Annexure A-3-3

Faculty of Science, Technology and Architecture

School of Physical and Biological Sciences

Department of Chemistry

Programme Structure and syllabus of 4-year Programme of B.Sc. (Honours/Honours with Research) in Chemistry

YEAR	FIRST SEMESTER							SECOND SEMESTER						
	Type	Course Code	Course Name	L	T	P	C	Type	Course Code	Course Name	L	T	P	C
I	*MAJ*	CHY1101	Atomic Structure, Bonding, and Periodicity	2	1	2	4	*MAJ*	CHY1201	States of Matter and Molecular Properties	2	1	2	4
	MIN	*****	Minor-1	-	-	-	4	*MIN*	*****	Minor-2	-	-	-	4
	MD	*****	MD-1	-	-	-	4	*MD*	*****	MD-2	-	-	-	4
	AEC-1	LN1106	Communicative English	2	0	0	2	*AEC-2*	PHY1240	Report Writing	1	1	0	2
	SEC-1	MAS1122	Fundamentals of Computer	1	0	2	2	*SEC-2*	MAS1221	Logical Reasoning and Competitive Aptitude	1	1	0	2
	VAC-1	CHY1003	Environmental Science	2	0	0	2	*SEC-3*	MAS1222	Introduction to Python Programming	1	0	2	2
	VAC-2	PES1030	Yoga & Wellness	0	1	2	2	*VAC-3*	MAS1223	Ancient Indian Knowledge System	2	0	0	2
		Total					**20**		**Total**					**20**

Minor -1							Minor -2						
SEM	Course Code	Subject Name	L	T	P	C	SEM	Code	Course Name	L	T	P	C
I	PHY1101	Mechanics	2	1	2	4	II	MAS1203	Ordinary Differential Equations	3	1	0	4
	BIO1107	Cell Biology	2	1	2	4	II	BIO1207	Fundamentals of Biotechnology	2	1	2	4

MD-1							MD -2						
SEM	Course Code	Subject Name	L	T	P	C	SEM	Code	Course Name	L	T	P	C
I	MAS1110	Fundamental of Calculus	3	1	0	4	II	PHY1201	Waves and Optics	2	1	2	4
	BIO1120	Diversity of Life	2	1	2	4	II	BIO1290	Fundamentals of Microbiology	2	1	2	4

YEAR		THIRD SEMESTER							FOURTH SEMESTER					
	Type	Course Code	Subject Name	L	T	P	C	Type	Course Code	Subject Name	L	T	P	C
II	*MAJ*	CHY2101	Reactions Of Hydrocarbons and Halogen Derivatives	2	1	2	4	*MAJ*	CHY2201	Main Group Elements-I and Ionic Bonding	3	1	0	4
	MAJ	CHY2102	Thermodynamics and Chemical Equilibrium	2	1	2	4	*MAJ*	CHY2202	Chemical Kinetics and Electrochemistry	3	1	0	4
	MIN	****	Minor-3	-	-	-	4	*MAJ*	CHY2203	Reaction Mechanisms and Stereochemistry	3	1	0	4
	MD	****	MD-3	-	-	-	3	*MAJ*	CHY2270	Project Based Learning	0	0	0	2
	AEC -3	CHY2170	Scientific Writing	2	0	0	2	*MIN*	****	Minor-4	-	-	-	4
	SEC-4	PHY2140	Basic Instrumentation Skills	2	1	0	3	*AEC -4*	PHY2240	Translation and Linguistic Competence	2	0	0	2
		Total					**20**		**Total**					**20**

Minor -3							Minor -4						
SEM	Course Code	Subject Name	L	T	P	C	SEM	Code	Course Name	L	T	P	C
III	PHY2190	Electromagnetism	3	1	0	4	IV	PHY2290	Heat and Thermodynamics	3	1	0	4
	MAS2124	Probability Distributions and Sampling Theory	3	1	0	4		MAS2225	Statistical Inference	3	1	0	4
	CHE1151	Chemical Process Calculations	3	1	0	4		CHE1251	Chemical Process Industries	3	1	0	4
	BIO2107	Biochemistry	2	1	2	4		BIO2208	Recombinant DNA Technology and Forensics	2	1	2	4
	CHY2121	General Chemistry	2	1	2	4		CHY2221	Principles of Analytical Chemistry	2	1	2	4

MD-3						
SEM	Course Code	Subject Name	L	T	P	C
III	MAS2125	Multivariable Calculus	2	1	0	3
	PHY2140	Introduction to Astrophysics	2	1	0	3
	CHE*****	Analytical Techniques				3

