1.1.3 Courses having focus on employability/ entrepreneurship/ skill development offered by the University during the year

Color Index	
Employability	Yellow
Entrepreneurship	Green
Skill Development	Pink

LINGAYA'S VIDYAPEETH
choose to know

(u/s 3 of UGC Act 1956)

SYLLABUS

BACHELOR OF SCIENCE- CHEMISTRY

(THREE YEAR FULL TIME PROGRAMME)

(SIX SEMESTER COURSE)

Year 2021-2024

Department of Chemistry

School of Basic & Applied Science

Lingaya's Vidyapeeth, Faridabad

Deemed to be university (u/s of UGC act 1956)

(Approved By UGC, MHRD, AICTE, BCI, PCI & ACI)

LINGAYA'S VIDYAPEETH
SCHEME OF STUDIES
SESSION: 2021-24

School: Basic and Applied Sciences	**Batch: 2021-2024**
Department: Chemistry	**Year: First**
Course: B.Sc (Hons.) Chemistry	**Semester:Ist**

SN	Cate-gory	Course Code	Course Name	Periods			Credits	Evaluation Scheme					Subject Total Marks
								Theory			Practical		
				L	T	P		ABQ	MSE	ESE	IP	EXP	
1	GE	BS-101	Electricity and Magnetism	4	0	0	4	15	25	60	-	-	100
2	GE	BS-103	Algebra	4	0	0	4	15	25	60	-	-	100
3	PCC	BS-105	Inorganic Chemistry-I	4	0	0	4	15	25	60	-	-	100
4	AEC	HSS-107	English and Communication Skills	2	0	0	2	15	25	60	-	-	100
5	GE	BS-151	Physics Laboratory-I	0	0	3	2				40	60	100
6	PCC	BS-155	Inorganic Chemistry Laboratory-I	0	0	3	2				40	60	100
			Total---->	**14**	**0**	**6**	**18**	**60**	**100**	**240**	**80**	**120**	**600**

School: Basic and Applied Sciences								Batch: 2021-2024					
Department: Chemistry								Year: I					
Course: B.Sc (Hons.) Chemistry								Semester:II[nd]					
SN	Cate-gory	Course Code	Course Name	Periods			Credits	Evaluation Scheme					Subject Total Marks
								Theory			Practical		
				L	T	P		ABQ	MSE	ESE	IP	EXP	
1	GE	BS-102	Statistical Physics	4	0	0	4	15	25	60	-	-	100
2	GE	BS-104	Calculus	4	0	0	4	15	25	60	-	-	100
3	PCC	BS-106	Organic Chemistry-I	4	0	0	4	15	25	60	-	-	100
4	AEC	CE-108	Environmental Science & Ecology	2	0	0	2	15	25	60	-	-	100
5	GE	BS-152	Physics Laboratory-II	0	0	3	2				40	60	100
6	PCC	BS-156	Organic Chemistry Laboratory-II	0	0	3	2				40	60	100
			Total---->	**14**	**0**	**6**	**18**	**60**	**100**	**240**	**80**	**120**	**600**

School: Basic and Applied Sciences														Batch: 2021-2024
Department: Chemistry														Year: II
Course: B.Sc (Hons.) Chemistry														Semester:III[rd]
SN	Cate-gory	Course Code	Course Name	Periods			Credits	Evaluation Scheme					Subject Total Marks
								Theory			Practical		
				L	T	P		ABQ	MSE	ESE	IP	EXP	
1	PCC	BCH-201	Inorganic Chemistry-II	4	0	0	4	15	25	60	-	-	100
2	PCC	BCH-203	Organic Chemistry-II	4	0	0	4	15	25	60	-	-	100
3	PCC	BCH-205	Physical Chemistry -I	4	0	0	4	15	25	60	-	-	100
4	DSE	BCH-207	Analytical Methods in Chemistry	5	1	0	6	15	25	60	-	-	100
5	SEC	BCH-209	Chemistry of Cosmetics and perfumes	2	0	0	2	15	25	60	-	-	100
6	PCC	BCH-251	Inorganic Chemistry-Laboratory-II	0	0	4	2				40	60	100
7	PCC	BCH-253	Organic Chemistry-Laboratory-II	0	0	4	2				40	60	100
8	PCC	BCH-255	Physical Chemistry-Laboratory-I	0	0	4	2				40	60	100
			Total---->	**19**	**1**	**12**	**26**	**75**	**125**	**300**	**120**	**180**	**800**

School: Basic and Applied Sciences	Batch: 2021-2024
Department: Chemistry	Year: II
Course: B.Sc (Hons.) Chemistry	Semester:IVth

SN	Cate-gory	Course Code	Course Name	Periods			Credits	Evaluation Scheme					Subject Total Marks
								Theory			Practical		
				L	T	P		ABQ	MSE	ESE	IP	EXP	
1	PCC	BCH-202	Inorganic Chemistry-III	4	0	0	4	15	25	60	-	-	100
2	PCC	BCH-204	Organic Chemistry-III	4	0	0	4	15	25	60	-	-	100
3	PCC	BCH-206	Physical Chemistry-II	4	0	0	4	15	25	60	-	-	100
4	DSE	BCH-208	Polymer Chemistry	5	1	0	6	15	25	60	-	-	100
5	SEC	BCH-210	Fuel Chemistry	2	0	0	2	15	25	60	-	-	100
6	PCC	BCH-252	Inorganic Chemistry-Laboratory-III	0	0	4	2				40	60	100
7	PCC	BCH-254	Organic Chemistry-Laboratory-III	0	0	4	2				40	60	100
8	PCC	BCH-256	Physical Chemistry-Laboratory-II	0	0	4	2				40	60	100
			Total---->	**19**	**1**	**12**	**26**	**75**	**125**	**300**	**120**	**180**	**800**

School: Basic and Applied Sciences	Batch: 2021-2024
Department: Chemistry	Year:IIIrd
Course: B.Sc (Hons.) Chemistry	Semester:Vth

SN	Cate-gory	Course Code	Course Name	Periods			Credits	Evaluation Scheme					Subject Total Marks
								Theory			Practical		
				L	T	P		ABQ	MSE	ESE	IP	EXP	
1	PCC	BCH-301	Inorganic Chemistry-IV	4	0	0	4	15	25	60	-	-	100
2	PCC	BCH-303	Organic Chemistry-IV	4	0	0	4	15	25	60	-	-	100
3	PCC	BCH-305	Physical Chemistry-III	4	0	0	4	15	25	60	-	-	100
4	DSE	BCH-307	Industrial Chemicals & Environment	5	1	0	6	15	25	60	-	-	100
5	PCC	BCH-351	Inorganic Chemistry-Laboratory-IV	0	0	4	2				40	60	100
6	PCC	BCH-353	Organic Chemistry-Laboratory-IV	0	0	4	2				40	60	100
7	PCC	BCH-355	Physical Chemistry-Laboratory-III	0	0	4	2				40	60	100
				17	**1**	**12**	**24**	**60**	**100**	**240**	**120**	**180**	**700**

School: Basic and Applied Sciences								Batch: 2021-2024					
Department: Chemistry								Year: III					
Course: B.Sc (Hons.) Chemistry								Semester:VIth					
SN	Cate-gory	Course Code	Course Name	Periods			Credits	Evaluation Scheme					Subject Total Marks
								Theory			Practical		
				L	T	P		ABQ	MSE	ESE	IP	EXP	
1	PCC	BCH-302	Inorganic Chemistry-V	4	0	0	4	15	25	60	-	-	100
2	PCC	BCH-304	Organic Chemistry-V	4	0	0	4	15	25	60	-	-	100
3	PCC	BCH-306	Physical Chemistry-IV	4	0	0	4	15	25	60	-	-	100
4	DSE	BCH-308	Green Chemistry	5	1	0	6	15	25	60	-	-	100
5	PCC	BCH-352	Inorganic Chemistry-Laboratory-V	0	0	4	2				40	60	100
6	PCC	BCH-354	Organic Chemistry-Laboratory-V	0	0	4	2				40	60	100
7	PCC	BCH-356	Physical Chemistry-Laboratory-IV	0	0	4	2				40	60	100
8	PROJ	BCH-358	Project	0	0	12	6						100
			Total---->	**17**	**1**	**24**	**30**	**60**	**100**	**240**	**120**	**180**	**800**

Abbreviations:

PCC-Programme Core Courses
GE: Generic Elective
DSE: Discipline Specific Elective
SEC: Skill Enhancement Courses
AEC: Ability Enhancement Courses
PROJ: Project
HSS: Humanity and Social Science
L: Lecture
T: Tutorial
P: Practical
ABQ: Assignment Based Quiz
MSE: Mid Semester Examination
ESE: End Semester Examination
IP: Internal Practical
EXP: External Practical

SEMESTER-I

Course Code	Subject Name	L-T-P	Credits
BS-101	Electricity and Magnetism	**4-0-0**	**4**

Unit I:Vector Calculus (8 Lectures)
Differentiation of vectors, scalar and vector fields, conservative fields and potentials, line integrals, gradient of a scalar field, divergence of a vector field and divergence theorem, curl of a vector field and its physical significance, Stokes' theorem, combination of grad, div and curl.

Unit II:Electric field and electric potential(14 Lectures)
Electric field: Electric field lines. Electric flux.Gauss' Law with applications to charge distributions with spherical, cylindrical and planar symmetry.Conservative nature of Electrostatic Field.Electrostatic Potential.Laplace's and Poisson equations.The Uniqueness Theorem.Potential and Electric Field of a dipole. Force and Torque on a dipole.
Electrostatic energy of system of charges.Electrostatic energy of a charged sphere.Conductors in an electrostatic Field. Surface charge and force on a conductor. Capacitance of a system of charged conductors.Parallel-plate capacitor.Capacitance of an isolated conductor. Method of Images and its application to: (1) Plane Infinite Sheet and (2) Sphere.

Unit III:Dielectric properties of matter(10 Lectures)
Electric Field in matter.Polarization, Polarization Charges.Electrical Susceptibility and Dielectric Constant. Capacitor (parallel plate, spherical, cylindrical) filled with dielectric. Displacement vector D. Relations between E, P and D. Gauss' Law in dielectrics.

Unit IV:Magnetic field(10 Lectures)
Magnetic force between current elements and definition of Magnetic FieldB.Biot-Savart's Law and its simple applications: straight wire and circular loop. Current Loop as a Magnetic Dipole and its Dipole Moment (Analogy with Electric Dipole). Ampere's Circuital Law and its application to (1) Solenoid and (2) Toroid. Properties of B: curl and divergence. Vector Potential. Magnetic Force on (1) point charge (2) current carrying wire (3) between current elements. Torque on a current loop in a uniform Magnetic Field.

Unit V: Electromagnetic induction & ballistic galvanometer(10 Lectures)
Faraday's Law.Lenz's Law.Self Inductance and Mutual Inductance. Energy stored in a Magnetic Field. Behavior of various substances in magnetic fields.Magnetic permeability and susceptibility and their interrelation.Orbital motion of electrons and diamagnetism.Electron spin and paramagnetic.Ferromagnetism.Domain theory of ferromagnetism, magnetization curve, hysterics loss, ferrites.

TEXT BOOKS/REFERENCE BOOKS:

1. Mathematical Methods in the Physical Sciences: ML Boas, Wiley, 2002.
2. Introduction to Mathematical Physics: C Harper, Prentice Hall of India, 2004.
3. Electricity and Magnetism (Berkley, Phys. Course 2): EM Purcell, Tata McGraw Hill, 1981

Course Code	Subject Name	L-T-P	Credits
BS-103	Algebra	**5-1-0**	**6**

Unit I: (10 Lectures)
Polar representation of complex numbers, nth roots of unity, De Moivre's theorem for rational indices and its applications.

Unit II: (11 Lectures)
Equivalence relations, Functions, Composition of functions, Invertible functions, One to one correspondence and cardinality of a set, Well-ordering property of positive integers, Division algorithm, Divisibility and Euclidean algorithm, Congruence relation between integers, Principles of Mathematical Induction, statement of Fundamental Theorem of Arithmetic.

Unit III: (11 Lectures)
Systems of linear equations, row reduction and echelon forms, vector equations, the matrix equation Ax=b, solution sets of linear systems, applications of linear systems, linear independence.

Unit IV:(10 Lectures)
Introduction to linear transformations, matrix of a linear transformation, inverse of a matrix, characterizations of invertible matrices.

