CY2240: Green Chemistry
2. CY2241: Petroleum Industrial Chemistry
3. CY2242: Manufacturing of Composites
4. CY2243: Environmental Chemistry

DSE – I Lab

1. CY2236: Analytical Laboratory
2. CY2237: Environmental Chemistry Laboratory
3. CY2238: Green Chemistry Laboratory
4. CY2239: Polymer Chemistry Laboratory

DSE-II

1. CY3140: Bioinorganic Chemistry
2. CY3141: Novel Inorganic Solids

DSE-III

1. CY3142 Material Chemistry
2. CY3147 Chemistry of Biomolecules

DSE-IV

1. CY3240 Geochemistry
2. CY3241 Modern Electrochemistry

DSE-V

1. CY3242 Statistical Thermodynamics
2. CY3243 Industrial Chemicals and Environment

Skill Enhancement Electives (SEC)

SEC - I

1. CY2150 Medicinal Chemistry
2. CY2151 Cheminformatics
3. CY2152 Fuel Chemistry

SEC - II

1. CY2153 Chemistry of Natural Products
2. CY2154 Polymer Chemistry
3. CY2155 Chemistry of Cosmetics and Perfumes
4. CY2156 Pesticide Chemistry

Generic Electives (GE)

GE-I & Lab

1. MA1141: Differential and Integral Calculus
2. PY1160: Mechanics and STR
3. PY1136: General Physics Lab-I
4. BT1150: Cytology
5. BT1136: Cytology Laboratory

GE-II (A) & Lab

1. MA1242: Elementary Differential Equations
2. PY1260: Oscillation and Wave Optics
3. PY1236: Optics Lab
4. BT1250: Phytochemistry
5. BT1236: Phytochemistry Laboratory

GE-II (B) & Lab

1. MA1243: Algebra
2. PY1261: Electromagnetism
3. BT1251: Microbiology
4. BT1237: Microbiology Laboratory

GE-III (A) & Lab

1. MA2144: Real Analysis
2. PY2160: Electronics
3. BT2150: Essentials of Molecular Biology
4. BT2136: Molecular Biology Laboratory

GE-III (B) & Lab

1. MA2145: Probability Theory and Numerical Analysis
2. PY2161: Heat and Thermodynamics
3. BT2151: Introductory Bioinformatics
4. BT2137: Bioinformatics Laboratory

GE-IV & Lab

1. MA3244: Complex Analysis
2. PY3260: Modern Physics
3. BT3250: Physiology of Plants
4. BY3236: Plant Physiology Laboratory

Open Electives (OE)

1. CY2280: Green Methods in Chemistry
2. CY2281: Water Technology and Safe Storage and Applications

CY1104: STRUCTURE, BONDING, AND PERIODICITY [3 1 0 4]

Atomic Structure: Schrodinger's wave equation, significance of Ψ1 and Ψ2, 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 form 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

CY1106: STATES OF MATTER [3 1 0 4]

Equation of State: Kinetic molecular theory, kinetic gas equation, imperfection in real gases, compressibility, isotherms, equations of state, van der Waal's equation, liquefaction of gases, critical phenomenon, P-V isotherms of carbon dioxide, principle of continuity of state. Transport Properties: kinetic energy and temperature, distribution of molecular speeds, derivation of Maxwell-Boltzmann distribution law, thermal conductivity, thermal conductivity in gases. Properties of Liquids: The kinetic molecular description, intermolecular forces in, density and its measurements, vapour pressure and its determination, surface tension and its determination, viscosity and measurement of viscosity. Colligative Properties: Solutions of non-volatile solutes, colligative properties. Solid State: Space lattice, unit cell. Miller indices, symmetry elements in crystals. X-ray diffraction. Bragg's equation, dimension and contents of unit cell. Electric and Magnetic Properties: Electric properties, polarization of molecules in electric field, Clausious-Mosotti equation, Debye equation, bond moments, dipole moment, group moment, magnetic properties, magnetic susceptibility. Photochemistry: General principles of absorption, electronic transition, Jablonski diagram, intersystem crossing, singlet and triplet states, fluorescence, phosphorescence, quantum yield, photochemical reactions of carbonyl compounds, alkenes and aromatic compounds, Barton Reaction, Norrish type I and II reactions, Hofmann-Loffler-Freytag reaction.

References:

1. P. Atkins & J. de Paula, Atkins's Physical Chemistry, Oxford University Press, NY, 2004.
2. B. R. Puri, L. R. Sharma & 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 & 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.

CY1133: CHEMISTRY LABORATORY-1 [0 0 8 4]

Determination of Physical Parameters: Calibration of thermometer, determination of melting points and boiling points of some organic compounds. Distillation: Simple distillation of ethanol-water mixture, distillation of nitrobenzene and aniline. Crystallization: Crystallization of some organic and inorganic compound.

References:

1. A. I. Vogel, Elementary Practical Organic Chemistry: Small Scale Preparations Part 1, Pearson India, 2010.
2. G. Svehla, B. Sivasankar, Vogel's Qualitative Inorganic Analysis, Pearson Education India, 2012.
3. A. K. Nad, B. Mahapatra, & A. Ghoshal, An Advanced Course in Practical Chemistry, New Central Book Agency, 2011.

CA1170 FUNDAMENTALS OF COMPUTERS [1 1 0 2]

Computer Fundamentals, Definition and Purpose, Data, Information and Knowledge, Characteristics of Computers, Classification of Computers, Generations of Computer, Basic organization of Computer, System Software and Application Software. Operating Systems and Multimedia, Types of Operating System, Windows v/s

Linux, Mobile based OS, Multimedia, Definition and Types , Multimedia Software, Computer Networks, Applications of Networking, Network Topologies- Mesh, Bus, Star, Ring, Types of Network (LAN, MAN, WAN), Network Cables- Optical Fiber, Twisted, Co-axial, Network Devices- Hubs, Switch, Router, Network Interface Card, Ethernet, Internet, Introduction and Usage of Internet, Internet Connectivity Options (Wired and Wireless), IP Addressing and DNS, Website, URL, HTML, Web Browser and Search Engines, Operational Guideline of Computer Usage, Do's and Don'ts of Computer, E-mails, Email Etiquettes, Cyber Security, Internet Frauds, Secure Password Formation , Computer Security, Malware, Virus, Ransomware, Social Media and its Impact.

References:

1. R. Thareja, *Fundamental of Computer*, (1e) Oxford Publications, 2014.
2. K. Atul, *Information Technology*, (3e) Tata McGraw Hill Publication, 2008.

CA1175 FUNDAMENTALS OF COMPUTERS LAB [0 0 2 1]

Computer Peripheral and Windows operations, MS WORD- Creating and formatting of a document, Introduction of cut, copy and paste operations, to explore various page layout and printing options, creating. Formatting, editing Table in MS word, Introduction of Graphics and print options in MS word, Introduce the student with mail merge option. MS EXCEL- creation of spreadsheet and usage of excel, Formatting and editing in worksheet, Sorting, Searching in Excel sheets, using formula and filter in MS excel, printing and additional features of worksheet, maintaining multiple worksheet and creating graphics chart. MS POWER POINT – creation of presentation, Power point views, creating slides and other operations, Using design, animation, and transition in slides, Internet Tools, Using Email and Outlook facilities, Google Drive, Google Forms, Google Spreadsheet, Google groups.

References:

1. R. Thareja, *Fundamental of Computer*, (1e) Oxford Publications, 2014.
2. K. Atul, *Information Technology*, (3e) Tata McGraw Hill Publication, 2008.