YEAR		FIFTH SEMESTER							SIXTH SEMESTER						
	Type	**Course Code**	**Subject Name**	**L**	**T**	**P**	**C**	**Type**	**Course Code**	**Subject Name**	**L**	**T**	**P**	**C**
III	***MAJ***	CHY3101	Chemistry of d and f Block Elements	3	1	0	4	***MAJ***	CHY3201	Organometallic Compounds and Industrial Chemistry	3	1	0	4
	MAJ	CHY3102	Quantum Chemistry and Statistical Thermodynamic	3	1	0	4	***MAJ***	CHY3202	Principles of Nuclear and Analytical Chemistry	3	1	0	4
	MAJ	CHY3103	Structure and Reactivity of Oxygen containing Derivatives	3	1	0	4	***MAJ***	CHY3203	Spectroscopic Techniques	3	1	0	4
	MAJ	CHY3130	Chemistry lab-1	0	0	8	4	***MAJ***	CHY3230	Chemistry lab-2	0	0	8	4
	MIN	****	Minor-5	-	-	-	4	***MIN***	****	Minor-6	-	-	-	4
			Total				**20**			**Total**				**20**

Minor -5							Minor -6						
SEM	**Course Code**	**Subject Name**	**L**	**T**	**P**	**C**	**SEM**	**Code**	**Course Name**	**L**	**T**	**P**	**C**
V	PHY3190	Basic Quantum Mechanics	3	1	0	4	VI	PHY3290	Condensed Matter Physics	3	1	0	4
	MAS3126	Applied Statistics	3	1	0	4		MAS3227	Econometrics	3	1	0	4
	CHE1152	Chemical Process Safety	3	1	0	4		MAS3228	Theory of Logical Mathematics	3	1	0	4
	BIO3122	Ethical Issue in IPR	2	1	2	4		CHE1252	Renewable and Non-Renewable Energy Resources	3	1	0	4
	BIO3190	GLP and Biosafety	2	1	2	4		CHY3221	Principles of Industrial Chemistry	2	1	2	4
	CHY3121	Materials Chemistry: Structure, Properties and Applications	2	1	2	4							

YEAR		SEVENTH SEMESTER							EIGHTH SEMESTER						
	Type	**Course Code**	**Subject Name**	**L**	**T**	**P**	**C**	**Type**	**Course Code**	**Subject Name**	**L**	**T**	**P**	**C**
IV	***MAJ***	CHY4101	Main group elements-II and Introduction to Symmetry	3	1	0	4	***EC/RP***	****	*EC* /Research Project	-	-	-	12
	MAJ	CHY4102	Advanced Physical Chemistry	3	1	0	4	***MIN***	****	Minor-7	-	-	-	4
	MAJ	CHY4103	Organic Synthesis: Methods and Reagents	3	1	0	4	***MIN***	****	Minor-8	-	-	-	4
	MAJ	CHY4104	Applied Chemistry	3	1	0	4							
	MAJ	CHY4130	Chemistry lab-3	0	0	8	4							
			Total				**20**			**Total**				**20**

Minor -7							Minor -8						
SEM	**Course Code**	**Subject Name**	**L**	**T**	**P**	**C**	**SEM**	**Course Code**	**Subject Name**	**L**	**T**	**P**	**C**
VIII	PHY4290	Nanomaterials and Applications	3	1	0	4		PHY4291	Semiconductors and Optoelectronics	3	1	0	4
	MAS4227	Research Methodology and Scientific Writing	3	1	0	4		MAS4229	Introduction to MATLAB	3	1	0	4
	CHY4221	Forensic Chemistry and Testing Methods	2	1	2	4		CHY4222	Medicinal and Pharmaceutical Chemistry	2	1	2	4

Type	Course Code	Subject Name	L	T	P	C
EC-1	CHY4201	Molecular Spectroscopy	3	1	0	4
EC-2	CHY4202	Photochemistry and Pericyclic Reactions	3	1	0	4
EC-3	CHY4230	Chemistry lab-4	0	0	8	4

FIRST SEMESTER

CHY1101: ATOMIC STRUCTURE, BONDING, AND PERIODICITY [2 1 2 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.

Flame test, potash alum synthesis, boric acid preparation, carbonate and hydroxide estimation, free alkali in soaps, alkali in antacids, borate detection by borax bead test. Preparation and standardization of reference solutions, buffer preparation, redox titration, iodometric titrations.

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

SECOND SEMESTER

CHY1201: STATES OF MATTER AND MOLECULAR PROPERTIES [2 1 2 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.

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. 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.
6. A. K. Nad, B. Mahapatra, & A. Ghoshal, An Advanced Course in Practical Chemistry, New Central Book Agency, 2011.
7. A. I. Vogel, Elementary Practical Organic Chemistry: Small Scale Preparations Part 1, Pearson India, 2010.

THIRD SEMESTER

CHY2101: REACTIONS OF HYDROCARBONS AND HALOGEN DERIVATIVES [2 1 2 4]

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.

