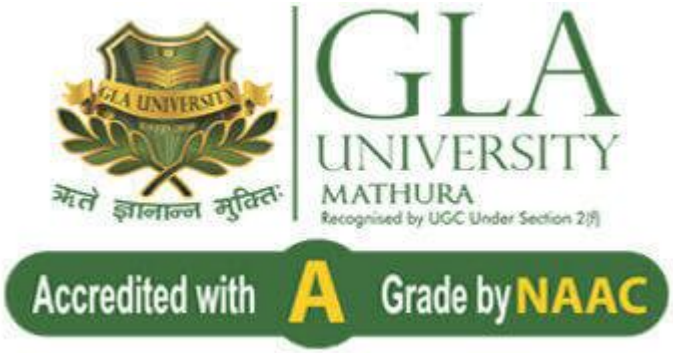

Course Curriculum

B.Sc. (H) Chemistry

w.e.f. Session: 2019-2020

[DEPARTMENT OF CHEMISTRY]

[Institute of Applied Sciences & Humanities]

PROGRAM OUTCOMES

After the completion of B. Sc. in Chemistry the students will be able to:

- ☞ Exploit the laboratory skills and safely to transfer and interpret knowledge entirely in the working environment in industries.
- ☞ Demonstrate, solve and an understanding of major concepts in all disciplines of chemistry.
- ☞ Solve the problem and also think methodically, independently and draw a logical conclusion.
- ☞ Employ critical thinking and the scientific knowledge to design, carry out, record and analyze the results of chemical reactions.
- ☞ Create an awareness of the impact of chemistry on the environment, society, and development outside the scientific community.
- ☞ Find out the green route for chemical reaction for sustainable development.
- ☞ Inculcate the scientific temperament in the students and outside the scientific community.
- ☞ Get exposures of a breadth of experimental techniques using modern instrumentation?
- ☞ Understand the importance of the elements in the periodic table including their physical and chemical role in the daily life.
- ☞ Inter relate and interact chemistry to the other subject like mathematics, physics, biological science etc.
- ☞ Expand the knowledge available opportunities related to chemistry in the government services through public service commission particularly in the field of food safety, health inspector, pharmacist etc.
- ☞ Afford a broad foundation in chemistry that stresses scientific reasoning and analytical problem solving with a molecular perspective.

- ☞ Achieve the skills to succeed in graduate school; professional school and the chemical industry like cement industries, agro product, Paint industries, Rubber industries, Petrochemical industries, Food processing industries, Fertilizer industries etc.

PROGRAM SPECIFIC OUTCOMES

- ☞ Gain the knowledge of Chemistry through theory and practical's.
- ☞ To explain nomenclature, stereochemistry, structures, reactivity, and mechanism of the chemical reactions
- ☞ Identify chemical formulae and solve numerical problems.
- ☞ Know structure-activity relationship.
- ☞ Understand good laboratory practices and safety.
- ☞ Develop research oriented skills
- ☞ Make aware and capable of handling the sophisticated instruments/equipments.
- ☞ Use modern chemical tools, Models, Chem-draw, Charts and Equipments.

MINIMUM COURSE CURRICULUM

FOR

UNDERGRADUATE COURSES

UNDER

CBCS

(COURSE STRUCTURE)

First Semester

S. NO.	CODE	SUBJECT	TEACHING SCHEME			CREDITS
			LECTURE	TUTORIALS	PRACTICALS	
1.	BCHC 0001	Physical Chemistry-I	3	2	0	4
2.	BCHC 0002	General Chemistry-I	3	0	0	3
3.	BMAS 0504	Applied Mathematics for Chemists (GE1)	3	0	0	3
4.	BPHS 0005	Ancillary Physics Course-I (GE2)	3	0	0	3
5.	BELH 0007	English Language Skills-I (AEC 1)	3	0	0	3
6.	BCSC0005	Fundamentals of Computers (SEC1)	2	0	0	2
PRACTICALS						
7.	BPHS 0805	Physics Lab – I	0	0	2	1
8.	BCHC 1901	Chemistry Lab-I	0	0	4	2
9.	BCSC 0074	Fundamentals of Computer Lab	0	0	2	1
						22