CY1003: ENVIRONMENTAL SCIENCE [3 0 0 3]

Introduction: Multidisciplinary nature, scope and importance, sustainability and sustainable development. Ecosystems: Concept, structure and function, energy flow, food chain, food webs and ecological succession, examples. Natural Resources (Renewable and Non-renewable Resources): Land resources and land use change, Land degradation, soil erosion and desertification, deforestation. Water: Use and over-exploitation, floods, droughts, conflicts. Energy resources: Renewable and non- renewable energy sources, alternate energy sources, growing energy needs, case studies. Biodiversity and Conservation: Levels, biogeographic zones, biodiversity patterns and hot spots, India as a mega-biodiversity nation; Endangered and endemic species, threats, conservation, biodiversity services. Environmental Pollution: Type, causes, effects, and controls of Air, Water, Soil and Noise pollution, nuclear hazards and human health risks, fireworks, solid waste management, case studies. Environmental Policies and Practices: Climate change, global warming, ozone layer depletion, acid rain, environment laws, environmental protection acts, international agreements, nature reserves, tribal populations and rights, human wildlife conflicts in Indian context. Human Communities and the Environment: Human population growth, human health and welfare, resettlement and rehabilitation, case studies, disaster management, environmental ethics, environmental communication and public awareness, case studies. Field Work and visit.

References:

1. R. Rajagopalan, Environmental Studies: From Crisis to Cure, Oxford University Press, 2016.
2. B. K. De, Environmental Studies, New Age International Publishers, New Delhi, 2007.
3. E. Bharucha, Text book of Environmental Studies for undergraduate courses, Universities Press, Hyderabad, 2013.
4. R. Carson, Silent Spring, Houghton Mifflin Harcourt, 2002.
5. M. Gadgil & R. Guha, This Fissured Land: An Ecological History of India, University of California Press, 1993.
6. M. J. Groom, K. Meffe Gary and C. R. Carroll, Principles of Conservation Biology, OUP, USA, 2005.

LN1106: COMMUNICATIVE ENGLISH [2 0 0 2]

Communication- Definition, Process, Types, Flow, Modes, Barriers; Types of Sentences; Modal Auxiliaries; Tenses and its Usage; Voice; Reported Speech; Articles; Subject-Verb Agreement; Spotting Errors; Synonyms and Antonyms; One Word Substitution; Reading Comprehension; Précis Writing; Essay Writing; Formal Letter Writing; Email Etiquettes; Résumé & Curriculum Vitae; Statement of Purpose; Presentations

References:

1. *Collins English Usage*. Harpers Collins, 2012.
2. Hobson, Archie Ed. *The Oxford Dictionary of Difficult Words.* Oxford, 2004.
3. D. Jones, English *Pronouncing Dictionary*. ELBS, 2011.
4. N. Krishnaswamy, *Modern English: A Book of Grammar Usage and Composition*, Macmillan India, 2015.
5. *Longman Dictionary of Contemporary English.* Pearson, 2008.
6. M. McCarthy, *English Idioms in Use*. Cambridge UP, 2002.
7. S. Mishra, and C. Muralikrishna. *Communication Skills for Engineers*. Pearson, 2004.
8. *Oxford Dictionary of English*. Oxford UP, 2012.

9. N. D. Turton, J.B. Heaton. *Longman Dictionary of Common Errors*. Pearson, 2004.

SECOND SEMESTER

CY1204: MAIN GROUP ELEMENTS-I AND IONIC STRUCTURES [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, Fazan'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.

CY1205: STEREOCHEMISTRY AND REACTION MECHANISMS [3 1 0 4]

Structure and Bonding: Hybridizations, bond lengths, bond angles, bond energy, localized and delocalized chemical bond, van der Waals interactions, resonance, hyperconjugation, aromaticity, inductive and field effects, hydrogen bonding. Mechanism of Organic Reactions: Curved arrow notations, drawing electron movement with arrows, half headed and double headed arrow, hemolytic and heterolysis bond breaking. Types of Reagents: Electrophiles and nucleophiles, types of organic reactions, energy consideration, reactive intermediates-carbocation, carbanion, free radicals. Stereochemistry of Organic Compounds: Isomerism, types of isomerism, optical isomerism, elements of symmetry, molecular chirality, Newman projection and Saw Horse formula, Fischer and Flying wedge formula, enantiomers, stereogenic centers, optical activity, properties of enantiomers, chiral and achiral molecules with two stereogenic centers, stereoisomers, mesocompounds, resolution of enantiomers, inversion, retention and racemization, Relative and absolute configurations, sequence rules, D&L and R&S systems of nomenclature, Nomenclature E and Z system, geometrical isomerism in alicyclic compounds. Conformation: conformational analysis of ethane, n-propane and n-butane, Conformations of cyclohexane, axial and equatorial bonds (mono and disubstituted cyclohexanes), optical isomerism in compounds without any stereocenters (allenes, biphenyls).

References:

1. R. T. Morrison, R. N. Boyd and S. K. Bhattacharjee, Organic Chemistry, Pearson India, 2011.
2. P. S. Kalsi, Stereochemistry: Conformation and Mechanism, New Age International Private Limited, 2017.
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.

CY1206: THERMODYNAMICS AND EQUILIBRIUM [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; Claudius 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.

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.

CY1233: CHEMISTRY LABORATORY-2 [0 0 8 4]

Inorganic Qualitative Analysis: Qualitative analysis of inorganic mixtures containing not more than six radicals including interfering radicals like phosphate, oxalate, tartrate. Inorganic Quantitative Analysis: Volumetric analyses.

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. A. K. Nad, B. Mahapatra, A. Ghoshal, An Advanced Course in Practical Chemistry, New Central Book Agency, 2011.

THIRD SEMESTER

CY2104: MAIN GROUP ELEMENTS-II AND GROUP THEORY [2 1 0 3]

The p-block Elements-II: Chemical reactivity and group trends of N, P, As, Sb & Bi, compounds of of N, P, As, Sb & Bi, some organometallic compounds. Oxygen, S, Se and Te Family: Chemical Reactivity, group trends and stereochemistry, dioxygen as a ligand, structure of O3 and H2O2, clathrate hydrates allotropic forms of S & Se, structures of halides, oxides and oxyacids of S, Se & Te, liquid SO2 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.

CY2105: 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.

CY2106: SURFACE, SOLUTIONS, AND MIXTURES [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. Macromolecules: Introduction, nomenclature and classifications of macromolecules, Addition and condensation polymerization, Molecular weight heterogeneity, number average and weight average molecular weights, determination of molecular weights.

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.

CY2133: 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. Thermochemistry: (i) To determine heat of neutralization of a strong acid by a strong base. (ii) To determine heat of ionization of a weak acid from heat of neutralization; (iii) to determine the heat of reaction of various processes. Distribution Law: Determination of partition coefficient of a solute in water and a non-aqueous solvent. Surface Phenomena: Adsorption of some organic acids on charcoal. Thin Layer and Column Chromatography: Determination of Rf value and purity of organic compounds by use of thin layer chromatography, separation of organic compound by column chromatography. 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

CY2204: CHEMISTRY OF TRANSITION AND INNER-TRANSITION METALS [3 1 0 4]

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 macrocylic 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.

CY2205: 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 α, β-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.

CY2206: 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, non-equilibrium electrode potentials, over potential, derivation of Butler-Volmer equation, Tafel plot, applications of dynamic electrochemistry.

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.

CY2207: NUCLEAR AND ANALYTICAL CHEMISTRY [3 1 0 4]

Nuclear Chemistry: Atomic Nucleus, radioactive decay; α, β and γ 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.

References:

1. H. J. Arnikar, 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.

CY2233: CHEMISTRY LABORATORY-4 [0 0 8 4]

Physical Chemistry – Liquids and Solutions: (i) To determine surface tensions of solutions of amyl 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 I2+KI =KI3 by the partition method and the corresponding free energy change, (iii) determination distribution coefficient between water and a non-aqueous solvent of a solute which associates or dissociates in one of the solvents. 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) Gravemetric Methods, Estimation of Ba2+ as BaSO4 and Ni2+ as Nickel dimethylglyoxime Complex and Co2+ 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. 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

CY3104: ORGANOMETALLIC AND INDUSTRIAL 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 (η), 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. Organo-Transition Metal 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. 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. Fuel Chemistry: Ultimate and proximate analysis, coking of coal, composition, classification, and refining of petroleum, cracking, octane number and cetane number; Paints: Introduction, classification, manufacture, and requirements.

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. J. A. Kent, Riegel's Handbook of Industrial Chemistry, CBS, 1997.