Qualitative analysis of organic compounds involving detection of elements (N, S, halogens) and identification of functional groups such as carboxylic acid, sulfonic acid, phenol, aldehyde, ketone, amines, nitro groups, and carbohydrates.

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.
6. A. K. Nad, B. Mahapatra, & A. Ghoshal, An Advanced Course in Practical Chemistry, New Central Book Agency, 2011.
7. A. I. Vogel, Elementary Practical Organic Chemistry: Small Scale Preparations Part 1, Pearson India, 2010.

CHY2102: THERMODYNAMICS AND CHEMICAL EQUILIBRIUM [2 1 2 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. Chemical Equilibrium: Direction of spontaneous change in a chemical reaction, extent of reaction, stoichiometric coefficients, equilibrium constant in terms of G. temperature and pressure dependence of equilibrium constant, homogeneous and heterogeneous equilibria. Complex Equilibria – acid base equilibria, salt hydrolysis.
Determination of neutralization equivalent, heat of neutralization and solution, indicator constant, solubility and solubility product, potentiometric titrations involving acids, bases, and redox systems, analysis of halide mixtures.

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.
7. A. K. Nad, B. Mahapatra, A. Ghoshal, An Advanced Course in Practical Chemistry, New Central Book Agency, 2011.
8. S. K. Maity & N. K. Ghosh, Physical Chemistry Practical, New Central Book Agency, 2012.

FOURTH SEMESTER

CHY2201: MAIN GROUP ELEMENTS-I AND IONIC BONDING [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.

CHY2202: CHEMICAL KINETICS AND ELECTROCHEMISTRY [3 1 0 4]

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

References:

1. P. Atkins and J. de Paula, Atkins's Physical Chemistry, Oxford University Press, NY, 2004.
2. B. R. Puri, L. R. Sharma and M. S. Pathania, Principal of Physical Chemistry, Vishal Publication Jalandhar, 2010.
3. P. C. Rakshit, Physical Chemistry, Sarat Book House, 2014.
4. S. Glasstone, An Introduction to Electrochemistry, East-West Press (Pvt.) Ltd., 2006.
5. A. J. Bard and L. R. Faulkner, Electrochemical Methods: Fundamentals and Applications, John Wiley & Sons, 2001.

CHY2203: REACTION MECHANISMS AND STEREOCHEMISTRY [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.

FIFTH SEMESTER

CHY3101: CHEMISTRY OF d AND f BLOCK ELEMENTS [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.

CHY3102: QUANTUM CHEMISTRY AND STATISTICAL THERMODYNAMIC [3 1 0 4]

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

the molecular partition function, physical interpretation of the partition function. The canonical ensemble, canonical partition function and its relation to molecular partition function for independent particles.

References:

1. I. N. Levine, Quantum Chemistry, Oxford University Press, 2000.
2. P. Atkins and J. De Paula, Atkins' Physical Chemistry, Oxford University Press, 2011.
3. C.N. Banwell and E. M. McCash, Fundamentals of Molecular Spectroscopy, 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.

CHY3103: STRUCTURE AND REACTIVITY OF 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, ß-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.

CHY3130: Chemistry lab-1 [0 0 8 4]

Physical Chemistry: Polarimetry - kinetics of inversion of cane sugar by means of polarimetry; Chemical Kinetics – determination of activation energy of a reaction by studying its temperature dependence, kinetics of the reactions of potassium iodide and ester hydrolysis; pH-metry – titrations, determination of ionization constant of the weak base. Colorimetry: (i) Verification of Lambert-Beer law, (ii) To determine the composition of a complex by Job's method of continuous variations (Ferric-salicylate Complex), (iii) To titrate copper with EDTA photometrically. Inorganic Chemistry: (i) Gravimetric Methods, Estimation of Ba^{2+} as $BaSO_4$ and Ni^{2+} as Nickel dimethylglyoxime Complex and Co^{2+} gravimetrically. Determination of two metal ions, Cu-Ni and Cu-Fe. (ii) Preparation of anhydrous stannous chloride, (iii) Complexometric titrations involving EDTA for quantitative determination of individual cation/mixture of cations. Determination distribution coefficient between water and a non-aqueous solvent of a solute which associates or dissociates in one of the solvents. Chromatography: Thin Layer, Paper, and Column Chromatography, Determination of Rf value and purity of organic compounds by use of thin layer chromatography, Separation of organic compound by column chromatography. Separation of cations and anions by paper chromatography.

Synthesis of organic compounds including dibenzyl acetone, esters, nitrated products, and

derivatives via Vilsmeier-Haack and benzoylation reactions. Preparation of phenol/urea-formaldehyde resins, hydrazones, and semicarbazones, and functional group transformations, reaction mechanisms and purification.
Surface tension and viscosity measurements, composition analysis of liquid mixtures, determination of partition coefficients, solubility product, and critical solution temperature. Adsorption isotherm studies, construction of binary and ternary phase diagrams, and determination of dimerization constant and coordination number using partition methods.
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.
1. A. K. Nad, B. Mahapatra, A. Mahapatra, & A. Ghoshal, An Advanced Course in Practical Chemistry, New Central Book Agency, 2011.