Unit V: (10 Lectures)
Subspaces of Rn, dimension of subspaces of Rn and rank of a matrix, Eigen values, Eigen Vectors and Characteristic Equation of a matrix, special matrices

TEXT BOOKS/REFERENCE BOOKS:

1. TituAndreescu and DorinAndrica, Complex Numbers from A to Z, Birkhauser, 2006.
2. Edgar G. Goodaire and Michael M. Parmenter, Discrete Mathematics with Graph Theory, 3rd Ed., Pearson Education (Singapore) P. Ltd., Indian Reprint, 2005.
3. David C. Lay, Linear Algebra and its Applications, 3rd Ed., Pearson Education Asia, Indian Reprint, 2007

Course Code	Subject Name	L-T-P	Credits
BS-105	Inorganic Chemistry-I	**4-0-0**	**4**

Unit I: Atomic Structure:(14 Lectures)
Bohr's theory, its limitations and atomic spectrum of hydrogen atom. Wave mechanics: de Broglie equation, Heisenberg's Uncertainty Principle and its significance, Schrödinger'swave equation, significance of ψ and ψ2. Quantum numbers and their significance.Normalized and orthogonal wave functions. Sign of wave functions. Radial and angular wavefunctions for hydrogen atom. Radial and angular distribution curves. Shapes of s, p, d and forbitals. Contour boundary and probability diagrams.Pauli's Exclusion Principle, Hund's rule of maximum multiplicity, Aufbau's principle and itslimitations, Variation of orbital energy with atomic number.

Unit II: Periodicity of Elements:(16 Lectures)
s, p, d, f block elements, the long form of periodic table. Detailed discussion of the following properties of the elements, with reference to s and p-block.(a) Effective nuclear charge, shielding or screening effect, Slater rules, variation of effectivenuclear charge in periodic table.
(b) Atomic radii (van der Waals)
(c) Ionic and crystal radii.
(d) Covalent radii (octahedral and tetrahedral)
(e) Ionization enthalpy, Successive ionization enthalpies and factors affecting ionizationenergy. Applications of ionization enthalpy.
(f) Electron gain enthalpy, trends of electron gain enthalpy.
(g) Electronegativity, Pauling's/ Mulliken's/ Allred Rachow's/ and Mulliken-Jaffé'selectronegativity scales. Variation of electronegativity with bond order, partial charge,hybridization, group electronegativity.Sanderson's electron density ratio.

Unit III: Chemical Bonding-I:(13 Lectures)
(i) Ionic bond: General characteristics, types of ions, size effects, radius ratio rule and its limitations. Packing of ions in crystals. Born-Landé equation with derivation and importance ofKapustinskii expression for lattice energy. Madelung constant, Born-Haber cycle and its application, Solvation energy.
(ii) Covalent bond: Lewis structure, Valence Bond theory (Heitler-London approach).Energetics of hybridization, equivalent and non-equivalent hybrid orbitals.Bent's rule,Resonance and resonance energy, Molecular orbital theory. Molecular orbital diagrams ofdiatomic and simple polyatomic molecules N_2, O_2, C_2, B_2, F_2, CO, NO, and their ions; HCl,BeF_2, CO_2, (idea of s-p mixing and orbital interaction to be given). Formal charge, Valenceshell electron pair repulsion theory (VSEPR), shapes of simple molecules and ions containinglone pairs and bond pairs of electrons, multiple bonding (σ and π bond approach) and bondlengths.Covalent character in ionic compounds, polarizing power and polarizability.Fajan's rules andconsequences of polarization.Ionic character in covalent compounds: Bond moment and dipole moment. Percentage ioniccharacter from dipole moment and electronegativity difference.

Unit IV: Chemical Bonding-II:(13 Lectures)

Metallic Bond: Qualitative idea of valence bond and band theories. Semiconductors andinsulators, defects in solids.(iv) Weak Chemical Forces: van der Waals forces, ion-dipole forces, dipole-dipoleinteractions, induced dipole interactions, Instantaneous dipole-induced dipole interactions.Repulsive forces, Hydrogen bonding (theories of hydrogen bonding, valence bond treatment), Effects of chemical force, melting and boiling points, solubility energetics of dissolutionprocess.

Unit V: Oxidation-Reduction:(4 Lectures)
Redox equations, Standard Electrode Potential and its application to inorganic reactions.
Principles involved in volumetric analysis to be carried out in class.

TEXTBOOK/REFERENCE BOOKS:

1. Lee, J.D. Concise Inorganic Chemistry ELBS, 1991.
2. Douglas, B.E. and McDaniel, D.H. Concepts & Models of Inorganic Chemistry Oxford, 1970
3. Atkins, P.W. & Paula, J. Physical Chemistry, 10th Ed., Oxford University Press, 2014.
4. Day, M.C. and Selbin, J. Theoretical Inorganic Chemistry, ACS Publications, 1962.
5. Rodger, G.E. Inorganic and Solid State Chemistry, Cengage Learning India Edition, 2002.

Course Code	Subject Name	L-T-P	Credits
BS-153	Physics Laboratory-I	0-0-4	2

1.	Use of Verniercallipers, Screw gauge, Spherometer, Barometer, Sphygmomanometer, Lightmeter, dry and wet thermometer, TDS/conductivity meter and other measuring instruments based on applications of the experiments. Use of Plumb line and Spirit level.
2.	Determination of 'g' by Kater's pendulum.
3.	To study the variation of time period with distance between centre of suspension and centre of gravity for a bar pendulum and to determine: (i) Radius of gyration of the bar about an axis through its C.G. and perpendicular to its length. (ii) The value of g in the laboratory.
4.	Determination of modulus of rigidity by (i) dynamic method Maxwell's needle/Torsional pendulum (ii) Forced torsional oscillations excited using electromagnet
5.	Determination of coefficient of viscosity of a given liquid by Stoke's method. Study its temperature dependence.
6.	To study moment of inertia of a flywheel.
7.	Determination of modulus of rigidity by static method
8.	To determine the Young's modulus by (i) bending of beam using traveling microscope/laser, (ii) Flexural vibrations of a bar.
9.	To study one dimensional collision using two hanging spheres of different materials
10.	Determination of height (of inaccessible structure) using sextant.
11.	Measurement of charge and current sensitivity and CDR of Ballistic Galvanometer
12.	Determine a high resistance by leakage method using Ballistic Galvanometer.
13.	To determine self-inductance of a coil by Rayleigh's method.
14.	To determine the mutual inductance of two coils by Absolute method.
15.	To study the Motion of Spring and calculate (a) Spring constant, (b) g and (c) Modulus of rigidity.
16.	To determine Coefficient of Viscosity of water by Capillary Flow Method (Poiseuille's method).
17.	To determine the value of g using Bar Pendulum.
18.	To determine the height of a building using a Sextant.

TEXTBOOK/REFERENCE BOOKS:

1. A Text Book of Practical Physics: I Prakash, Ramakrishna, KitabMahal, 11th ed., 2011.
2. BSc Practical Physics: GeetaSanon, R. Chand & Co., 1st ed., 2007.
3. BSc Physics Practical – I, II, III: Jain, Sharma, Agarwal, KrishanPrakashan, 2014.
4. B.Sc. Practical Physics: CL Arora, S Chand & Company Ltd., 2010.

Course Code	Subject Name	L-T-P	Credits
BS-155	Inorganic Chemistry laboratory-I	0-0-4	2

1	**Titrimetric Analysis:** Calibration and use of apparatus Preparation of solutions of different Molarity/Normality of titrants
2	Estimation of carbonate and hydroxide present together in mixture.
3	Determination of viscosity of (i) ethanol (ii) amyl alcohol and (iii) aqueous solution of sugar at room temperature
4	Estimation of free alkali present in different soaps/detergents
5	Determine the surface tension of given solution using drop number method.
6	**Preparation and purification through crystallization or distillation and ascertaining their purity through melting or boilingpoint**: (i) Phenyl benzoate from phenol and benzoylchloride (ii) M-dinitrobenzene from nitrobenzene (use 1:2 conc. HNO_3 - H_2SO_4 mixture if fuming HNO_3 is not available). (iii) Picricacid (iv) Aspirin from salicylicacid
7	Crystallization and decolourization of impure naphthalene fromethanol.

TEXTBOOK/REFERENCE BOOKS:

1. O.P. Pandey, D.N. Bajpai& S. Giri, Practical Chemistry, S. Chand &CompanyLtd.
2. B. D. Khosla, V. C. Garg& A. Gulati, *Senior Practical Physical Chemistry*, S. Chand & Co.: New Delhi(2011).

SEMESTER-II

Course Code	Subject Name	L-T-P	Credits
BS-102	Statistical Physics	**4-0-0**	**4**

Unit I: Basic Ideas of Statistical Physics(11 Lectures)
Introduction, Basic ideas of probability and their applications, Macrostates and microstates, Effect of constraints on the system.

Unit II: Distribution of particles(10 Lectures)
Distribution of n particles in two compartments, deviation from the state of maximum probability, Equilibrium state of a dynamic system, distribution of N distinguishable particles in unequal compartments, Division into cells, Phase space and its division into cells.

Unit III: Maxwell-Boltzmann Statistics(11 Lectures)
Phase space and its division into cells. Three kinds of statistics and their basic approach. Maxwell-Boltzmann Statistics for an ideal gas: Volume in phase space, values of α and β. Experimental verification and graphical depiction of Maxwell-Boltzmann distribution of molecular speeds.

Unit IV: Isolated System(11 Lectures)
Micro canonical Ensemble,Closed System : Canonical Ensemble, Open System : Grand Canonical Ensemble Bose-Einstein Statistics : Need for quantum statistics, Bose-Einstein statistics and its application to Black body radiation, photon gas, deductions from Planck's law.

Unit V: Fermi-Dirac Statistics(9 Lectures)
Fermi-Dirac Statistics: Fermi-Dirac statistics and its application to electron gas, Fermi energy, comparison of M.B., B.E. and F.D. statistics

TEXTBOOKS/REFERENCE BOOKS:

1. Statistical Physics, Thermodynamics and Kinetic Theory: VS Bhatia, Vishal Pub. Co. Jalandhar, 2003
2. Introduction to Statistical Physics: Kerson Huang Taylor & Francis Inc. 2002
3. An Introduction to Statistical Mechanics and Thermodynamics: Robert H. Swendsen. Oxford University Press Inc. 2012.
4. Statistical Mechanics, R.K. Pathria, Butterworth Heinemann: 2nd Ed., 1996, Oxford University Press.
5. Statistical Physics, Berkeley Physics Course, F. Reif, 2008, Tata McGraw-Hill.
6. Statistical and Thermal Physics, S. Lokanathan and R.S. Gambhir. 1991, Prentice Hall.

Course Code	Subject Name	L-T-P	Credits
BS-104	Calculus	**5-1-0**	**6**

Unit I:Limit &Continuity(11 Lectures)
The real line and its geometrical representation; e-δ treatment of limit and continuity; Properties of limit and classification of discontinuities; Properties of continuous functions.

Unit II: Differentiability(10 Lectures)
Successive differentiation; Leibnitz Theorem; Statement of Rolle's Theorem; Mean Value Theorem; Taylor and Maclaurin's Theorems; Indeterminate forms.

Unit III:Applications of Differentiation(11 Lectures)
Asymptotes; Concavity, convexity and points of inflection; Curvature; Extrema; elementary curves, tangent and normal in parametric form; Polar Coordinates.

Unit IV:Partial Differentiation(10 Lectures)
Limits and continuity of functions of two variables; Partial derivatives; Taylor's theorem and Maclaurin's Theorem for function of two variable; Maxima and minima for function of two variable.

Unit V: Double and triple integrals(10 Lectures)
Change of order in double integrals. Application of Integration: length of a curve; Arc length as a parameter; Evoute& Envelope; Volumes and surface areas of solids of revolution.

TEXTBOOKS/REFERENCE BOOKS:
1. Gorakh Prasad, Differential Calculus, Pothishala Pvt. Ltd. Allahabad, 2000.
2. Gorakh Prasad, Integral Calculus, Pothishala Pvt. Ltd. Allahabad, 2000.
3. Gabriel Klambauer, Mathematical Analysis, Marcel Dekkar Inc. New York 1975.
4. Shanti Narayan, Elements of Real Analysis, S. Chand & Company, New Delhi.
5. Shanti Narayan, A Text Book of Vector Calculus, S. Chand & Company, New Delhi.
6. G.B. Thomas and R.L. Finney, Calculus, 9th Ed., Pearson Education, Delhi, 2005.
7. M.J. Strauss, G.L. Bradley and K. J. Smith, Calculus, 3rd Ed., Dorling Kindersley (India) Ltd. (Pearson Education), Delhi, 2007.Structure, 6th Edition, Wiley, 2007.

Course Code	Subject Name	L-T-P	Credits
BS-106	Organic Chemistry-I	**4-0-0**	**4**

Unit I: Basics Of Organic Chemistry-I(6 Lectures)
Organic Compounds: Classification, and Nomenclature, Hybridization, Shapes of molecules, Influence of hybridization on bond properties. Electronic Displacements: Inductive, electromeric, resonance and mesomeric effects, hyperconjugation and their applications; Dipole moment; Organic acids and bases; their relative strength.