4. F. A. Cotton, G. Wilkinson, C. A. Murillo and M. Bochmann, Advanced Inorganic Chemistry, Wiley India, 2007.
5. P. C. Jain and M. Jain, Engineering Chemistry, Dhanpat Rai Publishing Company (P) Ltd, 2019.
6. D. Astruc, Organometallic Chemistry and Catalysis, Springer-Verlag, 2007.

CY3105: 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.

CY3133: 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

CY3205: 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, 1H (1H NMR) spectroscopy, nuclear shielding and deshielding, chemical shift and molecular structure, spin-spin splitting and coupling constants, areas of signals, interpretation of 1H NMR spectra of simple organic molecules such as ethyl bromide, ethanol, acetaldehyde, 1,1,2-tribromoethane, ethyl acetate, toluene and acetophenone basics of 13C 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 1H 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.

CY3206: QUANTUM CHEMISTRY AND ITS APPLICATIONS [3 1 0 4]

Elementary Quantum Chemistry: Historical background, classical ideas of energy and particle trajectory, blackbody radiation and Planck's hypothesis of quantization of energy, photoelectric effect, de Broglie's relation, Heisenberg's uncertainty principle, Schrödinger-wave equation, concept of wave function (ψ) physical significance of ψ and ψ2, normalization, free particle, particle in a one dimensional box, translational energy, energy levels, quantization of energy, wave functions for particle in a box, in a three dimensional box, operators, postulates of quantum mechanics, 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: Electromagnetic radiation, absorption co-efficient, Einstein coefficient, transition moment and oscillator strength and lasers, microwave absorption, rotational spectra, rotational Raman spectra, infrared absorption, vibrational spectra of diatomic molecules. UV-visible and Nuclear Spectroscopy: Visible-ultraviolet absorption, electronic spectra, electronic energy levels of molecules, selection rules for electronic spectra of molecules, Frank-Condon principle, Beer-Lambert Law, electronic spectra of polyatomic molecules, photoelectron spectroscopy.

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, McGrew Hill Education (Indial) 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.

CY3233: CHEMISTRY LABORATORY-6 [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 reaction between potassium iodide and potassium peroxodisulphate; pH-metry – titrations, determination of ionization constant of the weak base. 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

CY2240: GREEN CHEMISTRY [2 1 0 3]

Basic Concepts: Introduction to inorganic chemistry. Principles of Green Chemistry-I: (i) Prevention of waste/by-products, (ii) Maximum incorporation of materials used in process in to the final product (Atom economy): Green metrics, (iii) Prevention/Minimization of hazardous/toxic products, (iv) Designing safer chemicals-different basic approaches, (v) Selection of appropriate auxiliary substances (solvents, separation agents etc.), (vi) Energy requirements for reactions-use of microwave, ultrasonic energy. Principles of Green Chemistry-II: (vii) Selection of stating materials-use of renewable starting materials, (viii) Avoidance of unnecessary derivation-careful use of blocking/protection groups, (ix) Use of catalytic reagents (wherever possible) in preference to stoichiometric reagents, (x) Designing biodegradable products. (xi) Prevention of chemical accidents, (xii) Strengthening/development of analytical techniques to prevent and minimize the generation of hazardous substances in chemical processes. Development of accurate and reliable sensor and monitors for real time in process monitoring. Example of Green synthesis/reaction, the chemistry behind Green Chemistry, Future trend in green chemistry, biomimetic, multifunctional reagents, combinatorial green chemistry, biomass conversion, emission control, biocatalysts.

References:

1. V.K. Ahluwalia, Green Chemistry: A Textbook, Alpha Science International Ltd, 2013.
2. M. Lancaster, Green Chemistry: An Introductory Text, Royal Society of Chemistry, 2010.
3. V.K. Ahluwalia, Green Chemistry: Greener Alternatives to Synthetic Organic Transformations, Narosa Publishing House, 2011.

CY2241: PETROLEUM INDUSTRIAL CHEMISTRY [3 0 0 3]

Crude Oil and Natural Gas: Composition, terminology, classification system. History, Occurrence and Recovery: History, origin, terminology, recovery and transportation. Characterization and Analysis of Crude Oil: Petroleum analysis, properties, spectroscopic methods, chromatographic methods. Refining of Crude Oil: Atmospheric distillation and vacuum distillation, introduction to refining process, refining chemistry. Petrochemicals: Chemicals from paraffin, chemicals from aromatics, chemicals from natural gas, synthetic gas. Environmental Issues: Environmental regulation (amendments and acts), refinery waste, treatment methods.

References:

1. M. I. Deo, Petroleum Refining Technology, CBS Publishers and Distributors Pvt. Ltd. 2015.
2. B. K. Bhaskara Rao, Modern Petroleum Refining Process, Oxford 2008.
3. J. G. Speight, The Chemistry and Technology of Petroleum, CRC Press, New York, 2014.
4. V. Simanzhenkov & R. Idem, Crude Oil Chemistry, Marcel Dekker, New York 2003.
5. J. G. Speight, Natural Gas, Gulf Publishing Company, Houston, Texas, 2007.

CY2242: MANUFACTURING OF COMPOSITES [2 1 0 3]

Introduction to Composites, Types of composites and characterizations, Manufacturing of Composites: Basic guidelines. Thermoset Composites manufacturing processes: Lay-up and Spray-up processes, Fiber placement and Pultrusion processes, Compression molding and Roll wrapping processes. Thermoplastic composite manufacturing processes: Thermoplastic molding, and Filament winding processes. Forming of diaphragm and Hot press processes, Prevention of damage, repair of composites and selection of processes.

References:

1. S. Mazumdar, Composites Manufacturing: Materials, Product, and Process Engineering, CRC Press, 2001.
2. M. Balasubramanian, Composite Materials and Processing, CRC Press, 2013.
3. F. C. Campbell Jr, Manufacturing Processes for Advanced Composites, Elsevier, 2003.

CY2243: ENVIRONMENTAL CHEMISTRY [2 1 0 3]

Fundamentals of Environmental Chemistry: Concept and scope, principles and cyclic pathways, acid base reactions, chemical equilibria, solubility of gases in water, unsaturated and saturated hydro carbons, radio-nuclides. Atmospheric Chemistry: Composition, photochemical reactions in atmosphere, smog formation, aerosols, acid rain, case studies, reactions of NO2 and SO2, free radicals and ozone layer depletion. Air Pollution Control Technologies: Concept of air pollution, sources, particulate matter, control equipment, control of gaseous pollutants. Water chemistry: Introduction to aquatic chemistry, gases in water, alkalinity, chemical and physical properties of water, heavy metal, organic pollutants, & pesticides in water. Water Treatment Methods: Preliminary treatment process, primary treatments, biological treatment, tertiary treatment. Soil Chemistry: Nature and composition, organic carbon and organic matter, inorganic and organic components, soil humus, cation and anion exchange reactions, nitrogen, phosphorus and potassium in soil, phenolic compounds in soil, soil quality monitoring. Environmental Chemistry of Hazardous Wastes: Introduction, classification, sources, transport, effects, and fates of hazardous wastes.

References:

1. S. E. Manahan, Environmental Chemistry, CRC Press, 2010.
2. A. K. De, Environmental Chemistry, New age international (P) Ltd., 2000.
3. S. S. Dara, A Text Book of Environmental Chemistry and Pollution Control, S. Chand & Company Ltd, 1998.
4. R. I. Donalue, R. W. Miller and J. C. Shiekluna, An Introduction to Soils and Plant Growth, Prentice Hall of India, 1987.
5. G. Sposito, The Chemistry of Soils, Oxford University Press, 2008.

DSE-I LAB

CY2236: ANALYTICAL LABORATORY [0 0 2 1]

Separation Techniques: Chromatography, Rf values. Extraction: Ni extraction, zirconium extraction. Analysis: Cold drinks, soil, water. Spectrophotometry: Determination of pKa using spectrophotometry, UV and IR spectroscopy.

References:

1. A. K. Nad, B. Mahapatra, A. Ghoshal, An Advanced Course in Practical Chemistry, New Central Book Agency, 2011.
2. G. D. Christian, Analytical Chemistry, John Wiley, 2004.
3. D. A. Skoog., Principles of Instrumental Analysis, Holt-Saunders International edition 2004.