SIXTH SEMESTER

CHY3201: ORGANOMETALLIC COMPOUNDS 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. Paints: Introduction, classification, manufacture, and requirements. Metallurgy and alloys: Principles, processes, and applications of metallurgy, the behavior and properties of alloys.
References:

1. B.D. Gupta and A. J. Elias, Basic Organometallic Chemistry, University Press, 2010.
2. R.C. Mehrotra, Organometallic Chemistry: A Unified Approach, New Age Publishers, 1991.
3. F. A. Cotton, G. Wilkinson, C. A. Murillo and M. Bochmann, Advanced Inorganic Chemistry, Wiley India, 2007.
4. D. Astruc, Organometallic Chemistry and Catalysis, Springer-Verlag, 2007.
5. J. A. Kent, Riegel’s Handbook of Industrial Chemistry, CBS, 1997.

CHY3202: PRINCIPLES OF NUCLEAR AND ANALYTICAL CHEMISTRY [3 1 0 4]

Nuclear Chemistry: Atomic Nucleus, radioactive decay; α, ß 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. Chromatography: the principles, instrumentation, and applications of chromatography methods, including gas chromatography (GC), liquid chromatography (LC), and thin-layer chromatography (TLC).

References:

1. H. J. 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.

CHY3203: SPECTROSCOPIC TECHNIQUES [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.

CHY3230: Chemistry lab-2 [0 0 8 4]

Kinetics of hydrolysis, saponification, iodination, bromination, and redox reactions; determination of reaction order, rate constant, and effect of ionic strength. Conductometric and redox titrations, equivalent conductivity at infinite dilution, and ionization constants of weak electrolytes, enabling students to explore the quantitative aspects of reaction rates and electrochemical behavior.

Quantitative estimation of calcium, magnesium, copper, and iron using complexometric and redox titrations. Acid-base titrations using indicators. Nickel gravimetry using DMG, copper estimation as CuSCN, iodometric titration of Cu(II), paper chromatography of Ni(II) and Co(II), iron estimation via ferric hydroxide, Fe(II) titration with $K_2Cr_2O_7$ using indicators, inorganic preparations of Cu_2Cl_2, $MnPO_4{\cdot}H_2O$, $[Fe(SCN)_6]^{3-}$ with spectroscopic analysis, semi-micro analysis of binary cations, estimation of crystallization water in Mohr's salt using $KMnO_4$ titration.

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.

SEVENTH SEMESTER

CHY4101: MAIN GROUP ELEMENTS-II AND INTRODUCTION TO SYMMETRY [3 1 0 4]

The p-block Elements-II: Chemical reactivity and group trends of N, P, As, Sb & Bi, compounds of N, P, As, Sb & Bi, O, S, Se and Te Family: Chemical Reactivity, group trends and stereochemistry, dioxygen as a ligand, structure of 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.

CHY4102: ADVANCED PHYSICAL CHEMISTRY [3 1 0 4]

Thermodynamics: Laws of thermodynamics, reaction equilibrium, Gibbs energies of pure phases and allotropes, binary solutions, partial molar properties & their significance. Electrochemistry: Metal/Electrolyte interface, structure of the double layer, fundamental of electrolytic corrosion. Conversion and Storage of Electrochemical Energy: Fuel cell, efficiency, kinetics, porous electrode, types of fuel cell, batteries, classical of batteries, modern batteries, and electrochemical capacitor for energy storage. Chemical Kinetics: order or reaction, kinetic equivalence terms, theory of reaction rates, elementary gas phase reactions, fast reaction kinetics, chain reactions, acid base catalysis, kinetics in the excited electronic states, physical and chemical adsorption, adsorption isotherms, Langmuir Hinshelwood and Eley Rideal mechanisms, heat of adsorption, kinetics of solid state reactions.

References:

1. R. P. Rastogi & R. R. Mishra, *An Introduction to Chemical Thermodynamics*, Vikas Publishing House Pvt Ltd, 2010.
2. K. J. Laidler, *Chemical Kinetics*, Harper and Row, New York, 2007.
3. J. O. Bockris, A. K. N. Reddy, *Modern Electrochemistry 2B*, Kluwer Academic/Plenum Publishers, 2018.
4. M. J. Pilling, P. W. Seakins, *Reaction Kinetics*, Oxford Univ. Press, 2nd Edition, 2009.
5. J. Rajaram, J. C. Kuriacose, *Kinetics and Mechanism of Chemical Transformations*, Macmillan India, 2012.