Unit II: Basics Of Organic Chemistry-II(8 Lectures)
Homolytic and Heterolytic fission with suitable examples.Curly arrow rules, formal charges; Electrophiles and Nucleophiles; Nucleophlicity and basicity; Types, shape and their relative stability of Carbocations, Carbanions, Free radicals and Carbenes.
Introduction to types of organic reactions and their mechanism: Addition, Elimination and Substitution reactions.

Unit III: Stereochemistry(13 Lectures)
Fischer Projection, Newmann and Sawhorse Projection formulae and their interconversions; Geometrical isomerism: cis–trans and, syn-anti isomerism E/Z notations with C.I.P rules.
Optical Isomerism: Optical Activity, Specific Rotation, Chirality/Asymmetry, Enantiomers, Molecules with two or more chiral-centres, Distereoisomers, meso structures, Racemic mixture.and resolution. Relative and absolute configuration: D/L and R/S designations.

Unit IV: Chemistry of Aliphatic Hydrocarbons(22 Lectures)
(i) Carbon-Carbon sigma bonds:Chemistry of alkanes: Formation of alkanes, Wurtz Reaction, Wurtz-Fittig Reactions, Free radical substitutions: Halogenation -relative reactivity and selectivity.
(ii) Carbon-Carbon pi bonds:Mechanism of E1 and E2 reactions. Saytzeff and Hofmann eliminations.Electrophilic additions their mechanisms (Markownikoff/ Anti Markownikoff addition), mechanism of oxymercuration-demercuration, hydroboration-oxidation, ozonolysis, reduction (catalytic and chemical), syn and anti-hydroxylation (oxidation).Diels-Alder reaction.

Unit V: Aromatic Hydrocarbons(11 Lectures)
Aromaticity: Hückel's rule, aromatic character of arenes, cyclic carbocations/carbanions and heterocyclic compounds with suitable examples. Electrophilic aromatic substitution:halogenation, nitration, sulphonation and Friedel-Craft's alkylation/acylation with their
mechanism. Directing effects of the groups.

TEXTBOOKS/REFERENCE BOOKS:
1. Morrison, R. N. & Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. PearsonEducation).

2. Kalsi, P. S. Stereochemistry Conformation and Mechanism; New Age International,2005

Course Code	Subject Name	L-T-P	Credits
BS-152	Physics Laboratory-II	0-0-4	2

S. No.	Practical Description
1.	To determine Cauchy's constants and resolving power of a given prism.
2.	To find the refractive index of a given liquid using a prism spectrometer.
3.	To determine the wavelength of sodium light using Newton's rings method.
4.	To find the resolving power and magnification of a telescope.
5.	To find the resolving power and magnification of a diffraction grating.
6.	To study hydrogen/Neon gas discharge tube spectrum using diffraction grating.
7.	To study temperature dependence of refractive index of organic liquid using Abbe's refractometer.
8.	To study the variation of specific rotation of sugar solution with concentration.
9.	To measure power distribution and divergence parameters of He-Ne and Semiconductor Lasers.
10.	Study of G.M. Counter characteristics. Measurements of Background radiation and alpha, beta and gamma rays using natural sources.
11.	To find the first ionization potential of mercury.
12.	To determine the value of Stefan's Constant of radiation
13.	Determination of mechanical equivalent of heat by Calendar and Barne's constant flow method.
14.	To measure the thermal conductivity and thermal diffusivity of a conductor.
15.	To determine thermal conductivity of a bad conductor disc (i) Lees and Chorlton method using steam heating and thermometers (ii) Advance kit involving constant current source for heating and thermocouples for temperature measurements.
16.	Measurement of the electrical and thermal conductivity of copper to determine its Lorentz number.

TEXTBOOKS/REFERENCE BOOKS:

1. A Text Book of Practical Physics: I Prakash, Ramakrishna, KitabMahal, 11th ed., 2011.
2. BSc Practical Physics: GeetaSanon, R. Chand & Co., 1st ed., 2007.

Course Code	Subject Name	L-T-P	Credits
BS-156	Organic Chemistry laboratory-I	0-0-4	2

S. No.	Practical Description
1.	**Preparation of the following inorganic compounds** (I) $VO(acac)_2$ (II) (II) Cis-$K[Cr(C_2O_4)_2(H_2O)_2$ (III) (III) $Na[Cr(NH_3)_2(SCN)_4]$ (IV) (IV) $K_3[Fe(C_2O_4)_3]$
2.	**Quantitative Analysis** (a) Separation and determination of two metal ions Cu-Ni, Ni-Zn, Cu-Fe, Ba-Cu etc. involving volumetric and gravimetric methods.
3.	**Spectrophotometric Determinations** 1. Ni by extractive Spectrophotometric method. 2. Fe by Job's method of continuous variations 3. Fe in vitamin tablets 4. Nitrite in water in colorimetric method.
4.	Determination of heat capacity of the calorimeter and enthalpy of neutralization of hydrochloric acid with sodium hydroxide.
5.	Determination of enthalpy of hydration of copper sulphate.

TEXTBOOKS/REFERENCE BOOKS:

1. Experimental Inorganic Chemistry by W.G. Palmer, Cambridge.
2. Inorganic Synthesis, MC Graw Hill.
3. Handbook of Preparative Inorganic chemistry Vol. I and II, Academic press.
4. Standard methods of chemical analysis by W.W. Scaff, Technical Press.
5. Vogel's Qualitative Inorganic Analysis (revised), Orient Longman.

SEMESTER-III

Course Code	Subject Name	L-T-P	Credits
BCH-201	Inorganic Chemistry-II	**4-0-0**	**4**

Unit 1: General Principles of Metallurgy(6 Lectures)
Chief modes of occurrence of metals based on standard electrode potentials. Ellingham diagrams forreduction of metal oxides using carbon and carbon monoxide as reducing agent. Electrolytic Reduction, Hydrometallurgy. Methods of purification of metals: Electrolytic Kroll process, Partingprocess, van Arkel-de Boer process and Mond's process, Zone refining.

Unit II: Acids and Bases(8 Lectures)
Brönsted-Lowry concept of acid-base reactions, solvated proton, relative strength of acids, types of acid-base reactions, levelling solvents, Lewis acid-base concept, Classification of Lewis acids, Hard and Soft Acids and Bases (HSAB) Application of HSAB principle.

Unit III: Chemistry of s and p Block Elements(30 Lectures)
Inert pair effect, Relative stability of different oxidation states, diagonal relationship andanomalous behaviour of first member of each group. Allotropy and catenation.Complexformation tendency of s and p block elements.Hydrides and their classification ionic, covalent and interstitial.Basic beryllium acetate andnitrate.Study of the following compounds with emphasis on structure, bonding, preparation,properties and uses.
Boric acid and borates, boron nitrides, borohydrides (diborane) carboranes and graphiticcompounds, silanes, Oxides and oxoacids of nitrogen, Phosphorus and chlorine.Peroxo acids
ofsulphur, interhalogen compounds, polyhalide ions, pseudohalogens and basic properties of halogens.

Unit IV: Noble Gases (8 Lectures)
Occurrence and uses, rationalization of inertness of noble gases, Clathrates; preparation and properties of XeF2, XeF4 and XeF6; Nature of bonding in noble gas compounds (Valencebond treatment and MO treatment for XeF2). Molecular shapes of noble gas compounds(VSEPR theory).

Unit V: Inorganic Polymers (8 Lectures)
Types of inorganic polymers, comparison with organic polymers, synthesis, structural aspects and applications of silicones and siloxanes. Borazines, silicates and phosphazenes, andpolysulphates.

TEXTBOOKS/REFERENCE BOOKS:

1. Lee, J.D. Concise Inorganic Chemistry, ELBS, 1991.
2. Douglas, B.E; Mc Daniel, D.H. & Alexander, J.J. Concepts & Models ofInorganic Chemistry 3rd Ed., John Wiley Sons, N.Y. 1994.
3. Greenwood, N.N. &Earnshaw. Chemistry of the Elements, Butterworth-Heinemann. 1997.
4. Cotton, F.A. & Wilkinson, G. Advanced Inorganic Chemistry, Wiley, VCH, 1999.

5. Rodger, G.E. Inorganic and Solid State Chemistry, Cengage Learning IndiaEdition, 2002.

Course Code	Subject Name	L-T-P	Credits
BCH-203	Organic Chemistry-II	**4-0-0**	**4**

Unit I: Chemistry of Halogenated Hydrocarbons(16 Lectures)
Alkyl halides: Methods of preparation, nucleophilic substitution reactions – SN1, SN2 and SN1 mechanisms with stereochemical aspects and effect of solvent etc.; nucleophilic substitution vs. elimination.Aryl halides: Preparation, including preparation from diazonium salts. nucleophilic aromaticsubstitution; SNAr, Benzyne mechanism.Relative reactivity of alkyl, allyl/benzyl, vinyl and aryl halides towards nucleophilicsubstitution reactions.

Unit II: Alcohols, Phenols, Ethers and Epoxides (16 Lectures)
Alcohols: preparation, properties and relative reactivity of 1°, 2°, 3°alcohols, Bouvaelt-Blanc Reduction; Preparation and properties of glycols: Oxidation by periodic acid and leadtetraacetate, Pinacol-Pinacolone rearrangement;
Phenols: Preparation and properties; Acidity and factors effecting it, Ring substitutionreactions, Reimer–Tiemann and Kolbe's–Schmidt Reactions, Fries and Claisenrearrangements with mechanism;Ethers and Epoxides: Preparation and reactions with acids. Reactions of epoxides withalcohols, ammonia derivatives and $LiAlH_4$

Unit III: Carbonyl Compounds(14 Lectures)
Structure, reactivity and preparation;Nucleophilic additions, Nucleophilic addition-elimination reactions with ammoniaderivatives with mechanism; Mechanisms of Aldol and Benzoin condensation, Knoevenagelcondensation, Claisen-Schmidt, Perkin, Cannizzaro and Wittig reaction, Beckmann andBenzil-Benzilic acid rearrangements, haloform reaction and Baeyer Villiger oxidation, α-substitution reactions, oxidations and reductions (Clemmensen, Wolff-Kishner, $LiAlH_4$,$NaBH_4$, MPV, PDC and PGC);Addition reactions of unsaturated carbonyl compounds: Michael addition.Active methylene compounds: Keto-enoltautomerism. Preparation and synthetic applicationsof diethyl malonate and ethyl acetoacetate.

Unit IV: Carboxylic Acids and their Derivatives(10 Lectures)
Preparation, physical properties and reactions of monocarboxylic acids: Typical reactions of dicarboxylic acids, hydroxy acids and unsaturated acids: succinic/phthalic, lactic, malic,tartaric, citric, maleic and fumaric acids;Preparation and reactions of acid chlorides, anhydrides, esters and amides; Comparativestudy of nucleophilicsustitution at acyl group -Mechanism of acidic and alkaline hydrolysisof esters, Claisen condensation, Dieckmann and Reformatsky reactions, Hofmannbromamidedegradation and Curtius rearrangement.

Unit V: Sulphur containing compounds(4 Lectures)
Preparation and reactions of thiols, thioethers and sulphonic acids.

TEXTBOOKS/REFERENCE BOOKS:
1. Morrison, R. T. & Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).

2. Finar, I. L. Organic Chemistry (Volume 1), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).

Course Code	Subject Name	L-T-P	Credits
BCH-205	Physical Chemistry-I	**4-0-0**	**4**

Unit I: Gaseous state (18 Lectures)
Kinetic molecular model of a gas: postulates and derivation of the kinetic gas equation;collision frequency; collision diameter; mean free path and viscosity of gases, including theirtemperature and pressure dependence, relation between mean free path and coefficient ofviscosity, calculation of σ from η; variation of viscosity with temperature and pressure.Maxwell distribution and its use in evaluating molecular velocities (average, root meansquare and most probable) and average kinetic energy, law of equipartition of energy, degreesof freedom and molecular basis of heat capacities.Behaviour of real gases: Deviations from ideal gas behaviour, compressibility factor, Z, andits variation with pressure for different gases. Causes of deviation from ideal behaviour. Vander Waals equation of state, its derivation and application in explaining real gas behavior,mention of other equations of state (Berthelot, Dietrici); virial equation of state; van derWaals equation expressed in virial form and calculation of Boyle temperature. Isotherms ofreal gases and their comparison with van der Waals isotherms, continuity of states, criticalstate, relation between critical constants and van der Waals constants, law of correspondingstates.

Unit II: Liquid state(6 Lectures)
Qualitative treatment of the structure of the liquid state; Radial distribution function; physical properties of liquids; vapour pressure, surface tension and coefficient of viscosity, and their determination. Effect of addition of various solutes on surface tension and viscosity.Explanation of cleansing action of detergents.Temperature variation of viscosity of liquidsand comparison with that of gases.Qualitative discussion of structure of water.