CY2237: ENVIRONMENTAL CHEMISTRY LABORATORY [0 0 2 1]

Analysis: Water analysis – BOD, COD, DO, alkalinity, salinity, TDS. Chlorine in bleaching powder, SPM in air, bioindicators of pollution. Biochemistry: pKa of amino acids, isoelectric pH of proteins. Analysis of food: Ca, Fe, Cu in food. Extraction: Pigments in common food products, caffeine in drinks.

References:

1. A. K. Nad, B. Mahapatra, A. Ghoshal, An Advanced Course in Practical Chemistry, New Central Book Agency, 2011.
2. A. K. De, Environmental Chemistry, New Age International (P) Ltd., 2000.

CY2238: GREEN CHEMISTRY LABORATORY [0 0 2 1]

Analysis: Cation exchange method, determination of total solids, Clock reaction. Synthesis: Biodiesel from vegetable oil, synthesis of hydrogel, co-crystal controlled solid state synthesis, one-pot synthesis, photoreduction.

References:

1. A. K. Nad, B. Mahapatra, A. Ghoshal, An Advanced Course in Practical Chemistry, New Central Book Agency, 2011.
2. P. T. Anastas & J. C. Warner, Green Chemistry: Theory and Practice, Oxford, University Press, 1998.

CY2239: POLYMER CHEMISTRY LABORATORY [0 0 2 1]

Synthesis of Polymers: Addition, condensation, and redox polymerization – preparation of nylon 66/6, novolac, resins. Characterization: Determination of MW by viscometry, end group analysis, colorimetric method. Polymer Analysis: Instrumental techniques, IR spectra, DSC analysis, electrophoresis.

References:

1. A. K. Nad, B. Mahapatra, A. Ghoshal, An Advanced Course in Practical Chemistry, New Central Book Agency, 2011.
2. F.W. Billmeyer: Text Book of Polymer Science, John Wiley, 2007.

DSE - II

CY3140: BIOINORGANIC CHEMISTRY [2 1 0 3]

Overview of Bioinorganic Chemistry: Introduction to bioinorganic chemistry, classification of elements on the basis of their action in biological systems, function of inorganic elements and metal ions in biological systems, introduction of trace elements, the essential ultra-trace metals and non-metals, metal functions in metalloproteins, metalloenzyme functions, principles of coordination chemistry related to bioinorganic research. Dioxygen Reactions: Chemistry of dioxygen, dioxygen toxicity and biological defense and repair systems, superoxide dismutase and catalases, monooxygenases, cytochrome-P450, tyrosinase. Biological Redox Processes: Blue copper proteins, mitochondrial electron-transfer chain, iron-sulfur proteins, and cytochromes. Metalloenzymes: Molybdenum enzyme: xanthine oxidase, Zinc enzymes: carbonic anhydrase, carboxy peptidase and interchangeability of zinc and cobalt in enzymes, Vitamin B12 and B12 coenzymes. Nitrogen Fixation: Nitrogen metabolism, Chemistry of N2 reduction, Mo-Dependent nitrogenase, other nitrogenases. Mn in Photosynthesis and O2 evolution: Photosystem I and II – chlorophyll, oxygen evolving complex (OEC), 4Mn–cluster and O2 evolution. Transport and Storage Proteins: Storage and transport of metal ions. Metalloporphyrins: Oxygen Carrier, haemoglobin and myoglobin, physiology of blood (O2 affinity, cooperativity and Bohr's effect). Non-heme proteins: hemerythrin and hemocyanin.

References:

1. I. Bertini, H. B. Gray, S. J. Lippard & J. S. Valentine, Bioinorganic Chemistry, Viva Books Pvt. Ltd., 2004.
2. S. J. Lippard & J. M. Berg. Principles of Bioorganic Chemistry, Panima Publ. Corpn, 2011.
3. E. I. Ochiai. Bioinorganic Chemistry – An Introduction, Allyn and Bacon Inc., 1977.
4. M. N. Hughes. The Inorganic Chemistry of Biological Processes, Wiley, 1981.
5. R. R. Crichton, Biological Inorganic Chemistry: An Introduction, Elsevier, 2008.

CY3141: NOVEL INORGANIC SOLIDS [2 1 0 3]

Synthesis and Modification of Inorganic Solids: Conventional heat and beat methods, co-precipitation method, sol-gel methods, hydrothermal method, ion-exchange and intercalation methods. Inorganic Solids of Technological Importance: Solid electrolytes – Cationic, anionic, mixed Inorganic pigments – coloured solids, white and black pigments. Molecular material and fullerides, molecular materials & chemistry – one-dimensional metals, molecular magnets, inorganic liquid crystals. Nanomaterials: Overview, classifications, Preparation of gold and silver metallic nanoparticles, self-assembled nanostructures-control of nanoarchitecture-one dimensional control. Carbon nanotubes and inorganic nanowires. Bio-inorganic nanomaterials, DNA and nanomaterials, natural and artificial nanomaterials, bionano composites. Engineering Materials for Mechanical Construction: Composition, mechanical and fabricating characteristics and applications of various types of cast irons, plain carbon and alloy steels, copper, aluminum and their alloys like duralumin, brasses and bronzes cutting tool materials, super alloys thermoplastics, thermosets and composite materials. Speciality polymers: Conducting polymers – introduction, conduction mechanism, polyacetylene, polyparaphenylene and polypyrole, applications of conducting polymers, Ion-exchange resins and their applications. Ceramic & Refractory: Introduction, classification, properties, raw materials, manufacturing and applications.

References:

1. D. Shriver and P. Atkins, Inorganic Chemistry, Oxford University Press, 2011.
2. D. M. Adam, Inorganic Solids: An Introduction to Concepts in Solid-State Structural Chemistry, Wiley-Blackwell. 1974.
3. F. J. Ovens, Introduction to Nanotechnology, Wiley, 2007.

DSE - III

CY3142: MATERIAL CHEMISTRY [2 1 0 3]

Glasses, Ceramics, Composite and Nanomaterials: Glassy state, glass formers and glass modifiers, applications, Ceramic structures, mechanical properties, clay products. Reformatories, characterizations, properties and applications. High Tc Materials: Defect perovskites, high Tc superconductivity in cuprates, preparation and characterization of 1-2-3 and 2-1-4 materials, and normal state properties. Anisotropy, position lifetimes, microwave absorption - pairing and multigap structure in high Tc materials, applications of high Tc materials. Polymeric Materials: Molecular shape, structure and configuration, crystallinity. Thin films and Langmuir- Blodgett Films: Preparation techniques, evaporation / sputtering, chemical processes, sol – gel, etc.

References:

1. W. D. Callister, Material Science and Engineering, An introduction, 3rd Edition, Willey India, 2009.
2. H. V. Keer, Principals of Solid State, Willey Eastorn, 2011.
3. J. C. Anderson, K. D. Leaver, J. M. Alexander, & R. D. Rawlings, Materials Science, Willey India, 2013.

CY3147: CHEMISTRY OF BIOMOLECULES [3 0 0 3]

Carbohydrates: Classification and nomenclature, monosaccharides, mechanism of ozone formation, interconversion of glucose and fructose, configuration of monosaccharides, conversion of glucose into mannose, formation of glycosides, ethers and esters, cyclic structure of D(+)-glucose, mutarotation, structures of ribose and deoxyribose, disaccharides and polysaccharides. Amino Acids, Peptides, Proteins, Nucleic Acids, Lipids, Terpenes and Terpeniods. Classification, structure and stereochemistry of amino acid, acid-base behavior, isoelectric point and electrophoresis, preparation and reactions of α-amino acids, structure and nomenclature of peptides and proteins, classification of proteins, classical peptide synthesis, solid phase peptide synthesis, structures of peptides and proteins, protein denaturation, nucleic acids.

References:

1. I. L. Finar, Organic Chemistry (Volume 2: Stereochemistry and the Chemistry of Natural Products), Pearson Education, 2002.
2. J. M. Berg, J.L. Tymoczko, and L. Stryer, Biochemistry, W. H. Freeman, 2009.
3. D. L. Nelson, M.M. Cox, Lehninger's Principles of Biochemistry, W. H. Freeman, 2011.
4. Satyanarayana, Biochemistry, Elsevier, 2017.