CHY4103: ORGANIC SYNTHESIS: METHODS AND REAGENTS [3 1 0 4]

Oxidative reagents: PCC, DDQ, Dess-Martin periodinane, OsO_4, peracids, selenium dioxide. Reductive reagents: $LiAlH_4$, $NaBH_4$, DIBAL-H, catalytic hydrogenation, Wolff-Kishner,

Clemmensen, Birch reduction. C–C bond formation: Aldol, Michael, Claisen, Wittig, Baylis–Hillman, Benzoin, Arndt-Eistert. C–O bond formation: Williamson ether synthesis, Mitsunobu reaction, Baeyer–Villiger oxidation. C–N bond formation: Mannich, Buchwald–Hartwig amination, Gabriel synthesis, Ugi reaction. Name reactions widely used in organic synthesis.

References:

1. F. A. Carey, R. I. Sundberg, Advanced Organic Chemistry, Part A and B, 3rd edition, Plenum Press, New York, 2010.
2. J. March, Advanced Organic Chemistry, 4th edition, Wiley Interscience, 2011.
3. J. Clayden, N. Greeves, S. Warren, Organic Chemistry, 2nd edition, Oxford University Press, Oxford/London, 2012.

CHY4104: APPLIED CHEMISTRY [3 1 0 4]

Photoelectrochemistry: photoexcitation of electrons, semiconductor–electrolyte interface, p-type photocathodes, n-type photoanodes, surface states, photoelectrocatalysis and applications in solar energy conversion. Organoelectrochemistry: electro-organic synthesis, electrochemical routes for organic reactions, chiral electrodes, electrically conducting polymers and their applications. Electrochemistry in Materials Science: charge transfer processes, electrochemical corrosion, anodic and cathodic reactions, thermodynamics and stability of metals, Pourbaix and Evans diagrams, corrosion current and potential, corrosion rate measurement, Stern–Geary approach, passivation. Electrochemical Energy Conversion and Storage: fuel cells, efficiency and kinetics, porous electrodes, batteries (classical and modern), electrochemical capacitors. Bioelectrochemistry: bioelectrodics, membrane potential, nerve conduction, enzyme electrodics and biosensors. Environmental Electrochemistry: solar–hydrogen production, CO_2 fixation and electrochemical waste treatment.

References:

1. J. O. Bockris, A. K. N. Reddy, Modern Electrochemistry 2B, Kluwer Academic/Plenum Publishers, 2018.
2. A. J. Bard, L. R. Faulkner, Electrochemical Methods: Fundamentals and Applications, Wiley, 2001.
3. J. O'M. Bockris, S. U. M. Khan, Surface Electrochemistry: A Molecular Level Approach, Springer, 1993.
4. P. Atkins, J. de Paula, *Physical Chemistry*, Oxford University Press, 2018.

CHY4130: Chemistry lab-3 [0 0 8 4]

Synthesis of coordination compounds, bis(dimethylglyoximato)nickel(II), Prussian and Turnbull's blue, tetraammine copper(II), tris(acetylacetonato)manganese(III), and cobalt and chromium complexes. Quantitative estimation of metal ions like Zn and Mg using complexometric titration, quantitative estimation of metal ions and chloride, spectrophotometric analysis of transition metals, and synthesis of coordination complexes including tris-oxalato chromate, bis-glycinato copper(II), and tris-triphenylphosphine copper(I).

Synthesis of glucose/fructose osazones, aldoximes, ketoximes, thiazoles, and Diels-Alder products. Oxidation reactions of benzaldehyde and benzoin, detect reducing and non-reducing sugars, and identify functional groups using spectroscopic techniques.

References:

1. A. K. Nad, B. Mahapatra, A. Ghoshal, An Advanced Course in Practical Chemistry, New Central Book Agency, 2011.
2. J. Mendham, R.C. Denney, M.J.K Thomas and D. J. Barne, Vogel's Quantitative Chemical Analysis, Pearson India, 2009.
3. O. P. Pamdey, D. N. Bajpai, S. Giri, Practical Chemistry, S Chand, 2010.

EIGHTH SEMESTER

CHY4201: MOLECULAR SPECTROSCOPY [3 1 0 4]

Spectroscopy: Rotational & vibrational spectroscopy: Intensity & width of a spectral line, rotational raman spectra, selection rules for vibrational spectrum, vibration-rotation spectra & spectral branches, electronic spectroscopy: nature of transition, fluorescence & phosphorescence, elementary ideas of laser and laser action, symmetry aspects of molecular orbital theory with examples, UV-VIS spectroscopy: Electronic levels and types of electronic transitions in organic, inorganic and organometallic systems, IR and Raman spectroscopy: FT technique, group frequencies, vibrational coupling, Raman spectroscopy. Mass spectrometry: Ion production: EI, CI, FD, FAB, ion analysis techniques. Nuclear Magnetic Resonance Spectroscopy: NMR phenomenon, spin ½ nuclei, 1H, 13C, 19F and 31P, Zeeman splitting. ESR spectroscopy: ESR phenomenon, introduction to the ESR spectra of organic free radicals and ion radicals.