Unit III: Solid state(16 Lectures)
Nature of the solid state, law of constancy of interfacial angles, law of rational indices, Miller indices, elementary ideas of symmetry, symmetry elements and symmetry operations,qualitative idea of point and space groups, seven crystal systems and fourteen Bravaislattices; X-ray diffraction, Bragg's law, a simple account of rotating crystal method andpowder pattern method. Analysis of powder diffraction patterns of NaCl, CsCl and KCl.Defects in crystals. Glasses and liquid crystals.

Unit IV: Ionic equilibria-I(10 Lectures)
Strong, moderate and weak electrolytes, degree of ionization, factors affecting degree ofionization, ionization constant and ionic product of water. Ionization of weak acids and bases, pH scale, common ion effect; dissociation constants of mono-, di-and triprotic acids (exact treatment).Salt hydrolysis-calculation of hydrolysis constant, degree of hydrolysis and pH for differentsalts.

Unit V: Ionic equilibria-II (10 Lectures)

Buffer solutions; derivation of Henderson equation and its applications; buffer capacity,buffer range, buffer action and applications of buffers in analytical chemistry and
biochemical processes in the human body.Solubility and solubility product of sparingly soluble salts – applications of solubility productprinciple. Qualitative treatment of acid – base titration curves (calculation of pH at variousstages). Theory of acid–base indicators; selection of indicators and their limitations.Multistage equilibria in polyelectrolyte systems; hydrolysis and hydrolysis constants.

TEXTBOOKS/REFERENCE BOOKS:

1. Atkins, P. W. & Paula, J. de Atkin's Physical Chemistry 10th Ed., Oxford UniversityPress (2014).
2. Ball, D. W. Physical Chemistry Thomson Press, India (2007).
3. Castellan, G. W. Physical Chemistry 4th Ed. Narosa (2004).
4. Mortimer, R. G. Physical Chemistry 3rd Ed. Elsevier: NOIDA, UP

Course Code	Subject Name	L-T-P	Credits
BCH-207	Analytical Methods in Chemistry	**5-1-0**	**6**

Unit I: Qualitative and quantitative aspects of analysis

Sampling, evaluation of analytical data, errors, accuracy and precision, methods of their expression, normal law of distribution if indeterminate errors, statistical test of data; F, Q andt test, rejection of data, and confidence intervals.

Unit II: Optical methods of analysis

Origin of spectra, interaction of radiation with matter, fundamental laws of spectroscopy andelection rules, validity of Beer-Lambert's law.

UV-Visible Spectrometry: Basic principles of instrumentation (choice of source,monochromator and detector) for single and double beam instrument; *Basic principles of quantitative analysis:* estimation of metal ions from aqueous solution, geometrical isomers, keto-enoltautomers. Determination of composition of metal compl exesusing Job's method of continuous variation and mole ratio method.

Unit II: Infrared Spectrometry

Basic principles of instrumentation (choice of source, monochromator & detector) for single and double beam instrument; sampling techniques.Structural illustration through interpretation of data, Effect and importance of isotope substitution.

Unit III: Thermal methods of analysis

Theory of thermogravimetry (TG), basic principle of instrumentation.Techniques for quantitative estimation of Ca and Mg from their mixture. Classification of electroanalytical methods, basic principle of pH metric, potentiometric and conductometric titrations. Techniques used for the determination of equivalence points.Techniques used for the determination of pKa values.

Unit IV: Separation techniques

Solvent extraction: Classification, principle and efficiency of the technique. Mechanism of extraction: extraction by solvation and chelation. Technique of extraction: batch, continuous and counter current extractions. Qualitative and quantitative aspects of solvent extraction: extraction of metal ions from aqueous solution, extraction of organic species from the aqueous and nonaqueous media..

Unit V: Chromatography

Definition, general introduction on principles of chromatography, paper chromatography, TLC etc. a. Paper chromatographic separation of mixture of metal ion (Fe^{3+} and Al^{3+}). Ion-exchange: Column, ion-exchange chromatography etc.

TEXTBOOKS/REFERENCE BOOKS:

1. Mendham, J., *A. I. Vogel's Quantitative Chemical Analysis 6th Ed.,* Pearson, 2009.
2.Willard, H.H. *et al.*: *Instrumental Methods of Analysis*, 7th Ed. WardsworthPublishing Company, Belmont, California, USA, 1988.
3. Christian, G.D. *Analytical Chemistry*, 6th Ed. John Wiley & Sons, New York, 2004.
4. Harris, D.C.: *Exploring Chemical Analysis*, 9th Ed. New York, W.H. Freeman, 2016.
5.Khopkar, S.M. *Basic Concepts of Analytical Chemistry*. New Age International Publisher, 2009.

Course Code	Subject Name	L-T-P	Credits
BCH-209	Chemistry of Cosmetics and Perfumes	**2-0-0**	**2**

A general study including preparation and uses of the following: Hair dye, hair spray, shampoo, suntan lotions, face powder, lipsticks, talcum powder, nail enamel, creams (cold, vanishing and shaving creams), antiperspirants and artificial flavours. Essential oils and their importance in cosmetic industries with reference to Eugenol, Geraniol, sandalwood oil, eucalyptus, rose oil, 2-phenyl ethyl alcohol, Jasmone, Civetone, Muscone.

Practicals

1. Preparation of talcum powder.
2. Preparation of shampoo.
3. Preparation of enamels.
4. Preparation of hair remover.
5. Preparation of face cream.
6. Preparation of nail polish and nail polish remover.

TEXTBOOKS/REFERENCE BOOKS:

1.Stocchi, E. Industrial Chemistry, Vol-I, Ellis Horwood Ltd. UK (1990).

2. Jain, P.C. & Jain, M. Engineering Chemistry DhanpatRai& Sons, Delhi.

3. Sharma, B.K. & Gaur, H. Industrial Chemistry, Goel Publishing House, Meerut

Course Code	Subject Name	L-T-P	Credits
BCH-251	Inorganic Chemistry Laboratory-II	0-0-4	2

(A) **Iodo / Iodimetric Titrations**

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

(ii) Estimation of (i) arsenite and (ii) antimony in tartar-emetic iodimetrically

(iii) Estimation of available chlorine in bleaching powder iodometrically.

(B) Inorganic preparations

(i) Cuprous Chloride, Cu_2Cl_2

(ii) Preparation of Manganese(III) phosphate, $MnPO_4.H_2O$

(iii) Preparation of Aluminium potassium sulphate$KAl(SO_4)_2.12H_2O$ (Potash alum) or Chrome alum.

TEXTBOOKS/REFERENCE BOOKS:

Mendham, J., A. I. Vogel's Quantitative Chemical Analysis 6th Ed., Pearson, 2009.

Course Code	Subject Name	L-T-P	Credits
BCH-253	Organic Chemistry Laboratory-II	0-0-4	2

1. Functional group tests for alcohols, phenols, carbonyl and carboxylic acid group.
2. Organic preparations:
i. Acetylation of one of the following compounds: amines (aniline, o-, m-, ptoluidines and o-, m-, p-anisidine) and phenols (β-naphthol, vanillin, salicylic acid) by any one method:
a. Using conventional method.
b. Using green approach
ii. Benzolyation of one of the following amines (aniline, o-, m-, p- toluidines and o-, m-, p-anisidine) and one of the following phenols (β-naphthol, resorcinol, pcresol) bySchotten-Baumann reaction.
iii. Oxidation of ethanol/ isopropanol (Iodoform reaction).
iv. Bromination of any one of the following:
a. Acetanilide by conventional methods
b. Acetanilide using green approach (Bromate-bromide method)
v. Nitration of any one of the following:
a. Acetanilide/nitrobenzene by conventional method
b. Salicylic acid by green approach (using ceric ammonium nitrate).
vi. Selective reduction of meta dinitrobenzene to m-nitroaniline.
vii. Reduction of p-nitrobenzaldehyde by sodium borohydride.
viii. Hydrolysis of amides and esters.
ix. Semicarbazone of any one of the following compounds: acetone, ethyl methyl ketone, cyclohexanone, benzaldehyde.
x. S-Benzylisothiouronium salt of one each of water soluble and water insoluble acids (benzoic acid, oxalic acid, phenyl acetic acid and phthalic acid).
xi. Aldol condensation using either conventional or green method.
xii. Benzil-Benzilic acid rearrangement.
The above derivatives should be prepared using 0.5-1g of the organic compound. The solid samples must be collected and may be used for recrystallization, melting point and TLC.

TEXTBOOKS/REFERENCE BOOKS:

1. Mann, F.G. & Saunders, B.C. Practical Organic Chemistry, Pearson Education(2009)
2. Furniss, B.S., Hannaford, A.J., Smith, P.W.G. &Tatchell, A.R. Practical OrganicChemistry, 5th Ed. Pearson (2012)

3. Ahluwalia, V.K. &Aggarwal, R. Comprehensive Practical Organic Chemistry:Preparation and Quantitative Analysis, University Press (2000)

Course Code	Subject Name	L-T-P	Credits
BCH-255	Physical Chemistry Laboratory-I	0-0-4	2

1. Surface tension measurements.
a. Determine the surface tension by (i) drop number (ii) drop weight method.
b. Study the variation of surface tension of detergent solutions withconcentration.

2. Viscosity measurement using Ostwald's viscometer.
a. Determination of viscosity of aqueous solutions of (i) polymer (ii) ethanol and(iii) sugar at room temperature.
b. Study the variation of viscosity of sucrose solution with the concentration ofsolute.

3. Indexing of a given powder diffraction pattern of a cubic crystalline system.

4. pHmetry
a. Study the effect on pH of addition of HCl/NaOH to solutions of acetic acid,sodium acetate and their mixtures.
b. Preparation of buffer solutions of different pH
i. Sodium acetate-acetic acid
ii. Ammonium chloride-ammonium hydroxide
c. pH metric titration of (i) strong acid vs. strong base, (ii) weak acid vs. strong base.
d. Determination of dissociation constant of a weak acid.

TEXTBOOKS/REFERENCE BOOKS:
1.Khosla, B. D.; Garg, V. C. &Gulati, A. Senior Practical Physical Chemistry, R.Chand & Co.: New Delhi (2011).
2. Garland, C. W.; Nibler, J. W. & Shoemaker, D. P. Experiments in Physical Chemistry, 8th Ed.; McGraw-Hill: New York (2003).
3. Halpern, A. M. &McBane, G. C. Experi

SEMESTER-IV

Course Code	Subject Name	L-T-P	Credits
BCH-202	Inorganic Chemistry-III	4-0-0	4

Unit I: Coordination Chemistry-I(14 Lectures)
Werner's theory, valence bond theory (inner and outer orbital complexes), electroneutrality principle and back bonding. Crystal field theory, measurement of 10 Dq (Δo), CFSE in weak and strong fields, pairing energies, factors affecting the magnitude of 10 Dq (Δo, Δt). Octahedral vs. tetrahedral coordination, tetragonal distortions from octahedral geometry Jahn-Teller theorem, square planar geometry. Qualitative aspect of Ligand field and MO Theory.

Unit II: Coordination Chemistry-II (12 Lectures)
IUPAC nomenclature of coordination compounds, isomerism in coordination compounds.Stereochemistry of complexes with 4 and 6 coordination numbers. Chelate effect, polynuclear complexes, Labile and inert complexes.

Unit III: Transition Elements (18 Lectures)
General group trends with special reference to electronic configuration, colour, variable valency, magnetic and catalytic properties, ability to form complexes. Stability of various oxidation states and e.m.f. (Latimer &Bsworth diagrams). Difference between the first, second and third transition series.Chemistry of Ti, V, Cr Mn, Fe and Co in various oxidation states (excluding their metallurgy)

Unit IV: Lanthanoids and Actinoids(6 Lectures)
Electronic configuration, oxidation states, colour, spectral and magnetic properties, lanthanide contraction, separation of lanthanides (ion-exchange method only).

Unit V: Bioinorganic Chemistry (10Lectures)
Metal ions present in biological systems, classification of elements according to their action in biological system. Geochemical effect on the distribution of metals. Sodium / K-pump, carbonic anhydrase and carboxypeptidase. Excess and deficiency of some trace metals. Toxicity of metal ions (Hg, Pb, Cd and As), reasons for toxicity, Use of chelating agents in medicine.Iron and its application in bio-systems, Haemoglobin; Storage and transfer of iron.