DSE - IV

CY3240: GEOCHEMISTRY [2 1 0 3]

Introduction to Geosciences: Formation and abundance of the elements, Rheologic divisions of the Earth, Layers of Earth crust, Oceanic and continental crust, Orogeny, Petrology- Rock, Mineral and Ore. Structure of minerals. Structures of Silicate minerals, Rock types (Igneous, Sedimentary and Metamorphic rock). Characterization of Magmas, Metamorphism, Basic concepts on Land forms, Earthquake and Seismic waves, Continental drift theory-Wegener theory of continental drift. Aquatic geochemistry: pH-pE, the hydrologic cycle, Carbonate saturation, Seafloor Hydrothermal systems, river processes, Thermohaline circulation in oceans, pH buffer in marine environment. Soil Geochemistry: Basic concepts on Soil and Pedogenesis, Classification of soil, Diagenesis- Clay, Sandstone and Carbonate, Major elements in soil and biogeochemical cycles, Trace metals in soil and soil contamination, Basic concepts on Radiogenic isotope geology/Geochronology, Radioactive decay- Beta, alpha decay, spontaneous fission, δ18 O of marine carbonates, Temporal changes in δ13 C isotopes, Risk assessment of heavy metal pollution. Mining and Geochemistry: Mining in India, Opencast and underground mining, Ore deposits, Fossil fuel- Coal and Petroleum, Coalification process, Metal mines- Chromium and Iron mining, Metal extraction from ores, Mining pollution and remediation. Global Climate Change and Carbon Sequestration: Present and Future, atmospheric CO2, Stratospheric ozone, Photochemical smog, Carbon sequestration - Blue carbon, Black carbon, Brown carbon and Green carbon.

References:

1. J. V. Walther, Essentials of Geochemistry, Jones and Bartlett Publishers, 2010.
2. B. J. Skinner, S. C., Porter, J. J., Park, & H. L. Levin, The Dynamic Earth: An Introduction to Physical Geology, Wiley, 1995.
3. K. C. Misra, Introduction to Geochemistry: Principles and Applications, John Wiley & Sons, 2012.
4. A. K. De, Environmental Chemistry, New Age International Publishers, 2007.

CY3241: MODERN ELECTROCHEMISTRY [2 1 0 3]

Photoelectrochemistry: Photoexitation 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, electrodics 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: Bioelectrodics, membrane potential, electrical conduction in biological organism, electrochemical mechanism of nervous system, enzyme electrodics. Environmental Oriented Electrochemistry: The Solar-Hydrogen solution, large scale solar-hydrogen productions, Fixing of CO_2, 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.

DSE - V

CY3242: STATISTICAL THERMODYNAMICS [2 1 0 3]

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, 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.

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.

CY3243: 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.

SKILL ENHANCEMENT ELECTIVES (SEC)

SEC - I

CY2150: 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 Distributers, 2005.

CY2151: CHEMINFORMATICS [2 0 0 2]

Introduction to Cheminformatics: History and evolution of cheminformatics, Use of cheminformatics, Prospects of cheminformatics, 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, basic ideas, 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, Prediction of NMR, IR and Mass spectra, Computer Assisted Structure elucidations, Computer Assisted Synthesis Design, Introduction to drug design, Target Identification and Validation, Lead Finding and Optimization, Analysis of HTS data, Virtual Screening, Design of Combinatorial Libraries, Ligand-Based and Structure Based Drug design, 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.

CY2152: 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.

SEC - II

CY2153: 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.

CY2154: 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 (Tg): Determination of Tg, Free volume theory, WLF equation, Factors affecting glass transition temperature (Tg). Properties of Polymers: Physical, thermal, flow & mechanical properties. Case studies: Preparation, structure, properties and application of important polymers.

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.

CY2155: 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, Jasmone, 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.

CY2156: 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 – I & LAB

MA1141: DIFFERENTIAL & INTEGRAL CALCULUS [3 1 0 4]

Limits, Continuity and Mean Value Theorem: Definition of limit and continuity, types of discontinuities, properties of continuous functions on a closed interval, differentiability, Rolle's theorem, Lagrange's and Cauchy's first mean value theorems, Taylor's theorem (Lagrange's form), Maclaurin's theorem and expansions, convexity, concavity and curvature of plane curves, formula for radius of curvature in cartesian, parametric, polar and pedal forms, centre of curvature, asymptotes, singular points, cusp, node and conjugate points, tracing of standard cartesian, polar and parametric curves; **Partial Differentiation:** First and higher order derivatives, Euler's theorem, total derivative, differentiation of implicit functions and composite functions, Taylor's theorem for functions of two variables; **Integral Calculus:** Reduction formulae, application of integral calculus, length of arcs, surface areas and volumes of solids of revolutions for standard curves in cartesian and polar forms; **Beta and Gamma functions:** Beta and Gamma functions and relation between them; evaluation of integrals using Beta and Gamma functions.

References:

1. S. Narayan and P. K. Mittal, *Differential Calculus*, S. Chand & Company Ltd., New Delhi, 2011.
2. P. Saxena, *Differential Calculus,* McGraw Hill, New Delhi, 2014.
3. S. Narayanan & T. K. Manicavachagom Pillay, *Calculus I & II,* S. Viswanathan Pvt. Ltd., Chennai, 2010.
4. M. J. Strauss, G. L. Bradley and K. J. Smith, *Calculus (3rd Edition)*, Dorling Kindersley Pvt. Ltd., Delhi, 2007.

PY1160: MECHANICS AND SPECIAL THEORY OF RELATIVITY [2 1 0 3]

Dynamics of a System of Particles: Centre of mass, conservation of momentum, idea of conservation of momentum from Newton's third law, impulse, motion of rocket, potential energy, stable and unstable equilibrium, elastic potential energy, work-energy theorem, work done by non-conservative forces, law of conservation of energy, elastic and inelastic collisions between particles. Rotational Dynamics: Angular momentum of a particle and system of particles, conservation of angular momentum, rotation about a fixed axis, moment of inertia, kinetic energy of rotation, motion involving both translation and rotation. Gravitation and Central Force Motion: Law of gravitation, inertial and gravitational mass, gravitational potential energy, potential and field due to spherical shell and solid sphere. motion of a particle under central force field, two body problem and its reduction to one body problem and its solution, the energy equation and energy diagram, orbits of artificial satellites. Inertial and Non-inertial systems: Reference frames, inertial frames and Galilean transformations non-inertial frames and fictitious forces, uniformly rotating frame, physics laws in rotating coordinate systems, centrifugal forces, Coriolis force, components of velocity and acceleration in cylindrical and spherical coordinate systems. Special Theory of Relativity: Postulates, Michelson-Morley experiment, Lorentz transformations, simultaneity and order of events, Lorentz contraction, variation of mass with velocity, rest mass, massless particles, mass-energy equivalence, relativistic Doppler effect,

transformation of energy and momentum.

References:

1. D. Kleppner, R. J. Kolenkow, *An introduction to mechanics*, Tata McGraw-Hill, 2007.
2. D. S. Mathur, *Mechanics*, S. Chand & Company Limited, 2014.
3. M. R. Spiegel, *Theoretical Mechanics*, Tata McGraw-Hill, 2017.
4. C. Kittel, W. Knight, M. Ruderman, C. Helmholz, B. Moyer, *Mechanics,* Berkeley Physics course, Vol.-I, Tata McGraw-Hill, 2010.
5. F. W. Sears, M. W. Zemansky, H. D. Young, *University Physics*, Narosa Pub. House, 2013.
6. M. Alonso, E. Finn, *Physics* Addison-Wesley, 2000.

PY1136: GENERAL PHYSICS LAB-I [0 0 2 1]

Use of multimeter for measuring: (a) resistances, (b) a/c and dc voltages, (c) ac and dc currents, (d) capacitances, and (e) frequencies; Test a diode and transistor using: (a) a multimeter and (b) a CRO, to measure (a) voltage, (b) frequency and (c) phase difference using a CRO, to determine the moment of inertia of a flywheel, to determine the coefficient of viscosity of water by capillary flow method, to determine the young's modulus of a wire by optical lever method, to determine the elastic constants of a wire by Searle's method, to determine "g" by bar pendulum.