References:

1. R. M. Silverstein, G. C. Bassler, T.C. Morril, Spectrometric Identification of Organic Compounds, John Wiley, New York, 2009.
2. W. Kemp, Organic Spectroscopy, 2nd edition, ELBS Macmillan, Hongkong, 2011.
3. E. A. V. Ebsworth, D. W. H. Rankin, S. Cradock, Structural Methods in Inorganic Chemistry, Blackwell Publications, London, 2013.

CHY4202: PHOTOCHEMISTRY AND PERICYCLIC REACTIONS [3 1 0 4]

Photochemistry: Photochemical reactions, quantum yield, transfer of excitation energy, actinometry. Determination of Reaction Mechanism: Determination of rate constants of reactions. Photochemistry of Alkenes: Rearrangement of 1,4-
and 1,5-dienes. Photochemistry of Carbonyl Compounds: Intramolecular reactions of carbonyl compounds-saturated, intermolecular cyloaddition reactions-dimerisations and oxetane formation. Photochemistry of Aromatic Compounds: Isomerisations, additions and substitutions. Miscellaneous Photochemical Reactions: Photo-Fries reaction of anilides, Photo-Fries rearrangement. Pericyclic Reactions: Classification of pericyclic reactions. Electrocyclic Reactions: Conrotatory and disrotatory motions. Sigmatropic Rearrangements: H-shifts and alkyl-shifts, supra and antarafacial migrations.

References:

1. A. Gilbert, J. Baggot, Essentials of Molecular Photochemistry, Blackwell Scientific Publication, 2011.
2. J. Singh, Photochemistry and Pericyclic Reactions, New Age, 2012.
3. R. K. Bansal, Heterocyclic Chemistry, New Age International Private Limited, 2017.
4. N. J. Turro, Molecular Photochemistry, W.A. Benjamin Inc., New York, 2012.
5. A. Cox, T.J. Kemp, Introductory Photochemistry, McGraw Hill, 2014.

CHY4230: Chemistry lab-4 [0 0 8 4]

The laboratory course is designed to provide practical exposure to instrumental, electrochemical, and materials chemistry techniques. Experiments include spectrophotometric estimation of fluoride, sulphate, phosphate, silver ions, and zirconium–Alizarin Red S complex (mole-ratio method); flame photometric analysis of Ca^{2+}, Ba^{2+}, Sr^{2+}, and Li^{+} ions; and complexometric titration for simultaneous estimation of Zn^{2+} and Mg^{2+}. Estimation of phosphoric acid in cold drinks is included as an applied analysis. Inorganic synthesis involves preparation of cis-dichlorobis(ethylenediamine)cobalt(III) chloride. Electrochemical experiments include cyclic voltammetry of transition metal complexes. Surface chemistry experiments cover CMC determination, colloids, and emulsions. Materials synthesis includes sol–gel and co-precipitation methods, crystal growth by solution and melt techniques, and basic characterization using powder XRD, thermal analysis (TGA/DTA/DSC), and optical or magnetic methods (demonstration/data interpretation).

References:

1. A. K. Nad, B. Mahapatra, A. Ghoshal, An Advanced Course in Practical Chemistry, New Central Book Agency, 2011.
2. S. K. Maity, N. K. Ghosh, Physical Chemistry Practical, New Central Book Agency, 2012.

ABILITY ENHANCEMENT COURSES

CHY2170: SCIENTIFIC WRITING [2 0 0 2]

Introduction to scientific communication and ethics in writing. Structure of scientific documents: abstracts, research papers, review articles, theses, and project reports. Literature survey techniques and use of scientific databases. Referencing styles, citations, plagiarism, and use of reference management tools. Basics of data presentation: tables, graphs, figures, and captions. Writing laboratory reports and short scientific articles. Seminar skills: topic selection, preparation of seminar presentations, use of audio-visual aids, poster presentation, and effective oral communication. Group discussion, question handling, and peer evaluation.

References:

1. R. Alley, The Craft of Scientific Writing, Springer, 2018.
2. L. C. Parks, Scientific Writing: A Reader and Writer's Guide, Wiley, 2010.
3. B. Gastel & R. A. Day, How to Write and Publish a Scientific Paper, Cambridge University Press, 2016.
4. M. Pechenik, A Short Guide to Writing About Biology (useful for sciences generally), Pearson, 2016.