TEXTBOOKS/REFERENCE BOOKS:

1. Purcell, K.F &Kotz, J.C. *Inorganic Chemistry* W.B. Saunders Co, 1977.
2. Huheey, J.E., *Inorganic Chemistry*, Prentice Hall, 1993.
3. Lippard, S.J. & Berg, J.M. *Principles of Bioinorganic Chemistry* Panima Publishing
4. Company 1994.
5. Cotton, F.A. & Wilkinson, G, *Advanced Inorganic Chemistry* Wiley-VCH, 1999
6. Basolo, F, and Pearson, R.C. *Mechanisms of Inorganic Chemistry*, John Wiley &
7. Sons, NY, 1967.
8. Greenwood, N.N. &Earnshaw A. *Chemistry of the Elements*, Butterworth-

9. Heinemann, 1997.

Course Code	Subject Name	L-T-P	Credits
BCH-204	Organic Chemistry-III	4-0-0	4

Unit I:Nitrogen Containing Functional Groups(18 Lectures)
Preparation and important reactions of nitro and compounds, nitriles and isonitrilesAmines: Effect of substituent and solvent on basicity; Preparation and properties: Gabrielphthalimide synthesis, Carbylamine reaction, Mannich reaction, Hoffmann's exhaustivemethylation, Hofmann-elimination reaction; Distinction between 1°, 2°and 3°amines withHinsberg reagent and nitrous acid.Diazonium Salts: Preparation and their synthetic applications.

Unit II:PolynuclearHydrocarbons(8 Lectures)
Reactions of naphthalene phenanthrene and anthracene Structure, Preparation and structure elucidation and important derivatives of naphthalene and anthracene; Polynuclearhydrocarbons.

Unit III: Heterocyclic Compounds(22 Lectures)
Classification and nomenclature, Structure, aromaticity in 5-numbered and 6-membered rings containing one heteroatom; Synthesis, reactions and mechanism of substitution reactions of:Furan, Pyrrole (Paal-Knorr synthesis, Knorr pyrrole synthesis, Hantzsch synthesis),Thiophene, Pyridine (Hantzsch synthesis), Pyrimidine, Structure elucidation of indole,Fischer indole synthesis and Madelung synthesis), Structure elucidation of quinoline andisoquinoline, Skraup synthesis, Friedlander's synthesis, Knorr quinoline synthesis, Doebner-Miller synthesis, Bischler-Napieralski reaction, Pictet-Spengler reaction, Pomeranz-Fritschreaction. Derivatives of furan: Furfural and furoic acid.

Unit IV: Alkaloids(6 Lectures)
Natural occurrence, General structural features, Isolation and their physiological actionHoffmann's exhaustive methylation, Emde's modification, Structure elucidation andsynthesis of Hygrine and Nicotine. Medicinal importance of Nicotine, Hygrine, Quinine,Morphine, Cocaine, and Reserpine.

Unit V: Terpenes(6 Lectures)
Occurrence, classification, isoprene rule; Elucidation of stucture and synthesis of Citral, Neral and α-terpineol.

TEXTBOOKS/REFERENCE BOOKS:
1. Morrison, R. T. & Boyd, R. N. Organic Chemistry, Dorling Kindersley (India)Pvt. Ltd. (Pearson Education).
2. Finar, I. L. Organic Chemistry (Volume 1), Dorling Kindersley (India) Pvt. Ltd.(Pearson Education).
3. Finar, I. L. Organic Chemistry (Volume 2: Stereochemistry and the Chemistry of
4. Natural Products), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
5. Acheson, R.M. Introduction to the Chemistry of Heterocyclic compounds, JohnWelly& Sons (1976).

6.Graham Solomons, T.W. Organic Chemistry, John Wiley & Sons, Inc.

Course Code	Subject Name	L-T-P	Credits
BCH-206	Physical Chemistry-II	4-0-0	4

Unit I:Chemical Thermodynamics(8 Lectures)
Intensive and extensive variables; state and path functions; isolated, closed and open systems; zeroth law of thermodynamics.First law: Concept of heat, q, work, w, internal energy, U, and statement of first law;enthalpy, H, relation between heat capacities, calculations of q, w, U and H for reversible,irreversible and free expansion of gases (ideal and van der Waals) under isothermal andadiabatic conditions.

Unit II: Thermochemistry(28 Lectures)
Heats of reactions: standard states; enthalpy of formation of molecules and ions and enthalpy of combustion and its applications; calculation of bond energy, bonddissociation energy and resonance energy from thermochemical data, effect of temperature(Kirchhoff's equations) and pressure on enthalpy of reactions. Adiabatic flame temperature,explosion temperature.Concept of entropy; thermodynamic scale of temperature, statement of the second law of thermodynamics; molecular and statistical interpretation of entropy. Calculation of entropy change for reversible and irreversible processes.Third Law: Statement of third law, concept of residual entropy, calculation of absolute entropy of molecules. Free Energy Functions: Gibbs and Helmholtz energy; variation of S, G, A with T, V, P; Freeenergy change and spontaneity. Relation between Joule-Thomson coefficient and otherthermodynamic parameters; inversion temperature; Gibbs-Helmholtz equation; Maxwellrelations; thermodynamic equation of state.

Unit III: Systems of Variable Composition (8 Lectures)
Partial molar quantities, dependence of thermodynamic parameters on composition; Gibbs-Duhem equation, chemical potential of ideal mixtures, change in thermodynamic functions in mixing of ideal gases.

Unit IV: Chemical Equilibrium:(8 Lectures)
Criteria of thermodynamic equilibrium, degree of advancement of reaction, chemicalequilibria in ideal gases, concept of fugacity.Thermodynamic derivation of relation betweenGibbs free energy of reaction and reaction quotient.Coupling of exoergic and endoergicreactions.Equilibrium constants and their quantitative dependence on temperature, pressureand concentration. Free energy of mixing and spontaneity; thermodynamic derivation ofrelations between the various equilibrium constants Kp, Kc and Kx. Le Chatelier principle(quantitative treatment); equilibrium between ideal gases and a pure condensed phase.

Unit V: Solutions and Colligative Properties: (8 Lectures)
Dilute solutions; lowering of vapour pressure, Raoult's and Henry's Laws and theirapplications. Excess thermodynamic functions.Thermodynamic derivation using chemical potential to derive relations between the fourcolligative properties [(i) relative lowering of vapour pressure, (ii) elevation of boiling point,(iii) Depression of freezing point, (iv) osmotic pressure] and amount of

solute. Applicationsin calculating molar masses of normal, dissociated and associated solutes in solution.

TEXTBOOKS/REFERENCE BOOKS:

1.Peter, A. & Paula, J. de. Physical Chemistry 10th Ed., Oxford University Press (2014).
2.Castellan, G. W. Physical Chemistry 4th Ed., Narosa (2004).
3.Engel, T. & Reid, P. Physical Chemistry 3rd Ed., Prentice-Hall (2012).
4.McQuarrie, D. A. & Simon, J. D. Molecular Thermodynamics Viva Books Pvt. Ltd.:
5.Assael, M. J.; Goodwin, A. R. H.; Stamatoudis, M.; Wakeham, W. A. & Will, S.Commonly Asked Questions in Thermodynamics. CRC Press: NY (2011).
6.Levine, I .N. Physical Chemistry 6th Ed., Tata McGraw Hill (2010).
7.Metz, C.R. 2000 solved problems in chemistry, Schaum Series (2006).

Course Code	Subject Name	L-T-P	Credits
BCH-208	Polymer Chemistry	5-1-0	6

Unit 1: Introduction and history of polymeric materials (12 Lectures)
Different schemes of classification of polymers, Polymer nomenclature, Molecular forces and chemical bonding in polymers, Texture of Polymers.Functionality and its importance: Criteria for synthetic polymer formation, classification of polymerization processes, Relationships between functionality, extent of reaction and degree of polymerization. Bifunctional systems, Poly-functional systems.

Unit II: Kinetics of Polymerization (8 Lectures)
Mechanism and kinetics of step growth, radical chain growth, ionic chain (both cationic and anionic) and coordination polymerizations, Mechanism and kinetics of copolymerization, polymerization techniques.

Unit III: Crystallization and crystallinity(22 Lectures)
Determination of crystalline melting point and degree of crystallinity, Morphology of crystalline polymers, Factors affecting crystalline melting point. Nature and structure of polymers-Structure Property relationships.Determination of molecular weight of polymers (M_n, M_w, etc) by end group analysis, viscometry, light scattering and osmotic pressure methods.Molecular weight distribution and its significance.Polydispersity index.Glass transition temperature (Tg) and determination of Tg, Free volume theory, WLF equation, Factors affecting glass transition temperature (Tg).

Unit IV: Polymer Solution (8 Lectures)
Criteria for polymer solubility, Solubility parameter, Thermodynamics of polymer solutions, entropy, enthalpy, and free energy change of mixing of polymers solutions, Flory- Huggins theory, Lower and Upper critical solution temperatures.

Unit V: Properties of Polymers (10 Lectures)
(Physical, thermal, Flow & Mechanical Properties). Brief introduction to preparation, structure, properties and application of the following polymers: polyolefins, polystyrene and styrene copolymers, poly(vinyl chloride) and related polymers, poly(vinyl acetate) and related polymers, acrylic polymers, fluoro polymers, polyamides and related polymers. Phenol formaldehyde resins (Bakelite, Novalac), polyurethanes, silicone polymers, polydienes, Polycarbonates, Conducting Polymers, [polyacetylene, polyaniline, poly(p-phenylene
sulphidepolypyrrole, polythiophene)].

TEXTBOOKS/REFERENCE BOOKS:
1. R.B. Seymour & C.E. Carraher: *Polymer Chemistry: An Introduction,* Marcel Dekker,Inc. New York, 1981.
2. G. Odian: *Principles of Polymerization*, 4th Ed. Wiley, 2004.
3. F.W. Billmeyer: *Textbook of Polymer Science*, 2nd Ed. Wiley Interscience, 1971.
4. P. Ghosh: Polymer Science & Technology, Tata McGraw-Hill Education, 1991.

Course Code	Subject Name	L-T-P	Credits
BCH-210	Fuel Chemistry	2-0-0	2

Unit I:Introduction

Review of energy sources (renewable and non-renewable). Classification of fuels and theircalorific value.

Unit II: Coal: Uses of coal (fuel and nonfuel) in various industries, its composition, carbonization ofcoal. Coal gas, producer gas and water gas—composition and uses. Fractionation of coal tar,uses of coal tar bases chemicals, requisites of a good metallurgical coke, Coal gasification(Hydro gasification and Catalytic gasification), Coal liquefaction and Solvent Refining.

Unit III: Petroleum and Petrochemical Industry:

Composition of crude petroleum, Refining anddifferent types of petroleum products and their applications.

Unit IV: Fractional Distillation (Principle and process)

Cracking (Thermal and catalytic cracking),Reforming Petroleum and non-petroleum fuels (LPG, CNG, LNG, bio-gas, fuels derivedfrom biomass), fuel from waste, synthetic fuels (gaseous and liquids), clean fuels.

Petrochemicals: Vinyl acetate, Propylene oxide, Isoprene, Butadiene, Toluene and its derivatives Xylene.

Unit V: Lubricants:

Classification of lubricants, lubricating oils (conducting and non-conducting)

Solid and semisolid lubricants, synthetic lubricants.

Properties of lubricants (viscosity index, cloud point, pore point) and their determination.

TEXTBOOKS/REFERENCE BOOKS:

1.Stocchi, E. *Industrial Chemistry*, Vol-I, Ellis Horwood Ltd. UK (1990).

2.Jain, P.C. & Jain, M. *Engineering Chemistry* DhanpatRai& Sons, Delhi.

Course Code	Subject Name	L-T-P	Credits
BCH-252	Inorganic Chemistry Laboratory-III	0-0-4	2

Gravimetric Analysis:

i. Estimation of nickel (II) using Dimethylglyoxime (DMG).
ii. Estimation of copper as CuSCN
iii. Estimation of iron as Fe_2O_3 by precipitating iron as $Fe(OH)_3$.
iv. Estimation of Al (III) by precipitating with oxine and weighing as $Al(oxine)_3$ (aluminiumoxinate).

Inorganic Preparations:

i. Tetraamminecopper (II) sulphate, $[Cu(NH_3)4]SO_4.H2O$
ii. *Cis*and *trans* $K[Cr(C_{2O4})_2.(H_2O)_2]$ Potassium dioxalatodiaquachromate (III)
iii. Tetraamminecarbonatocobalt (III) ion
iv. Potassium tris(oxalate)ferrate(III)

Chromatography of metal ions

Principles involved in chromatographic separations. Paper chromatographic separation of following metal ions:
i. Ni (II) and Co (II)
ii. Fe (III) and Al (III)

TEXTBOOKS/REFERENCE BOOKS:

3.Mendham, J., *A. I. Vogel's Quantitative Chemical Analysis 6th Ed.,* Pearson, 2009.

Course Code	Subject Name	L-T-P	Credits
BCH-254	Organic Chemistry Laboratory-III	0-0-4	2

1. Detection of extra elements.
2. Functional group test for nitro, amine and amide groups.
3. Qualitative analysis of unknown organic compounds containing simple functional groups (alcohols, carboxylic acids, phenols and carbonyl compounds)

TEXTBOOKS/REFERENCE BOOKS:

1. Mann, F.G. & Saunders, B.C. *Practical Organic Chemistry*, Pearson Education(2009)
2. Furniss, B.S.; Hannaford, A.J.; Smith, P.W.G.; Tatchell, A.R. *Practical OrganicChemistry, 5th Ed.*, Pearson (2012)
3. Ahluwalia, V.K. &Aggarwal, R. *Comprehensive Practical Organic Chemistry:Preparation and Quantitative Analysis*, University Press (2000).
4. Ahluwalia, V.K. &Dhingra, S. *Comprehensive Practical Organic Chemistry:Qualitative Analysis,* University Press (2000).