References:

1. D. Chattopadhyay, P. C. Rakshit, *An Advanced Course in Practical Physics*, New Central Book Agency (P) Ltd., 2012.
2. C. L Arora, *BSc Practical Physics*, S. Chand Publication, 2012.
3. R. K. Shukla, A. Srivastava, *Practical Physics*, New Age Publisher, 2006.
4. D. P. Khandelwal, *A Laboratory Manual of Physics for Undergraduate Classes*, Vani Publication House, New Delhi, 2000.
5. G. Sanon, *B. Sc. Practical Physics*, S. Chand, 2010.
6. B. L. Worsnop, H. T. Flint, *Advanced Practical Physics*, Asia Publishing House, 2002.

BT1150: CYTOLOGY [2 1 0 3]

Cell: Introduction and history, cell theory. **Type of Cells**: Eukaryotic and prokaryotic cells, animal & plant cells. **Cell Membrane**: Models, structure of cell wall. **Cell Organelles**: Endoplasmic reticulum, Golgi complex, Mitochondria, Chloroplasts, Ribosome, Liposome, Peroxisomes, Nucleus, lysosomes, Vacuole, Cytosol and Cytoskeleton (Microtubules, Microfilaments and Intermediate filaments)**. Cell Division**: Mitosis & meiosis, cell cycle. **Chromosomes**: Structure & functions, karyotype, salivary gland and lamp brush chromosomes. Cell signaling.

References:

1. S.C. Rastogi. Cell Biology, Tata Mc Graw Hill Pub. Co. New Delhi, 2017.
2. P. K. Gupta. A Text Book of Cell and Molecular Biology, Rastogi Publications, Merrut, 2012.
3. B. Alberts, D. Bray, J. Lewis, M. Raff and J.D. Watson. Molecular Biology of the Cell, Garland Publishing Inc. New York, 2017.
4. D. Robertis, Cell and Molecular Biology, Waverly International, New York, 2011.
5. H. Lodish, A. Berk, S.L. Zipursky, P. Matsudiara, D. Baltimore, and J. Darnell, Molecular Cell Biology, WH Freeman & Co., New York, 2013.

BT1136: CYTOLOGY LABORATORY [0 0 2 1]

Laboratory: Introduction to lab and lab environment, Good Laboratory Practices (GLP), Identification of different cells, mitosis in onion root tip. Study of electron micrographs of cell organelles- cell ultrastructure, chromosomes, nucleus, Golgi body and endoplasmic reticulum. Study of different stages of mitosis in onion root tip. Study of Permanent slides of different cell organelles and specimens in the above mentioned class work material.

GE – II (A) & LAB

MA1242: ELEMENTARY DIFFERENTIAL EQUATIONS [3 1 0 4]

Ordinary Differential Equations: Order and degree of a differential equation, linear and non-linear differential equations, formation of differential equations. **Equations of First Order and First Degree:** Variable separable method, homogeneous equations, equations reducible to homogeneous form, linear equations and equations reducible to linear form, exact equations, equations reducible to exact form, some applications of first order equations; **Higher Order Linear Differential Equations:** Higher order linear differential equations with constant coefficients - complementary function (C. F.), particular integral of the forms e^{ax}, $\sin ax$, $\cos ax$, x^m, $e^{ax}V$, x^mV, higher order linear differential equations with variable coefficients- Cauchy's homogeneous equation.

References:

1. J. L. Bansal, S. L. Bhargava and S. M. Agarwal, *Differential Equations,* Jaipur Publishing House, Jaipur, 2012.
2. M. D. Raisinghania, *Ordinary and Partial Differential Equations,* S. Chand & Comp., New Delhi, 2013.
3. S. L. Ross, *Differential Equations*, Wiley India, 2013.

4. E.A. Coddington, *An Introduction to Ordinary Differential Equations*, PHI, 2011.
5. R. K. Jain and S.R.K. Iyengar, *Advanced Engineering Mathematics*, 4th Edition, Narosa Publishing House, 2014.
6. G. F. Simmons, Differential Equations, Tata McGraw-Hill, 2006.

PY1260: OSCILLATION AND WAVE OPTICS [2 1 0 3]

Simple Harmonic Motion: Simple harmonic oscillations, oscillations having equal frequencies and oscillations having different frequencies (beats), superposition of n-collinear harmonic oscillations with equal phase differences and equal frequency differences, superposition of two mutually perpendicular simple harmonic motions with frequency ratios 1:1 and 1:2 using graphical and analytical methods. Damped Oscillations: Log decrement, forced oscillations, transient and steady states, amplitude, phase, resonance, sharpness of resonance, power dissipation and quality factor, Helmholtz Resonator. Standing Waves in a String: Fixed and free ends, analytical treatment, phase and group velocities, changes w.r.t position and time, energy of vibrating string, transfer of energy, normal modes of stretched strings. Wave Optics: Electromagnetic nature of light, definition and properties of wave front, Huygens principle, coherence. Interference: Division of amplitude and wavefront. Young's double slit experiment. Lloyd's Mirror, Fresnel's biprism, interference in thin films (parallel and wedge-shaped), fringes of equal inclination and thickness, Newton's Rings, Michelson Interferometer, Fabry-Perot interferometer. Diffraction: Fresnel diffraction, Fresnel's half-period zones, theory of a zone plate, multiple foci, comparison of a zone plate with a convex lens, Fresnel's integrals, Cornu's spiral, Fresnel diffraction pattern due to a straight edge, a slit, and a wire, diffraction due to a single slit, a double slit and a plane transmission grating, Rayleigh's criterion, resolving power, dispersive power of grating.

Polarization: Light polarization by reflection, refraction, Brewster's Law, Malus Law, double refraction.

References:

1. F. A. Jenkins, H. Elliott White, *Fundamentals of Optics*, Tata McGraw-Hill, 2013.
2. A. Ghatak, *Optics*, Tata McGraw-Hill, 2015.
3. S. Subrahmaniyam, B. Lal, M. N. Avadhanulu, *A Textbook of optics*, S. Chand, 2010.
4. E. Hecht, A. R. Ganesan, *Optics*, Pearson Education, 2002.
5. A. Al-Azzawi, *Light and Optics: Principles and Practices*, CRC Press, 2007.
6. M. Alonso, E. Finn, *Physics* Addison-Wesley, 2000.

PY1236: OPTICS LAB [0 0 2 1]

Familiarization with: Schuster`s focusing; determination of angle of prism, to determine refractive index of the material of a prism using sodium source, to determine the dispersive power and Cauchy constants of the material of a prism using mercury source, to determine wavelength of sodium light using Fresnel Biprism, to determine wavelength of sodium light using Newton's Rings, To determine the thickness of a thin paper by measuring the width of the interference fringes produced by a wedge-shaped Film, to determine wavelength of (1) Na source and (2) spectral lines of Hg source using plane diffraction grating, to determine dispersive power and resolving power of a plane diffraction grating.

References:

1. D. Chattopadhyay, P. C. Rakshit, *An Advanced Course in Practical Physics*, New Central Book Agency (P) Ltd., 2012.
2. C. L. Arora, *BSc Practical Physics*, S. Chand Publication, 2012.
3. R. K. Shukla, A. Srivastava, *Practical Physics*, New Age Publisher, 2006.
4. D. P. Khandelwal, *A Laboratory Manual of Physics for Undergraduate Classes*, Vani Publication House, New Delhi, 2000.
5. G. Sanon, *B. Sc. Practical Physics*, S. Chand, 2010.
6. B. L. Worsnop, H. T. Flint, *Advanced Practical Physics*, Asia Publishing House, 2002.

BT1250: PHYTOCHEMISTRY [2 1 0 3]

Introduction to Chemistry of Plants: Cell as a natural chemical factory. Chemistry of Cytoplasm: **Carbohydrates**: Classification, chemical structure and properties. **Lipids**: Saturated and unsaturated fatty acids and glycerol. **DNA & Protein**: Structure and classification. Purine and Pyrimidine: structure and properties, nucleotide biosynthesis, Conformation of nucleic acids [helix (A, B, Z), t-RNA, micro-RNA]. Significance of DNA & proteins. **Enzymes**: classification, and types. Biological membranes and signaling.