MINOR COURSES

CHY2121: GENERAL CHEMISTRY [2 1 2 4]

Introduction to stereochemistry; Conformational analysis of open chain systems; Conformational analysis of cyclic systems; Symmetry elements, Point group analysis; Stereochemical conventions; Stereogenicity, Topicity; Stereochemical reactions; Reactions involving stereo centres; Aromaticity, Aromatic stabilization energy, Hückel MO, Polycyclic aromatic hydrocarbon (PAH), Polyacenes, Annulene; Aromatic Electrophilic substitutions; Aromatic Nucleophilic substitutions; Reaction dynamics, Hammond postulate; Linear free energy relationship, Hammett equation; Carbocation: Generation, Structure and Geometry, Stabilization of carbocation, Reactions of Carbocation; Carbanions: pKa and its significance; Hard and Soft Acid and Base principle; Structure, Formation, Stability, Reactivity; Free radical: Formation, Structure, Stability, Reactivity; Carbene, Nitrene: Generation, Structure, Reactivity.

Basics: Distillation, crystallization, decolourization and crystallization using charcoal, sublimation. Qualitative Analysis: Identification, functional group analysis, melting point, preparation of derivatives.

References:

1. G. W. Solomon and B. F. Craig, Organic Chemistry, John Wiley & Sons, Inc., 2010.
2. P. Sykes, A Guidebook to Mechanism in Organic Chemistry, Pearson India, 2003.
3. A. K. Nad, B. Mahapatra, A. Ghoshal, An Advanced Course in Practical Chemistry, New Central Book Agency, 2011.

CHY2221: PRINCIPLES OF ANALYTICAL CHEMISTRY [2 1 2 4]

Basic Concepts: Introduction to analytical chemistry. Measurement Basics: Introduction, working principle in chemical instrumentation for qualitative and quantitative analysis. Atomic spectroscopy: Introduction to spectrometric methods, components of optical instruments, atomic absorption and atomic fluorescence spectrometry, atomic emission

spectrometry, atomic mass spectrometry, atomic X-ray spectrometry. Molecular Spectroscopy: UV-Vis, IR, NMR, mass, Raman, fluorescence spectroscopy, instrumentations, and applications. Electroanalytical Chemistry: Introduction to electroanalytical chemistry, potentiometry, coulometry, voltammetry, instrumentation, and application. Separation Methods: An introduction to chromatographic separations, gas chromatography, high-performance liquid chromatography, capillary electrophoresis and capillary electrochromatography, components of instruments and applications.
Analytical: TLC, paper chromatography, determination of Rf values, separation techniques.

References:

1. D. A. Skoog, F. J. Holler, T. A. Nieman, Principles of Instrumental Analysis, Saunders College Publishing, 2013.
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. Donald L. Pavia, Introduction to Spectroscopy, 5th Edition, Cengage India Private Limited, 2015.
5. A. K. Nad, B. Mahapatra, A. Ghoshal, An Advanced Course in Practical Chemistry, New Central Book Agency, 2011.

CHY3121: MATERIALS CHEMISTRY: STRUCTURE, PROPERTIES AND APPLICATIONS [2 1 2 4]

Basic Concepts: Introduction to inorganic chemistry. Structure of crystalline solids: Classification of materials, crystalline and amorphous solids crystal. Structure, symmetry and point groups, Brvais lattice, unit cells, types of close packing - hcp and ccp, packing efficiency, radius ratios; crystallographic direction and plane. Ceramics: Classification, structure, impurities in solids. Electrical Properties: Introduction, basic concept of electric conduction, free electron and band theory, classification of materials, insulator, semiconductor, intrinsic & extrinsic semi-conductors, metal, superconductor etc., novel materials. Magnetic Properties: Introduction, origin of magnetism, units, types of magnetic ordering: dia-para-ferro-ferri and antiferro-magnetism, soft and hard magnetic materials, examples of some magnetic materials with applications. Special topics: Biomaterials, nanomaterials, composite materials.
Determination of rate constants, conductometric titrations, thermochemistry, phase diagrams.

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

CHY3221: PRINCILPLES OF INDUSTRIAL CHEMISTRY [2 1 2 4]

Handling of Chemicals- 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. **Environmental crisis & legislations** – Global environmental problems, Environmental acts, Laws and Policies, EIA, Case studies of the past related to environmental issues, Practical activity related to environmental problems and its impacts on environment. **Pollution -** Air / Water / Soil / Noise pollution, Water demand, Water quality standards, basics of water treatment, Conservation of water, Characteristics of sewage, treatment and disposal, Solid waste management; 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. **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.
Experiments: determination of water hardness and treatment efficiency; analysis of fuels (proximate/ultimate); basic tests on plastics, rubber, paints, sugar, and cellulose products.
References:

1. J. A. Kent, Riegel's Handbook of Industrial Chemistry, CBS, 1997.
2. Rajagopalan, R., Environmental Studies; From Crisis to Cure 3rd Edition, Oxford University Press, 2016.
3. Industrial Chemistry (including chemical - engineering) - B.K. Sharma - Goel publishing house, Meerut
4. P. C. Jain and M. Jain, Engineering Chemistry, Dhanpat Rai Publishing Company (P) Ltd, 2019.