Course Code	Subject Name	L-T-P	Credits
BCH-256	Physical Chemistry Laboratory-II	0-0-4	2

Thermochemistry

(a) Determination of heat capacity of a calorimeter for different volumes using change ofenthalpy data of a known system (method of back calculation of heat capacity of calorimeterfrom known enthalpy of solution or enthalpy of neutralization).

(b) Determination of heat capacity of the calorimeter and enthalpy of neutralization ofhydrochloric acid with sodium hydroxide.

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

(d) Determination of heat capacity of the calorimeter and integral enthalpy (endothermic andexothermic) solution of salts.

(e) Determination of basicity/proticity of a polyprotic acid by the thermochemical method in terms of the changes of temperatures observed in the graph of temperature versus time fordifferent additions of a base. Also calculate the enthalpy of neutralization of the first step.

(f) Determination of enthalpy of hydration of copper sulphate.

(g) Study of the solubility of benzoic acid in water and determination of ΔH.

TEXTBOOKS/REFERENCE BOOKS:

1. Khosla, B. D.; Garg, V. C. &Gulati, A., Senior Practical Physical Chemistry, R.Chand & Co.: New Delhi (2011).

2. Athawale, V. D. &Mathur, P. Experimental Physical Chemistry New AgeInternational: New Delhi (2001).

SEMESTER-V

Course Code	Subject Name	L-T-P	Credits
BCH-301	Inorganic Chemistry- IV	4-0-0	4

Unit I: Group I Elements
Hydrogen: Isotopes (separation method not needed). Ortho and para hydrogen, Hydrides and their classification. Alkali metals: Chemical properties of the metals: reaction with water, air, nitrogen; uses of s-block metals and their compounds, Compounds of s-block metals: oxides, hydroxides, peroxides, superoxides.

Unit II: **Group II Elements**
Alkaline earth metals: Comparative study of these elements with special reference to their hydrides, oxides, hydroxide and halides. Diagonal relationship, solvation and Complexes of *s*-block metals including their applications in Biosystems.

Unit III: **Group III Elements**
Comparative study of physical and chemical properties of these elements with special reference to their oxides, hydrides, halides and nitirides. Preparation and properties of boric acids (ortho&meta boric acids) and borax, borax bead test. Boron Hydrides, structure and bonding in diboranes, borazine, borohydrides.

Unit IV: Group IV Elements
Comparative study of physical and chemicals properties of these elements with special references to their oxides, hydrides, nitrides, sulphides and carbides, fluorocarbons, study of silicates (structural aspects only), silicones, allotropy, inert pair effect, metallic and nonmetallic character, catenation and hetero catenation**.**

Unit V: Group V Elements
Comparative study of the physical and chemical properties of these elements with special reference to their hydrides, oxides, halides, oxyhalides and sulphides, Oxoacids of nitrogen: nitrous acid, nitric acid, hyponitrous acid, hydrazoic acid, pernitric acid; oxoacids of phosphorusorthophosphorous acid, metaphosphorous acid, hypophosphorous acid; orthophosphoric acid, di-, tri-, and tetrapolyphosphoric acids.

TEXTBOOKS/REFERENCE BOOKS:
1. Cotton, F.A.G.; Wilkinson &Gaus, P.L. Basic Inorganic Chemistry 3rd Ed.; Wiley India,
2. Huheey, J. E.; Keiter, E.A. &Keiter, R.L. Inorganic Chemistry, Principles of Structure and Reactivity 4th Ed., Harper Collins 1993, Pearson, 2006.
3. Sharpe, A.G. Inorganic Chemistry, 4th Indian Reprint (Pearson Education) 2005.
5. Basolo, F. & Pearson, R. Mechanisms of Inorganic Reactions: Study of Metal Complexes in Solution 2nd Ed., John Wiley & Sons Inc; NY.

Course Code	Subject Name	L-T-P	Credits
BCH-303	Organic Chemistry-IV	4-0-0	4

Unit I: Nucleic Acids (9 Lectures)
Components of nucleic acids, Nucleosides and nucleotides; Structure, synthesis and reactions of: Adenine, Guanine, Cytosine, Uracil and Thymine; Structure of polynucleotides.

Unirt III: Amino Acids, Peptides and Proteins (16 Lectures)
Amino acids, Peptides and their classification.α-Amino Acids - Synthesis, ionic properties and reactions. Zwitterions, p*K*a values, isoelectric point and electrophoresis; Study of peptides: determination of their primary structures-end group analysis, methods of peptide synthesis. Synthesis of peptides using N-protecting, C-protecting and C-activating groups -Solid-phase synthesis

Unit III: Enzymes and Lipids (17 Lectures)
Introduction, classification and characteristics of enzymes. Salient features of active site of enzymes. Mechanism of enzyme action (taking trypsin as example), factors affecting enzyme action, coenzymes and cofactors and their role in biological reactions, specificity of enzyme action (including stereospecificity), enzyme inhibitors and their importance, phenomenon of inhibition (competitive, uncompetitive and non-competitive inhibition including allosteric inhibition).
Introduction to oils and fats; common fatty acids present in oils and fats, Hydrogenntion of fats and oils, Saponification value, acid value, iodine number. Reversion and rancidity.

Unit IV: Concept of Energy in Biosystems(7 Lectures)
Cells obtain energy by the oxidation of foodstuff (organic molecules).Introduction to metabolism (catabolism, anabolism).ATP: The universal currency of cellular energy, ATP hydrolysis and free energy change.Agents for transfer of electrons in biological redox systems: NAD+, FAD.Conversion of food to energy: Outline of catabolic pathways of carbohydrate-glycolysis,fermentation, Krebs cycle.Overview of catabolic pathways of fat and protein.Interrelationship in the metabolic pathways of protein, fat and carbohydrate.Caloric value of food, standard caloric content of food types.

Unit V:Pharmaceutical Compounds: Structure and Importance (11 Lectures)
Classification, structure and therapeutic uses of antipyretics: Paracetamol (with synthesis), Analgesics: Ibuprofen (with synthesis), Antimalarials: Chloroquine (with synthesis). An elementary treatment of Antibiotics and detailed study of chloramphenicol, Medicinal values ofcurcumin (haldi), azadirachtin (neem), vitamin C and antacid (ranitidine).

TEXTBOOKS/REFERENCE BOOKS:

1. Berg, J.M., Tymoczko, J.L. &Stryer, L. (2006) *Biochemistry*. 6th Ed. W.H. Freemanand Co.
2. Nelson, D.L., Cox, M.M. &Lehninger, A.L. (2009) *Principles of Biochemistry. IVEdition.* W.H. Freeman and Co.

3. Murray, R.K., Granner, D.K., Mayes, P.A. &Rodwell, V.W. (2009) Harper'sIllustrated Biochemistry. XXVIII edition. Lange Medical Books/ McGraw-Hill.

Course Code	Subject Name	L-T-P	Credits
BCH-305	Physical Chemistry-III	4-0-0	4

Unit I: Phase Equilibria(20 Lectures)
Concept of phases, components and degrees of freedom, derivation of Gibbs Phase Rule fornonreactive and reactive systems; Clausius-Clapeyron equation and its applications to solidliquid,liquid-vapour and solid-vapourequilibria, phase diagram for one component systems,with applications.Phase diagrams for systems of solid-liquid equilibria involving eutectic, congruent andincongruent melting points, solid solutions.Three component systems, water-chloroform-acetic acid system, triangular plots.

Unit II: Binary solutions (8 Lectures)
Gibbs-Duhem-Margules equation, its derivation and applications tofractional distillation of binary miscible liquids (ideal and nonideal), azeotropes, lever rule,partial miscibility of liquids, CST, miscible pairs, steam distillation.Nernst distribution law: its derivation and applications.

Unit III: Chemical Kinetics(18 Lectures)
Order and molecularity of a reaction, rate laws in terms of the advancement of a reaction,differential and integrated form of rate expressions up to second order reactions, experimental
methods of the determination of rate laws, kinetics of complex reactions (integrated rate
expressions up to first order only): (i) Opposing reactions (ii) parallel reactions and (iii)consecutive reactions and their differential rate equations (steady-state approximation inreaction mechanisms) (iv) chain reactions.Temperature dependence of reaction rates; Arrhenius quation; activation energy. Collisiontheory of reaction rates, Lindemann mechanism, qualitative treatment of the theory ofabsolute reaction rates.

Unit IV: Catalysis(8 Lectures)
Types of catalyst, specificity and selectivity, mechanisms of catalyzed reactions at solidsurfaces; effect of particle size and efficiency of nanoparticles as catalysts.Enzyme catalysis,Michaelis-Menten mechanism, acid-base catalysis.

Unit V: Surface chemistry (6 Lectures)
Physical adsorption, chemisorption, adsorption isotherms.nature of adsorbed state.

TEXTBOOKS/REFERENCE BOOKS:
1. Peter Atkins & Julio De Paula, *Physical Chemistry* 10th Ed., Oxford University Press(2014).
2.Castellan, G. W. *Physical Chemistry*, 4th Ed., Narosa (2004).

3.McQuarrie, D. A. & Simon, J. D., *Molecular Thermodynamics*, Viva Books Pvt. Ltd.:New Delhi (2004).
4. Engel, T. & Reid, P. *Physical Chemistry 3rd Ed.,* Prentice-Hall (2012).
5. Assael, M. J.; Goodwin, A. R. H.; Stamatoudis, M.; Wakeham, W. A. & Will, S.*Commonly Asked Questions in Thermodynamics.* CRC Press: NY (2011).
6. Zundhal, S.S. *Chemistry concepts and applications* Cengage India (2011).
7. Ball, D. W. *Physical Chemistry* Cengage India (2012).
8. Mortimer, R. G. *Physical Chemistry 3rd Ed.,* Elsevier: NOIDA, UP (2009).

Course Code	Subject Name	L-T-P	Credits
BCH-307	Industrial Chemicals and Environments	5-1-0	4

Unit I: Industrial Gases and Inorganic Chemicals(10 Lectures)
Industrial Gases: Large scale production, uses, storage and hazards in handling of thefollowing gases: oxygen, nitrogen, argon, neon, helium, hydrogen, acetylene, carbonmonoxide, chlorine, fluorine, sulphur dioxide and phosgene.*Inorganic Chemicals:* Manufacture, application, analysis and hazards in handling thefollowing chemicals: hydrochloric acid, nitric acid, sulphuric acid, caustic soda, common salt,borax, bleaching powder, sodium thiosulphate, hydrogen peroxide, potash alum, chromealum, potassium dichromate and potassium permanganate.

Unit II: Industrial Metallurgy(4 Lectures)
Preparation of metals (ferrous and nonferrous) and ultrapure metals for semiconductortechnology.

Unit III: Environment and its segments(30 Lectures)
Ecosystems. Biogeochemical cycles of carbon, nitrogen and sulphur.Air Pollution: Major regions of atmosphere.Chemical and photochemical reactions inatmosphere. Air pollutants: types, sources, particle size and chemical nature; Photochemicalsmog: its constituents and photochemistry. Environmental effects of ozone, Major sources ofair pollution.Pollution by SO2, CO2, CO, NOx, H2S and other foul smelling gases.Methods of estimationof CO, NOx, SOx and control procedures.Effects of air pollution on living organisms and vegetation.Greenhouse effect and Globalwarming, Ozone depletion by oxides of nitrogen, chlorofluorocarbons and Halogens, removalof sulphur from coal.Control of particulates.
Water Pollution: Hydrological cycle, water resources, aquatic ecosystems, Sources andnature of water pollutants, Techniques for measuring water pollution, Impacts of waterpollution on hydrological and ecosystems.Water purification methods. Effluent treatment plants (primary, secondary and tertiarytreatment). Industrial effluents from the following industries and their treatment:electroplating, textile, tannery, dairy, petroleum and petrochemicals, agro, fertilizer, etc.Sludge disposal.Industrial waste management, incineration of waste. Water treatment and purification(reverse osmosis, electro dialysis, ion exchange). Water quality parameters for waste water,industrial water and domestic water.

Unit IV: Energy & Environment(10 Lectures)
Sources of energy: Coal, petrol and natural gas. Nuclear Fusion / Fission, Solar energy, Hydrogen, geothermal, Tidal and Hydel, etc.
Nuclear Pollution: Disposal of nuclear waste, nuclear disaster and its management.

Unit V: Biocatalysis(6 Lectures)

Introduction to biocatalysis: Importance in “Green Chemistry” and Chemical Industry.