References:

1. H.S**.** Srivastav. *Elements of Biochemistry***,** Rastogi Publication, Meerut, 2005.
2. J.L. Jain. *Fundamentals of Biochemistry*. S. Chand & Co. Pvt. Ltd. New Delhi, 2016.
3. J. Jayaraman. *Laboratory Manual in Biochemistry*, New Age Publishers, New Delhi, 2011.
4. A.J. Ninfa, D.P. Ballou and M.B. Parsons. *Fundamental Laboratory Approaches for Biochemistry and Biotechnology*. Wiley Inter Science, 2009.
5. D. Voet and J. G. Voet. *Biochemistry,* John Wiley & Sons Inc*.,* New Delhi, India, 1995.

6. A. Lehninger, D. L. Nelson and M. M. Cox. *Principles of Biochemistry*, Freeman Publishers, New York, 2017.
7. M. Holtzhauer. *Basic Methods for the Biochemical Lab*, Springer, USA, 2006.
8. S. O. Farrell and L.E. Taylor. *Experiments in Biochemistry: A Hands-on Approach*, Cengage Learning, USA, 2005.

BT1236: PHYTOCHEMISTY LABORATORY [0 0 2 1]

Biochemical tests for the following- carbohydrate, starch, proteins, fats, from natural sources. Histological localization of biomolecules. Extraction of DNA, purification, separation of amino acids and Lipid by paper chromatography and thin layer chromatography. Amylase activity – determination (salivary amylase), verification of Beer's law, estimation of peroxidase and polyphenol oxidase activity.

GE – II (B) & LAB

MA1243: ALGEBRA [3 1 0 4]

Group Theory: Definition and examples of groups, examples of abelian and non-abelian groups, the group Zn of integers under addition modulo n and the group U(n) of units under multiplication modulo n, cyclic groups from number systems, complex roots of unity, the general linear group GLn (n,R), the permutation group, Symmetric group, Group of quaternions. Subgroups, cyclic subgroups, the concept of a subgroup generated by a subset and the commutator subgroup of group, examples of subgroups including the center of a group, cosets, Index of subgroup, Lagrange's theorem, order of an element; **Normal subgroups:** their definition, examples, and characterizations, quotient groups; **Ring Theory:** Definition and examples of rings, examples of commutative and non-commutative rings: rings from number systems, Zn the ring of integers modulo n, ring of real quaternions, rings of matrices, polynomial rings, and rings of continuous functions. Subrings and ideals, Integral domains; **Fields**: Introduction, examples of fields: Zp, Q, R, and C, field of rational functions.

References:

1. P. B. Bhattacharya, S. K. Jain and S. R. Nagpaul, *Basic Abstract Algebra,* 2nd Edition, Cambridge University Press, 1997.
2. N. S. Gopalakrishanan, *University Algebra*, New Age International (P) Ltd., 2004.
3. H. S. Hall and S. R. Knight, *Higher Algebra*, H. M. Publications, 1994.
4. I. N. Herstein, *Topics in Algebra*, Wiley Eastern Ltd., New Delhi, 2013.
5. J. A. Gallian, *Contemporary Abstract Algebra*, Cengage learning, 2013.

PY1261: ELECTROMAGNETISM [3 1 0 4]

Electric Field and Electric Potential: Electric field and lines, electric flux, Gauss's law, Gauss's law in differential form, calculation of E due to various charge distribution, electric potential difference and electric potential V, potential and electric field due to various charge distribution force and torque on a dipole, conductors in an electrostatic field, description of a system of charged conductors, an isolated conductor and capacitance, electrostatic energy due to various charge distribution. Electric Field in Matter: Dielectric constant, parallel plate capacitor with a dielectric, polarization charges and polarization vector, electric susceptibility, Gauss's law in dielectrics, displacement vector D, relations between the three electric vectors, capacitors filled with dielectrics. Magnetic Effect of Currents: Magnetic Field B, magnetic force between current elements and definition of B, magnetic flux, Biot-Savart's law: calculation of B due to various charge distribution, magnetic dipole and its dipole moment, Ampere's Circuital law, B due to a solenoid and a toroid, curl and divergence of B, vector potential. forces on an isolated moving charge, magnetic force on a current carrying wire, torque on a current loop in a uniform magnetic field, Gauss's law of magnetism, magnetic intensity (H), relation between B, M and H, stored magnetic energy in matter, B-H curve, Faraday's law, Lenz's law, self and mutual induction, single phase transformer, energy stored in a magnetic field, potential energy of a current loop. Ballistic Galvanometer: Current and charge sensitivity, electromagnetic damping, logarithmic damping, critical damping.

References:

1. D. J. Griffiths, *Introduction to Electrodynamics*, PHI learning, 2015.
2. E. M. Purcel, *Electricity and Magnetism*, Tata McGraw-Hill Education, 2011.
3. J. H. Fewkes, J. Yarwood, *Electricity and Magnetism*, Oxford University Press, 1991.
4. D. C. Tayal, *Electricity and Magnetism*, Himalaya Publishing House, 2014.
5. M. Alonso, E. Finn, *Physics,* Addison-Wesley, 2000.

BT1251: MICROBIOLOGY [2 1 0 3]

History: Contribution of Anton Leeuwenhoek, Edward Jenner, Louis Pasteur, Robert Koch, Martinus W. Beijerinck, Sergei N. Winogradsky, Alexander Fleming. Medical microbiology. **Diversity of Microbes**: Introduction to archaea, bacteria and eukaryote. Binomial Nomenclature, Whittaker's five kingdom and Carl Woese's three kingdom classification systems and their utility. **General characteristics of different groups**: Acellular microorganisms (Viruses, Viroids, Prions) and cellular microorganisms (Bacteria, Algae, Fungi and Protozoa) with emphasis on distribution and occurrence, morphology, mode of reproduction and economic importance. Role of microbes in chemical processes.

References:

1. R.Y. Stainer, M.J. Doudoroff and E.A. Adelberg. *The Microbial World.* Prentice Hall (India) Pvt. Ltd. 2005.
2. J.W. Brown. *Principles of microbial diversity*, 1st edition ASM press, 2015.
3. M.J. Pelczar, E.C.S. Chan and N.R. Krieg. *Microbiology*. 5th edition. McGraw Hill Book Company, 2005.
4. M.T. Madigen, J.M. Martinko, K.S. Bender, D.H. Buckley, D. A. Stahl and T. Brock. *Brock Biology of Microorganisms*. 14th edition, Benjamin Cunnings-Pearson, 2014.
5. J. Cappucino and Sherman. *Microbiology: Laboratory Manual.* 9th Edition. Pearson Education limited, 2010.
6. R.Y. Stanier, J.L. Ingraham, M.L. Wheelis, and P.R. Painter. *General Microbiology.* 5th edition. McMillan publishers, 2005.
7. J Willey, L. Sherwood and J Woolverton. Prescott's Microbiology. McGwaw Hill Education, USA. 2017.

BT1236: MICROBIOLOGY LABORATORY [0 0 2 1]

Methods of sterilization, preparation of culture media, pure culture techniques – streak, spread, pour plate methods. Simple staining and differential staining, culture of bacteria on solid and liquid medium, determination of bacterial growth by turbidimetric method. Isolation of bacteria and fungi from soil, water and air. Morphological, cultural and biochemical identification.

GE – III (A) & LAB

MA2144: 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^{th} 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*, 3rd Edition, McGraw Hill, New York, 2013.
4. R. G. Bartle and D. R. Sherbert, *Introduction to Real Analysis*, 3rd Edition, John Wiley & Sons, 2011.
5. T. M. Apostal, *Mathematical Analysis*, Addison-Wesley, 2008.
6. H. L. Royden and P. M. Fitzpatrick, *Real Analysis*, 3rd Edition, Macmillan, New York, 2010.