CHY4221: FORENSIC CHEMISTRY AND TESTING METHODS [2 1 2 4]

Alcohols and alcoholic beverages, Analysis of alcohols, country made liquor, illicit liquor and medicinal preparations, Analysis of various denaturants of alcohol, detection and determination of ethanol, methanol, aldehyde, ester by colour test and instrumental technique, Relevant sections of Excise Act. Metals and alloys their composition; Importance of analysis, purity of metals, trace elements, asht dhatu and their analysis. Analysis of trap case:- Mechanism of colour reaction, factor affecting the colour, detection of phenolphthalein and alkali used, method of detection of degraded product on conversion of pink colour to colourless solution by TLC and UV visible spectrophotometer. Photo and videography and voice recording as supporting evidence. Dyes: Role of dyes in crime investigation, comparison of dyes in fibres and different inks by TLC and UV-VIS Spectrophotometer. Pesticides: Different types of pesticide, formulation, identification of pesticide, standard or sub-standard or substituted pesticides. Determination of purity by analysis by chemical test, thin layer chromatography, ultraviolet - visible spectrophotometry and gas liquid chromatography. Determination of level of pesticide in water, cold drinks, milk, food materials. Analysis of Drugs: Narcotic drugs, Depressants, Barbiturates, methaquolone, Benzodiazipines, Stimulants, Hallucinogens, Designer Drugs, Club drugs, date rape drugs and precursors by Field test kits for drugs and precursors using colour test, thin layer chromatography and further confirmation by HPTLC, UV-Vis spectrophotometry, Gas Chromatography, HPLC, GC-Mass Spectrometry and LC-Mass Spectrometry, Raman Spectroscopy and FTIR after extraction of drug from the seized sample. Detection of common adulterants and determination of percentage purity in seized sample

Reference:

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

CHY4222: MEDICINAL AND PHARMACEUTICAL CHEMISTRY [2 1 2 4]

Classification and Nomenclature of Drugs: Synthesis and application. Antibiotics: Synthesis of Streptomycin, penicillins, cephalosporin-C, chloroamphenicol, tetramycin. Antidiabetics: Synthesis of Sequence of A-and B-chains of insulin, glibenclamide, metformin, ciglitazone. Antihistamines: Synthesis of Methapyrilene, chlorpheniramine. Antivirals: Synthesis of Acyclovir, amantidine, rimantidine and Zidovudine. Antineoplastic Agents: Synthesis of mechlorethamine, cyclophosphamide, melaphan, uracil mustards and 6-mercaptopurine. Cardiovascular Drugs: Synthesis of amyl nitrite, sorbitrate, diltiazem, quinidine, verapamil, methyldopa, atenolol and oxrprenol. Local Anti-infective Agents: Synthesis of sulphonamides, furazolidone, nalidixic acid, ciprofloxacin, dapsone, aminosalicylic acid,

isoniazide, ethionamide, ethambutal, fluconazole, econozole, griseofulvin. Psychoactive Drugs: Synthesis of diazepam, oxazepam, chlorazepam, alprazolam, phenytoin, ethosuximide, trimethadione, barbiturates, thiopental sodium, gluethimide.

References:

1. G. R. Chatwal, Synthetic drugs, Himalaya, New Delhi 2005.
2. W. D. Foye, T. L. Lemke, D. A. Williams, Principles of Medicinal Chemistry 4th Edition, Wiley India, New Delhi, 2009.
3. R. B. Siwerman, Organic Chemistry of Drug action and Design, Academic press, New Delhi, 2010.

MULTIDISCIPLINARY COURSES

CHY2140: COMPUTATIONAL METHODS [2 1 0 3]

Definition and scope of computational chemistry, Role of computers in chemical sciences, Overview of molecular modeling, quantum chemistry, and simulation techniques, Review of basic calculus and linear algebra, Functions, limits, differentiation, and integration, Matrices and determinants in chemical problems, Solving linear equations (Gauss elimination method), Eigenvalues and eigenvectors (chemical significance) Errors and approximations Roots of equations: Bisection method, Newton–Raphson method, Numerical differentiation and integration, Trapezoidal rule, Simpson's rule, Application to kinetics and thermodynamics**,** Computational treatment of chemical kinetics, Thermodynamic calculations, Potential energy curves and molecular stability, Basic molecular visualization concepts, Introduction to open-source chemistry software.

References:

1. A. R. Leach, Molecular Modelling: Principles and Applications, Pearson, 2nd Edition, 2001.
2. F. Jensen, Introduction to Computational Chemistry, Wiley, 2nd Edition, 2007.
3. S. S. Rao, Numerical Methods for Engineers and Scientists, PHI Learning, New Delhi, 2002.
4. D. A. McQuarrie, Quantum Chemistry, Viva Books, New Delhi, 2008.

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