TEXTBOOKS/REFERENCE BOOKS:

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

Course Code	Subject Name	L-T-P	Credits
BCH-351	Inorganic Chemistry Laboratory-IV	0-0-4	2

1. Estimation of Cu(II) and $K_2Cr_2O_7$ using sodium thiosulphate solution(Iodimetrically).
2. Estimation of available chlorine in bleaching powder iodometrically.
3. **Inorganic Preparations:**
   Cuprous chloride,Cu_2Cl_2
   Preparation of Manganese(III) phosphate,$MnPO_4.H_2O$.
   Preparation of Aluminium potassium sulphate$K_2SO_4.Al(SO_4)_2.12H_2O$ (Potash alum) or Chromealum.

TEXTBOOKS/REFERENCE BOOKS:

1. Mendham, J., *A. I. Vogel's Quantitative Chemical Analysis 6th Ed.,* Pearson, 2009.

Course Code	Subject Name	L-T-P	Credits
BCH-353	Organic Chemistry Laboratory-IV	0-0-4	2

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

TEXTBOOKS/REFERENCE BOOKS:

1. Manual of Biochemistry Workshop, 2012, Department of Chemistry, Universityof Delhi.
2. Arthur, I. V. *Quantitative Organic Analysis,* Pearson.

Course Code	Subject Name	L-T-P	Credits
BCH-355	Physical Chemistry Laboratory-III	0-0-4	2

I. Determination of critical solution temperature and composition of the phenol-watersystem and to study the effect of impurities on it.
II. Phase equilibria: Construction of the phase diagram using cooling curves or ignitiontube method:
a. simple eutectic and
b. congruently melting systems.
III. Distribution of acetic/ benzoic acid between water and cyclohexane.
IV. Study the equilibrium of at least one of the following reactions by the distributionmethod:

(i) $I_2(aq) + I^- \rightarrow I_3^-(aq)^{2+}$

(ii) $Cu^{2+}(aq) + nNH_3 \rightarrow Cu(NH_3)n$

V. Study the kinetics of the following reactions.
1. Initial rate method: Iodide-persulphate reaction
2. Integrated rate method:
a. Acid hydrolysis of methyl acetate with hydrochloric acid.
b. Saponification of ethyl acetate.

3. Compare the strengths of HCl and H2SO4 by studying kinetics of hydrolysis of methylacetate.
VI. Adsorption
I. Verify the Freundlich and Langmuir isotherms for adsorption of acetic acid on activated charcoal.

TEXTBOOKS/REFERENCE BOOKS:

1. Khosla, B. D.; Garg, V. C. &Gulati, A. Senior Practical Physical Chemistry, R.Chand & Co.: New Delhi (2011).
2. Garland, C. W.; Nibler, J. W. & Shoemaker, D. P. Experiments in Physical Chemistry8th Ed.; McGraw-Hill: New York (2003).
3. Halpern, A. M. &McBane, G. C. Experimental Physical Chemistry 3rd Ed.; W.H.Freeman & Co.: New York (2003).

SEMESTER-VI

Course Code	Subject Name	L-T-P	Credits
BCH-302	Inorganic Chemistry-V	4-0-0	4

Unit I: Theoretical Principles in Qualitative Analysis (H_2S Scheme) (10 Lectures)
Basic principles involved in analysis of cations and anions and solubility products, commonion effect. Principles involved in separation of cations into groups and choice of groupreagents. Interfering anions (fluoride, borate, oxalate and phosphate) and need to removethem after Group II.

Unit II: Organometallic Compounds-I (12 Lectures)
Definition and classification of organometallic compounds on the basis of bond type.Concept of hapticity of organic ligands.Metal carbonyls: 18 electron rule, electron count of mononuclear, polynuclear and substitutedmetal carbonyls of 3d series. General methods of preparation (direct combination, reductivecarbonylation, thermal and photochemical decomposition) of mono and binuclear carbonylsof 3d series.Structures of mononuclear and binuclear carbonyls of Cr, Mn, Fe, Co and Niusing VBT.π-acceptorbehaviour of CO (MO diagram of CO to be discussed), synergiceffect and use of IR data to explain extent of back bonding.Zeise's salt: Preparation and structure, evidences of synergic effect and comparison ofsynergic effect with that in carbonyls.

Unit II: Organometallic Compounds-II (10 Lectures)
Metal Alkyls: Important structural features of methyl lithium (tetramer) and trialkylaluminium (dimer), concept of multicentre bonding in these compounds. Role oftriethylaluminiumin polymerisation of ethene (Ziegler – Natta Catalyst). Species present inether solution of Grignard reagent and their structures, Schlenk equilibrium.Ferrocene: Preparation and reactions (acetylation, alkylation, metallation, MannichCondensation). Structure and aromaticity. Comparison of aromaticity and reactivity with thatof benzene.

Unit III: Reaction Kinetics and Mechanism(18 Lectures)
Introduction to inorganic reaction mechanisms. Substitution reactions in square planar omplexes, Trans- effect, theories of trans effect, Mechanism of nucleophilic substitution in square planar complexes, Thermodynamic and Kinetic stability, Kinetics of octahedral substitution, Ligand fieldeffects and reaction rates, Mechanism of substitution in octahedral complexes.

Unit IV: Catalysis by Organometallic Compounds(10 Lectures)
Study of the following industrial processes and their mechanism:
1. Alkene hydrogenation (Wilkinsons Catalyst)
2. Hydroformylation (Co salts)
3. Wacker Process
4. Synthetic gasoline (Fischer Tropsch reaction)
5. Synthesis gas by metal carbonyl complexes

TEXTBOOKS/REFERENCE BOOKS:
1. Svehla, G. Vogel's Qualitative Inorganic Analysis, 7th Edition, Prentice Hall,1996.

2. Cotton, F.A.G.; Wilkinson &Gaus, P.L. Basic Inorganic Chemistry 3rd Ed.;Wiley India,
3. Huheey, J. E.; Keiter, E.A. &Keiter, R.L. Inorganic Chemistry, Principles ofStructure and Reactivity 4th Ed., Harper Collins 1993, Pearson,2006.
4. Sharpe, A.G. Inorganic Chemistry, 4th Indian Reprint (Pearson Education) 2005
5. Douglas, B. E.; McDaniel, D.H. & Alexander, J.J. Concepts and Models inInorganic Chemistry3rd Ed., John Wiley and Sons, NY, 1994.
6. Greenwood, N.N. &Earnshaw, A. Chemistry of the Elements, Elsevier 2nd Ed,1997 (Ziegler Natta Catalyst and Equilibria in Grignard Solution).
7. Lee, J.D. Concise Inorganic Chemistry 5th Ed., John Wiley and sons 2008.
8. Powell, P. Principles of Organometallic Chemistry, Chapman and Hall, 1988.
9. Shriver, D.D. & P. Atkins, Inorganic Chemistry 2nd Ed., Oxford University Press,1994.
10. Basolo, F. & Pearson, R. Mechanisms of Inorganic Reactions: Study of Metal Complexes in Solution 2nd Ed., John Wiley & Sons Inc; NY.
11. Purcell, K.F. &Kotz, J.C., Inorganic Chemistry, W.B. Saunders Co. 1977

Course Code	Subject Name	L-T-P	Credits
BCH-304	Organic Chemistry-V	4-0-0	4

Unit I: Organic Spectroscopy-I (14 Lectures)
General principles Introduction to absorption and emission spectroscopy.UV Spectroscopy: Types of electronic transitions, λmax, Chromophores and Auxochromes,Bathochromic and Hypsochromic shifts, Intensity of absorption; Application of WoodwardRules for calculation of λmax for the following systems: α,β unsaturated aldehydes, ketones,carboxylic acids and esters; Conjugated dienes: alicyclic, homoannular and heteroannular;Extended conjugated systems (aldehydes, ketones and dienes); distinction between cis andtrans isomers.IR Spectroscopy: Fundamental and non-fundamental molecular vibrations; IR absorptionpositions of O, N and S containing functional groups; Effect of H-bonding, conjugation,resonance and ring size on IR absorptions; Fingerprint region and its significance; applicationin functional group analysis.

Unit I: Organic Spectroscopy-I **(**10 Lectures)
NMR Spectroscopy: Basic principles of Proton Magnetic Resonance, chemical shift andfactors influencing it; Spin – Spin coupling and coupling constant; Anisotropic effects inalkene, alkyne, aldehydes and aromatics, Interpretation of NMR spectra of simplecompounds.
Applications of IR, UV and NMR for identification of simple organic molecules.

Unit II: Carbohydrates(16 Lectures)
Occurrence, classification and their biological importance.
Monosaccharides: Constitution and absolute configuration of glucose and fructose, epimersand anomers, mutarotation, determination of ring size of glucose and fructose, Haworthprojections and conformational structures; Interconversions of aldoses and ketoses; Killiani-Fischersynthesis and Ruff degradation;Disaccharides – Structure elucidation of maltose, lactose and sucrose.Polysaccharides – Elementary treatment of starch, cellulose and glycogen.

Unit IV: Dyes(8 Lectures)
Classification, Colour and constitution; Mordant and Vat Dyes; Chemistry of dyeing;Synthesis and applications of: Azo dyes – Methyl Orange and Congo Red (mechanism ofDiazo Coupling); Triphenyl Methane Dyes -Malachite Green, Rosaniline and Crystal Violet;Phthalein Dyes – Phenolphthalein and Fluorescein; Natural dyes –structure elucidation andsynthesis of Alizarin and Indigotin; Edible Dyes with examples.

Unit V: Polymers(12 Lectures)
Introduction and classification including di-block, tri-block and amphiphilic polymers;Number average molecular weight, Weight average molecular weight, Degree ofpolymerization, Polydispersity Index.Polymerisation reactions -Addition and condensation -Mechanism of cationic, anionic andfree radical addition polymerization; Metallocene-based Ziegler-Natta polymerisation ofalkenes; Preparation and applications of plastics – thermosetting (phenol-formaldehyde,Polyurethanes) and thermosoftening (PVC, polythene);Fabrics – natural and synthetic (acrylic, polyamido, polyester); Rubbers – natural andsynthetic: Buna-S, Chloroprene

and Neoprene; Vulcanization; Polymer additives;Introduction to liquid crystal polymers; Biodegradable and conducting polymers withexamples.

TEXTBOOKS/REFERENCE BOOKS:

1. Kalsi, P. S. Textbook of Organic Chemistry 1st Ed., New Age International (P)Ltd. Pub.
2. Morrison, R. T. & Boyd, R. N. Organic Chemistry, Dorling Kindersley (India)Pvt. Ltd. (Pearson Education).
3. Billmeyer, F. W. Textbook of Polymer Science, John Wiley & Sons, Inc.
4. Gowariker, V. R.; Viswanathan, N. V. &Sreedhar, J. Polymer Science, New AgeInternational (P) Ltd. Pub.
5. Finar, I. L. Organic Chemistry (Volume 2: Stereochemistry and the Chemistry ofNatural Products), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
6. Graham Solomons, T.W. Organic Chemistry, John Wiley & Sons, Inc.
7. McMurry, J.E. Fundamentals of Organic Chemistry, 7th Ed. Cengage LearningIndia Edition, 2013.
8. Clayden, J.; Greeves, N.; Warren, S.; Wothers, P.; Organic Chemistry, OxfordUniversity Press.
9. Singh, J.; Ali, S.M. & Singh, J. Natural Product Chemistry, PrajatiPrakashan(2010).
10. Kemp, W. Organic Spectroscopy, Palgrave.
11. Pavia, D. L. et al. Introduction to Spectroscopy 5th Ed. Cengage Learning IndiaEd. (2015).

Course Code	Subject Name	L-T-P	Credits
BCH-306	Physical Chemistry-IV	4-0-0	4

Unit I: Quantum Chemistry (12 Lectures)

Postulates of quantum mechanics, quantum mechanical operators, Schrödinger equation and its application to free particle and "particle-in-a-box" (rigorous treatment), quantization of energy levels, zero-point energy and Heisenberg Uncertainty principle; wavefunctions, probability distribution functions, nodal properties, Extension to two and three dimensional boxes, separation of variables, degeneracy. Qualitative treatment of simple harmonic oscillator model of vibrational motion: Setting up of Schrödinger equation and discussion of solution and wavefunctions. Vibrational energy of diatomic molecules and zero-point energy. Angular momentum: Commutation rules, quantization of square of total angular momentum and z-component. Rigid rotator model of rotation of diatomic molecule.Schrödinger equation, transformation to spherical polar coordinates.Separation of variables.Spherical harmonics. Discussion of
solution.