Second Semester

S. NO.	CODE	SUBJECT	TEACHING SCHEME			CREDITS
			LECTURE	TUTORIALS	PRACTICALS	
1.	BCHC 0003	Organic Chemistry-I	3	2	0	4
2.	BCHC 1004	General Chemistry-II	3	2	0	4
3.	BMAS 0505	Statistics and Numerical methods (GE 3)	3	2	0	4
4.	BSBE 0001	Remedial Biology (GE 3)	3	2	0	4
5.	BPHS 1006	Ancillary Physics Course-II (GE 4)	3	2	0	4
6.	BCSK 1006	Introduction to Programming (GE 5)	3	0	0	3
7	BCHS 0201	Environmental Studies (AEC 2)	2	0	0	2
PRACTICALS						
8.	BPHS 1806	Physics Lab II	0	0	4	2
9.	BCHC 1902	Chemistry Lab-II	0	0	4	2
10.	BCSO 0075	Programming Lab	0	0	2	1
						26

Third Semester

S. NO.	CODE	SUBJECT	TEACHING SCHEME			CREDITS
			LECTURE	TUTORIALS	PRACTICALS	
1.	BCHC 0005	Physical Chemistry-II	3	2	0	4
2.	BCHC 0006	Organic Chemistry-II	3	2	0	4
3.	BCHC 0007	Inorganic Chemistry –I	3	2	0	4
4.	BCHE 0001	Analytical Chemistry-I (DSE-1)	3	2	0	4
PRACTICALS						
6.	BCHC 0903	Chemistry Lab-III	0	0	4	2
7.	BCHC 0904	Chemistry Lab-IV	0	0	4	2
8.	BCHC 0905	Chemistry Lab-V	0	0	4	2
						22

Fourth Semester

S. NO.	CODE	SUBJECT	TEACHING SCHEME			CREDITS
			LECTURE	TUTORIALS	PRACTICALS	
1.	BCHC 0008	Physical Chemistry-III	3	2	0	4
2.	BCHC 0009	Organic Chemistry-III	3	2	0	4
3.	BCHC 0010	Inorganic Chemistry –II	3	2	0	4
4.	BCHE 0002	Analytical Chemistry-II (DSE-2)	3	2	0	4
5.	BCHE 0005	Fuel Cell Technology (SEC 2)	3	2	0	4
PRACTICALS						
6.	BCHC 0906	Chemistry Lab-VI	0	0	4	2
7.	BCHC 0907	Chemistry Lab-VII	0	0	4	2
8.	BCHC 0908	Chemistry Lab-VIII	0	0	4	2
						26

Fifth Semester

S. NO.	CODE	SUBJECT	TEACHING SCHEME			CREDITS
			LECTURE	TUTORIALS	PRACTICALS	
1.	BCHC 0011	Physical Chemistry-IV	3	2	0	4
2.	BCHC 0012	Organic Chemistry - IV	3	2	0	4
3.	BCHC 0013	Inorganic Chemistry – III	3	2	0	4
4.	BCHE 0003	Analytical Chemistry - III (DSE-4)	3	2	0	4
PRACTICALS						
6.	BCHC 0909	Chemistry Lab-IX	0	0	4	2
7.	BCHC 0910	Chemistry Lab-X	0	0	4	2
8.	BCHC 0911	Chemistry Lab-XI	0	0	4	2
						22