PY2160: ELECTRONICS [3 1 0 4]

Network theorems: Fundamentals of AC and DC networks, Thevenin, Norton, superposition, maximum power transfer theorem; 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. Bipolar Junction transistors: n-p-n and p-n-p transistors, characteristics of CB, CE and CC configurations, current gains α and β, relations between α and β, 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, transistor as 2-port network, h-parameter, equivalent circuit, analysis of a single-stage CE amplifier using hybrid model, input and output Impedance, current, voltage and power gain, class A, B & C amplifiers, coupled amplifier, RC-coupled amplifier and its frequency response. Feedback in Amplifiers: Effects of positive and negative feedback on input impedance, output impedance, gain, stability, distortion and noise; Sinusoidal Oscillators: Barkhausen's criterion for self-sustained oscillations. RC Phase shift oscillator, determination of frequency, Hartley & Colpitts oscillators; Operational Amplifiers and its Applications: characteristics of an ideal and practical Op-Amp, open-loop and closed-loop gain, frequency response, CMRR, slew rate and concept of virtual ground, inverting and non-inverting amplifiers, adder, subtractor, differentiator, integrator, log amplifier, zero crossing detector Wein bridge oscillator. Three-terminal Devices (UJT and FETs): Characteristics and equivalent circuit of UJT and 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. N. N. Bhargava, D. C. Kulshreshtha, S. C. Gupta, *Basic Electronics and Linear Circuits*, Tata Mc-Graw-Hill, 2012.

BT2150: 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.

BT2136: 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

MA2145: 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 there-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.

PY2160: ELECTRONICS [3 1 0 4]

Network theorems: Fundamentals of AC and DC networks, Thevenin, Norton, superposition, maximum power transfer theorem; 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. Bipolar Junction transistors: n-p-n and p-n-p transistors, characteristics of CB, CE and CC configurations, current gains α and β,

relations between α and β, 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, transistor as 2-port network, h-parameter, equivalent circuit, analysis of a single-stage CE amplifier using hybrid model, input and output Impedance, current, voltage and power gain, class A, B & C amplifiers, coupled amplifier, RC-coupled amplifier and its frequency response. Feedback in Amplifiers: Effects of positive and negative feedback on input impedance, output impedance, gain, stability, distortion and noise; Sinusoidal Oscillators: Barkhausen's criterion for self-sustained oscillations. RC Phase shift oscillator, determination of frequency, Hartley & Colpitts oscillators; Operational Amplifiers and its Applications: characteristics of an ideal and practical Op-Amp, open-loop and closed-loop gain, frequency response, CMRR, slew rate and concept of virtual ground, inverting and non-inverting amplifiers, adder, subtractor, differentiator, integrator, log amplifier, zero crossing detector Wein bridge oscillator. Three-terminal Devices (UJT and FETs): Characteristics and equivalent circuit of UJT and 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. N. N. Bhargava, D. C. Kulshreshtha, S. C. Gupta, *Basic Electronics and Linear Circuits*, Tata Mc-Graw-Hill, 2012.

BT2151: INTRODUCTORY BIOINFORMATICS [2 1 0 3]

Introduction and Scope of Bioinformatics: databanks: nucleotide databanks (NCBI, EMBL, DDBJ), protein databanks (sequence databanks: PIR, SWISSPROT, TrEMBL; structural databases: PDB, SCOP, CATH). **Sequence Relationship**: BLAST, FASTA. Multiple sequence alignment. Introduction to Genomics-information flow in biology, DNA sequence data, experimental approach to genome sequence data, genome information resources. Introduction to proteomics. Role of bioinformatics in drug discovery, target discovery, lead discovery, microarray, docking and prediction of drug quality. Bioinformatics companies.

References:

1. T. K. Attwood, and P. Smith. *Introduction to Bioinformatics*, Pearson Education, New Delhi 2004.
2. S.C. Rastogi, N. Mendairatta and P. Rostogi. *Bioinformatics: Methods and Applications (Genomics, proteomics and drug discovery,)* Printice Hall India Pvt. Ltd. New Delhi, 2008.
3. S. Pennigton and M.J. Dunn. *Proteomics: From protein sequences to function*, Viva Books Publishers, New Delhi, 2002.
4. D. H. Mount. *Bioinformatics*, CBS Publishers, New Delhi, 2005.

BT2137: BIOINFORMATICS LABORATORY [0 0 2 1]

PDB analysis of protein structure by RASMOL, NCBI, EMBL and DDBJ (accession of informations), BLAST and FASTA search, alignments – pair wise and multiple sequence alignment – CLUSTALW and X, program for function, operation overloading program for multiple constructors in a class program for multiple handling program for error handling

GE – IV & LAB

MA3244: 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.

PY3260: 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, γ-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.

BT3250: 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, Kreb'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.

BY3236: 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, CO2 and chlorophyll are necessary for photosynthesis. Demonstrate that O2 is evolved during photosynthesis by Bell Jar experiment. Determine the value of RQ of different respiratory substrates by Ganong's respirometer.

OPEN ELECTIVES OFFERED BY THE DEPARTMENT

CY2280: GREEN CHEMISTRY [3 0 0 3]

Green Chemistry: Introduction to Green Chemistry and Sustainability. Dimensions of Sustainability, Limitations/Obstacles in pursuit of the goals of Green Chemistry. Basic principles of Green Chemistry-I (i) Prevention of waste/byproducts (ii) Maximum Incorporation of the materials used in the process into the final product (Atom Economy): Green metrics (iii) Prevention/Minimization of hazardous/toxic products (iv) Designing safer chemicals - different basic approaches (v) Selection of appropriate auxiliary substances (solvents, separation agents etc) (vi) Energy requirements for reactions—use of microwave, ultrasonic energy. Basic principles of Green Chemistry –II: (vii) Selection of starting materials—use of renewable starting materials (viii) Avoidance of unnecessary derivatization—careful use of blocking/protection groups (ix) Use of catalytic reagents (wherever possible) in preference to stoichiometric reagents (x) Designing biodegradable products (xi) Prevention of chemical accidents. (xii) Strengthening/development of analytical techniques to prevent and minimize the generation of hazardous substances in chemical processes. Development of accurate and reliable sensors and monitors for real time in process monitoring. The Chemistry Behind Green Chemistry. Examples of green synthesis/reaction: Green starting materials, Green reagents, Green solvents and reaction conditions, Green catalysis. Future trends in Green Chemistry: Oxidation-reduction reagents and catalysts; Biomimetic, multifunctional reagents; Combinatorial green chemistry; Proliferation of solvent less reactions; Non covalent derivatization, Biomass conversion, emission control, Biocatalysis.

References:

1. V.K. Ahluwalia, Green Chemistry: A Textbook, Alpha Science International Ltd, 2013.
2. M. Lancaster, Green Chemistry: An Introductory Text, Royal Society of Chemistry, 2010.

3. V.K. Ahluwalia, Green Chemistry: Greener Alternatives to Synthetic Organic Transformations, Narosa Publishing House, 2011.

CY2281: WATER TREATMENT AND SAFE STORAGE [3 0 0 3]

Characterization imparted by impurities in water: Hardness of Water, Municipal Water Supply, Requisites of Drinking water, Scale and Sludge Formation in Boilers, Caustic Embrittlement, Boiler Corrosion. Softening methods: Drinking water or Municipal water. Desalination of brackish water: Chemical analysis of water. Global burden of disease: Water-borne Diseases, Water-borne Pathogens. Household water treatment and safe storage: rain water harvesting. Millennium development goals: A Frame work for water safety, Sedimentation, Filtration: Synthetic membrane, Ceramic filters, Biological filtration, Heat, Ultraviolet Radiation, Safe Storage HWTS in emergencies, Roles of Government Bodies, Evaluation and validation of household water treatment technologies. Health impact assessment: HWTS Selection, Case Studies.

References:

1. M. Natarajan, Industrial Water Quality, Chemical Publishing Company, 2011.
2. P. C. Nicholas, Handbook of Water & Waste Water Treatment Technology, Elsevier, 2002.
3. S. Vigneswaran & Visvanathan, Water Treatment Processes, CRC Press, 1995.
4. I. Colin, The Drinking Water Book: How to Eliminate Harmful Toxins from Your Water, Celestial Arts, 1991.
5. J. S. Singh, S. P. Singh, S. R. Gupta, Ecology, Environmental Science and conservation, S. Chand Publishing, New Delhi, 2014.