Unit II: Qualitative treatment of hydrogen (12 Lectures)

Setting up of Schrödinger equation in spherical polar coordinates, radial part, quantization of energy (only final energy expression). Average and most probable distances of electron from nucleus.Setting up of Schrödinger equation for many-electron atoms (He, Li). Need for approximation methods. Statement of variation theorem and application to simple systems (particle-in-a-box, harmonic oscillator, hydrogen atom). Chemical bonding: Covalent bonding, valence bond and molecular orbital approaches, LCAO-MO treatment of H2 +. Bonding and antibonding orbitals.Qualitative extension to H2. Comparison of LCAO-MO and VB treatments of H2 (only wavefunctions, detailed solution not required) and their limitations. Refinements of the two approaches (Configuration Interaction for MO, ionic terms in VB).Qualitative description of LCAO-MO treatment of homonuclear and heteronuclear diatomic molecules (HF, LiH).Localised and non-localised molecular orbitals treatment of triatomic (BeH2, H2O) molecules. Qualitative MO theory and its application to AH2 type molecules.

Unit III: Molecular Spectroscopy (12 Lectures)

Interaction of electromagnetic radiation with molecules and various types of spectra; Born-Oppenheimer approximation. Rotation spectroscopy: Selection rules, intensities of spectral lines, determination of bond lengths of diatomic and linear triatomic molecules, isotopic substitution. Vibrational spectroscopy: Classical equation of vibration, computation of force constant, amplitude of diatomic molecular vibrations, anharmonicity, Morse potential, dissociation energies, fundamental frequencies, overtones, hot bands, degrees of freedom for polyatomic molecules, modes of vibration, concept of group frequencies. Vibration-rotation spectroscopy: diatomic vibrating rotator, P, Q, R branches. Raman spectroscopy: Qualitative treatment of Rotational Raman effect; Effect of nuclear
spin, Vibrational Raman spectra, Stokes and anti-Stokes lines; their intensity difference, rule of mutual exclusion.

Unit IV: Electronic spectroscopy (12 Lectures)
Franck-Condon principle, electronic transitions, singlet and triplet states, fluorescence and hosphorescence, dissociation and predissociation, calculation of electronic transitions of polyenes using free electron model. Nuclear Magnetic Resonance (NMR) spectroscopy: Principles of NMR spectroscopy, Larmor precession, chemical shift and low resolution spectra, different scales, spin-spin coupling and high resolution spectra, interpretation of PMR spectra of organic molecules. Electron Spin Resonance (ESR) spectroscopy: Its principle, hyperfine structure, ESR of
simple radicals.

Unit V: Photochemistry (12 Lectures)
Characteristics of electromagnetic radiation, Lambert-Beer's law and its limitations, physical significance of absorption coefficients. Laws, of photochemistry, quantum yield, actinometry, examples of low and high quantum yields, photochemical equilibrium and the differential rate of photochemical reactions, photosensitised reactions, quenching. Role of photochemical reactions in biochemical processes, photostationary states, chemiluminescence.

TEXTBOOKS/REFERENCE BOOKS:

1. Banwell, C. N. &McCash, E. M. *Fundamentals of Molecular Spectroscopy* 4th Ed. Tata McGraw-Hill: New Delhi (2006).
2. Chandra, A. K. *Introductory Quantum Chemistry* Tata McGraw-Hill (2001).
3. House, J. E. *Fundamentals of Quantum Chemistry* 2nd Ed. Elsevier: USA (2004).
4. Kakkar, R. *Atomic & Molecular Spectroscopy*: *Concepts & Applications*, Cambridge University Press (2015).
5. Lowe, J. P. & Peterson, K. *Quantum Chemistry*, Academic Press (2005).

Course Code	Subject Name	L-T-P	Credits
BCH-308	Green Chemistry	5-1-0	6

Unit I: Introduction to Green Chemistry(4 Lectures)
What is Green Chemistry? Need for Green Chemistry.Goals of Green Chemistry.Limitations/ Obstacles in the pursuit of the goals of Green Chemistry

Unit II: Principles of Green Chemistry and Designing a Chemical synthesis(30 Lectures)
Twelve principles of Green Chemistry with their explanations and examples and specialemphasis on the following:

- Designing a Green Synthesis using these principles; Prevention of Waste/ byproducts; maximum incorporation of the materials used in the process into the final products ,Atom Economy, calculation of atom economy of the rearrangement, addition, substitution and elimination reactions.

- Prevention/ minimization of hazardous/ toxic products reducing toxicity. risk = (function) hazard × exposure; waste or pollution prevention hierarchy.

- Green solvents– supercritical fluids, water as a solvent for organic reactions, ionic liquids, fluorous biphasic solvent, PEG, solventless processes, immobilized solvents and how to compare greenness of solvents.

- Energy requirements for reactions – alternative sources of energy: use of microwaves and ultrasonic energy.

- Selection of starting materials; avoidance of unnecessary derivatization – careful use of blocking/protecting groups.

- Use of catalytic reagents (wherever possible) in preference to stoichiometric reagents; catalysis and green chemistry, comparison of heterogeneous and homogeneouscatalysis, biocatalysis, asymmetric catalysis and photocatalysis.

- Prevention of chemical accidents designing greener processes, inherent safer design, principle of ISD “What you don’t have cannot harm you”, greener alternative to Bhopal Gas Tragedy (safer route to carcarbaryl) and Flixiborough accident (saferroute to cyclohexanol) subdivision of ISD, minimization, simplification, substitution,moderation and limitation.

- Strengthening/ development of analytical techniques to prevent and minimize the generation of hazardous substances in chemical processes.

Unit III: Examples of Green Synthesis

- Green Synthesis of the following compounds: adipic acid, catechol, disodiumiminodiacetate (alternative to Strecker synthesis)
- Microwave assisted reactions in water: Hofmann Elimination, methyl benzoate to benzoicacid, oxidation of toluene and alcohols; microwave assisted reactions in organic solvents,Diels-Alder reaction and Decarboxylation reaction
- Ultrasound assisted reactions: sonochemical Simmons-Smith Reaction (Ultrasonicalternative to Iodine)

Unit IV: Green Synthesis Reactions and some real world cases

Surfactants for carbon dioxide – replacing smog producing and ozone depletingsolvents with CO2 for precision cleaning and dry cleaning of garments.

- Designing of Environmentally safe marine antifoulant.
- Rightfit pigment: synthetic azopigments to replace toxic organic and inorganicpigments.
- An efficient, green synthesis of a compostable and widely applicable plastic (polylactic acid) made from corn.
- Healthier Fats and oil by Green Chemistry: Enzymatic Inter esterification forproduction of no Trans-Fats and Oils
- Development of Fully Recyclable Carpet: Cradle to Cradle Carpeting

Unit V: Future Trends in Green Chemistry(10 Lectures)

Oxidation reagents and catalysts; Biomimetic, multifunctional reagents; Combinatorial greenchemistry; Proliferation of solventless reactions; co crystal controlled solid state synthesis(C^2S^3); Green chemistry in sustainable development.

TEXTBOOKS/REFERENCE BOOKS:

1. Ahluwalia, V.K. &Kidwai, M.R. New Trends in Green Chemistry, AnamalayaPublishers (2005).
2. Anastas, P.T. & Warner, J.K.: Green Chemistry - Theory and Practical, OxfordUniversity Press (1998).
3. Matlack, A.S. Introduction to Green Chemistry, Marcel Dekker (2001).
4. Cann, M.C. &Connely, M.E. Real-World cases in Green Chemistry, AmericanChemical Society, Washington (2000).
5. Ryan, M.A. &Tinnesand, M. Introduction to Green Chemistry, American ChemicalSociety, Washington (2002).
6.Lancaster, M. Green Chemistry: An Intr

Course Code	Subject Name	L-T-P	Credits
BCH-352	Inorganic Chemistry Laboratory-V	0-0-4	2

Qualitative semimicro analysis of mixtures containing 3 anions and 3 cations. Emphasisshould be given to the understanding of the chemistry of different reactions. The followingradicals are suggested:
$CO3^{2-}$, NO_2^-, S^{2-}, SO_{32-},$S_2O_3^{2-}$, CH_3COO^-, F^-,Cl^-, Br^-, I^-, NO_3^-, BO_3^{3-}, $C_2O_4^{2-}$, PO_4^{3-}, NH_4^+, K^+, Pb^{2+}, Cu^{2+}, Cd^{2+}, Bi^{3+}, Sn^{2+}, Sb^{3+}, Fe^{3+}, Al^{3+},, Cr^{3+}, Zn^{2+}, Mn^{2+}, Co^{2+}, Ni^{2+}, Ba^{2+},Sr^{2+}, Ca^{2+},Mg^{2+}

Mixtures should preferably contain one interfering anion, or insoluble component ($BaSO_4$,SO_4, $PbSO_4$, CaF_2 or Al_2O_3) or combination of anions e.g. $CO_3^{2-}$and SO_3^{2-}, NO_2^- and NO_3^-, Cl^- and Br^-, $Cl^-$and I^-, $Br^-$and I^-, NO_3^- and Br^-, NO_3^- and I^-.

Spot tests should be done whenever possible.
i. Measurement of 10 Dq by spectrophotometric method
ii. Verification of spectrochemical series.
iii. Controlled synthesis of two copper oxalate hydrate complexes: kinetic vsthermodynamic factors.
iv. Preparation of acetylacetanato complexes of Cu2+/Fe3+. Find the λmax of the complex.
v. Synthesis of ammine complexes of Ni(II) and its ligand exchange reactions (e.g.bidentate ligands like acetylacetone, DMG, glycine) by substitution method.

TEXTBOOKS/REFERENCE BOOKS:

1. Vogel's Qualitative Inorganic Analysis, Revised by G. Svehla. Pearson Education,2002.
2. Marr &Rockett Practical Inorganic Chemistry. John Wiley & Sons 1972.

Course Code	Subject Name	L-T-P	Credits
BCH-354	Organic Chemistry Laboratory-V	0-0-4	2

1. Extraction of caffeine from tea leaves.
2. Preparation of sodium polyacrylate.
3. Preparation of urea formaldehyde.
4. Analysis of Carbohydrate: aldoses and ketoses, reducing and non-reducing sugars.
5. Qualitative analysis of unknown organic compounds containing monofunctionalgroups (carbohydrates, aryl halides, aromatic hydrocarbons, nitro compounds, aminesand amides) and simple bifunctional groups, for e.g. salicylic acid, cinnamic acid,nitrophenols, etc.
6. Identification of simple organic compounds by IR spectroscopy and NMRspectroscopy (Spectra to be provided).
7. Preparation of methyl orange.

TEXTBOOKS/REFERENCE BOOKS:

1. Vogel, A.I. Quantitative Organic Analysis, Part 3, Pearson (2012).
2. Mann, F.G. & Saunders, B.C. Practical Organic Chemistry, Pearson Education(2009)
3. Furniss, B.S.; Hannaford, A.J.; Smith, P.W.G.; Tatchell, A.R. Practical OrganicChemistry, 5th Ed., Pearson (2012)
4. Ahluwalia, V.K. &Aggarwal, R. Comprehensive Practical Organic Chemistry:Preparation and Quantitative Analysis, University Press (2000).
5. Ahluwalia, V.K. &Dhingra, S. Comprehensive Practical Organic Chemistry:Qualitative Analysis, University Press (2000).

Course Code	Subject Name	L-T-P	Credits
BCH-356	Physical Chemistry Laboratory-IV	0-0-4	2

UV/Visible spectroscopy

I. Study the 200-500 nm absorbance spectra of KMnO4 and K2Cr2O7 (in 0.1 M H2SO4)and determine the λmax values. Calculate the energies of the two transitions indifferent units (J molecule-1, kJ mol-1, cm-1, eV).

II. Study the pH-dependence of the UV-Vis spectrum (200-500 nm) of K2Cr2O7.

III. Record the 200-350 nm UV spectra of the given compounds (acetone, acetaldehyde,2-propanol, acetic acid) in water. Comment on the effect of structure on the UVspectra of organic compounds.

Colourimetry

I. Verify Lambert-Beer's law and determine the concentration of CuSO4/KMnO4/K2Cr2O7 in a solution of unknown concentration

II. Determine the concentrations of KMnO4 and K2Cr2O7 in a mixture.

III. Study the kinetics of iodination of propanone in acidic medium.

IV. Determine the amount of iron present in a sample using 1,10-phenathroline.

V. Determine the dissociation constant of an indicator (phenolphthalein).

VI. Study the kinetics of interaction of crystal violet/ phenolphthalein with sodiumhydroxide.

VII. Analysis of the given vibration-rotation spectrum of HCl(g)

TEXTBOOKS/REFERENCE BOOKS:

1.Khosla, B. D.; Garg, V. C. &Gulati, A., *Senior Practical Physical Chemistry*, R. Chand & Co.: New Delhi (2011).

2. Garland, C. W.; Nibler, J. W. & Shoemaker, D. P. *Experiments in Physical Chemistry 8th Ed.;* McGraw-Hill: New York (2003).

3.Halpern, A. M. &McBane, G. C. *Experimental Physical Chemistry 3rd Ed.;* W.H. Freeman & Co.: New York (2003).