Sixth Semester

S. NO.	CODE	SUBJECT	TEACHING SCHEME			CREDITS
			LECTURE	TUTORIALS	PRACTICALS	
1.	BCHC 0014	Physical Chemistry-V	3	2	0	4
2.	BCHC 0016	Inorganic Chemistry –IV	3	2	0	4
3.	BCHE 0004	Analytical Chemistry-IV (DSE-5)	3	2	0	4
4.	BCHE 0007	Pericyclic, Heterocyclic and Photochemistry (DSE – 6)	3	2	0	4
PRACTICALS						
5.	BCHC0912	Chemistry Lab-XII	0	0	6	3
6.	BCHJ0951	PROJECT (DSE-7)	-	-	-	4
						23

Semester	**Core Course (C)** **Minimum Credit = 84** **Maximum Credit = 84**	**Ability Enhancement Compulsory Course (AECC)** **Minimum Credit = 4** **Maximum Credit = 8**	**Ability Enhancement Elective Course (AEEC) (2) (Skill Based)** **Minimum Credit = 4** **Maximum Credit = 8**	**Elective: Discipline Specific DSE (Minimum 6)** **Minimum credit = 24** **Maximum Credit = 32**	**Elective: Generic (GE)** **Minimum Credit = 24** **Maximum Credit = 24**
I	Physical chemistry-I (4) General Chemistry-I (3) Chemistry Lab - I (2)	English Language Skills-I (**AEC-1)** (3)	Fundamentals of Computers **SEC-1** (3)		1. Ancillary Physics Course-I (4) 2. Applied Mathematics for Chemists (3)
II	Organic chemistry-I (4) General Chemistry-II (4) Chemistry Lab-II (2)	Environmental Studies (**AEC-2)** (2)			3. Ancillary Physics Course-II (6) 4. Statistics and Numerical methods (4) Or Biochemistry (4) 5. Introduction to Programming (4)
III	Physical Chemistry-II (4) Organic Chemistry-II (4) Inorganic Chemistry –I (4) Chemistry Lab-3 (2) Chemistry Lab-4 (2) Chemistry Lab-5 (2)			Analytical Chemistry-I (DSE-1) (4)	
IV	Physical Chemistry-III (4) Inorganic Chemistry -II (4) Organic Chemistry-III (4) Chemistry Lab-6 (2) Chemistry Lab-7 (2) Chemistry Lab-8 (2)		Fuel Cell Technology **SEC-2** (4)	Analytical Chemistry-II (DSE-2) (4)	
V	Physical Chemistry-IV (4) Organic Chemistry-IV (4) Inorganic Chemistry –III (4) Chemistry Lab-9 (2) Chemistry Lab-10 (2) Chemistry Lab-11 (2)			Analytical Chemistry-III (DSE-3) (4)	
VI	Physical Chemistry-V (4) Inorganic Chemistry –IV (4) Chemistry Lab-12 (3)			Analytical Chemistry-IV (DSE-4) (4) + DSE-5 (4) + Project (DSE-6) (4)	
	84	5	7	24	21

Minimum Requirement as per UGC CBCS system
(w.e.f. session 2019-20)

I. Core Courses (C): Total Credit = 84

IA (Theory Papers)

S. No.	Course Name	Code	L-T-P	Credit
1.	Physical Chemistry - I	BCHC 0001	3-2-0	4
2.	General Chemistry - I	BCHC 0002	3-0-0	3
3.	Organic Chemistry - I	BCHC 0003	3-2-0	4
4.	General Chemistry - II	BCHC 1004	3-2-0	4
5.	Physical Chemistry - II	BCHC 0005	3-2-0	4
6.	Organic Chemistry - II	BCHC 0006	3-2-0	4
7.	Inorganic Chemistry - I	BCHC 0007	3-2-0	4
8.	Physical Chemistry - III	BCHC 0008	3-2-0	4
9.	Organic Chemistry - III	BCHC 0009	3-2-0	4
10.	Inorganic Chemistry - II	BCHC 0010	3-2-0	4
11.	Physical Chemistry - IV	BCHC 0011	3-2-0	4
12.	Organic Chemistry - IV	BCHC 0012	3-2-0	4
13.	Inorganic Chemistry - III	BCHC 0013	3-2-0	4
14.	Physical Chemistry - V	BCHC 0014	3-2-0	4
15.	Inorganic Chemistry - IV	BCHC 0016	3-2-0	4
		Total		59

IB (Core Courses Lab)

S. No.	Course Name	Code	L-T-P	Credit
1.	Chemistry Lab I	BCHC 1901	0-0-4	2
2.	Chemistry Lab II	BCHC 1902	0-0-4	2
3.	Chemistry Lab III	BCHC 0903	0-0-4	2
4.	Chemistry Lab IV	BCHC 0904	0-0-4	2
5.	Chemistry Lab V	BCHC 0905	0-0-4	2
6.	Chemistry Lab VI	BCHC 0906	0-0-4	2
7.	Chemistry Lab VII	BCHC 0907	0-0-4	2
8.	Chemistry Lab VIII	BCHC 0908	0-0-4	2
9.	Chemistry Lab IX	BCHC 0909	0-0-4	2
10.	Chemistry Lab X	BCHC 0910	0-0-4	2
11.	Chemistry Lab 11	BCHC 0911	0-0-4	2
12.	Chemistry Lab 12	BCHC 0912	0-0-4	3
		Total		25

II. Elective Course (48 Credits)

IIA Discipline Specific Elective Papers:

Minimum Credit = 24 Maximum Credit = 32

S. No.	Course Name	Existing Credit	L-T-P	New Code
1.	Analytical Chemistry -I	4	3-2-0	BCHE 0001
2.	Analytical Chemistry -II	4	3-2-0	BCHE 0002
3.	Analytical Chemistry –III	4	3-2-0	BCHE 0003
4.	Analytical Chemistry -IV	4	3-2-0	BCHE 0004
5.	Fuel Cell Technology	4	3-2-0	BCHE 0005
6.	Heterocyclic, Pericyclic and Photochemistry	4	3-2-0	BCHE 0006
7.	Green Chemistry and Corrosion Science	4	3-2-0	BCHE 0007
8.	Nanomaterials And Nanotechnology	4	3-2-0	BCHO 0101
9.	Technology of Surface Coating	4	3-2-0	BCHO 0102
10.	Material Science & Engineering	4	3-2-0	BCHO 0103
11.	Introduction to Biophysical Chemistry	4	3-2-0	BCHO 0104
12.	Industrial Chemicals & Environment	4	3-2-0	BCHE 0008
13.	Dissertation/ Project**	6	0-0-12	BCHE 0951
	Total	**24-32**		

IIB Generic Elective (Other Discipline)-

Total Credit = 24

S. No.	Course Name	Code	L-T-P	Credit
1	Applied Mathematics for Chemists	BMAS 0504	3-0-0	3
2	Statistics and Numerical Methods	BMAS 0505	3-2-0	4
3	Ancillary Physics Course-I	BPHS 1005	4-0-4	4
4	Ancillary Physics Course-II	BPHS 1006	4-0-4	6
5	Biochemistry	BSBC 0008	4-0-0	4
6	Remedial Biology	BSBO 0001	4-0-0	4
7	Introduction to Programming	BCSK 1006	3-0-2	4
	Total Credit			21

III Ability Enhancement Compulsory (Minimum 4 Credits)

S. No.	Course Name	Code	L-T-P	Credit
1	English Language Skills-I	BELH 0007	3-0-0	3
2	Environmental Studies	BCHS0201	2-0-0	2
				5

IV Skill Enhancement Courses

(Minimum Credit: 04)

S. No.	Course Name	Code	L-T-P	Credit
1.	Fundamentals of Computer	BCSC 0005	2-0-2	3
2.	Fuel Cells	BCHE 0010	4-0-0	4
3.	Chemical Technology & Society	-		
4.	Chemo-informatics	-		
5.	Business Skills for Chemists	-		
6.	Intellectual Property Rights	-		
7.	Analytical Clinical Biochemistry	-		
8.	Green Methods	-		

DETAILED SYLLABUS

SEMESTER - I

BCHC 0001: PHYSICAL CHEMISTRY - I

Credits: 04 **Semester I** **L–T–P : 3–2–0**

Objective: This course aims to expose the students to the various concepts and applications of Chemical Kinetics, Ionic Equilibrium, and solutions.

Module No.	Content	Teaching Hours (Approx.)
I	**Chemical Kinetics:** Chemical kinetics and its scope, rate of reaction, order and molecularity of reactions, pseudomolecular reactions. Derivation of rate equation of zero, first, second and fractional order reactions and their characteristics. Determination of order of reaction by rate determining step reactions method, integration method, graphical method, differential method, equi-fractional method and Ostwald isolation method. Collision theory for bimolecular reactions, transient state theory. Factors affecting rate of reaction-concentration, pressure, light, catalyst and temperature (temperature coefficient), quantitative effect of temperature on rate of reaction by Arrhenius equation. Concept of activation energy. Lindeman's theory of unimolecular reactions. **Ionic equilibria–I :** Strong and weak electrolytes, degree of ionization, factors affecting degree of ionization, ionization constant, ionic product of water. Ostwald dilution law and its limitations. pH value. Buffer solution; derivation of Henderson equation; buffer capacity, buffer action and application of buffer solution in analytical chemistry and biological processes in human body.	24
II	**Ionic equilibria–II:** Salt hydrolysis – calculations of hydrolysis constant, degree of hydrolysis and pH of different types of salts. Common ion effect, solubility and solubility product of sparingly soluble salts and its applications. **Solution**: Dilute solution, semi-permeable membrane and its preparation, osmotic pressure and it's measurement by Berkley & Hartley method. Colligative properties-Lowering of vapour pressure, Raoult's law for solution of non volatile solute and its derivation. Ostwald & Walker dynamic method for determination of molecular weight of non volatile solute. Raoult's law for missicible liquids, Ideal and non–ideal solutions. Henry's law. Elevation in boiling point, Derivation of expression in between elevation in boiling point and molecular weight of non volatile solute. Landsberger method & Cottrell's method for determination of molecular weight of non volatile solute. Depression in freezing point., derivation of expression in between depression in freezing point and molecular weight of non volatile solute. Beckmann's method for depression in freezing point and Rast camphor method for determination of molecular weight of non volatile solute. Vant Hoff's factor. Abnormal osmotic pressure and molecular weight.	24

Intended Outcome:

After studying this course students will able to:

i. Determine the order of reaction, reaction rate, degree of ionization constant pH etc.

ii. Desire the relation for rate constant, half life.
iii. Understand theories of reaction rate.
iv. Derive the expression for colligative properties.
v. Calculate modular weight using difference colligative properties, degree of hydrolysis
vi. Deduce Raoult's – Law, Henry's law, Van't Hoff factor.

Reference Books:

1. *A text book of Physical Chemistry*: S. Glasstone McMillian

Text Book:

1. *Essentials of Physical Chemistry*: Bahl & Tuli S.Chand & Co.
2. Principles of Physical Chemistry: Puri & Sharma Shobhanlal nagin chand & Co

BCHC 1002: GENERAL CHEMISTYRY - I

Credits: 03 **Semester I** **L–T–P : 3–0–0**

Objective: This course aims to expose the students to the various concepts and applications of general chemistry.

Module No.	Content	Teaching Hours (Approx.)
I	**General Topic:** The concept of atoms and molecules; Earlier model (Rutherford model, Dalton's atomic theory, Bohr's Theory) **Mole concept**: Chemical formulae; Expressing concentration (Molarity, Normality, Formality, Molality, mole fraction etc) Types & balancing of chemical equations involving common oxidation-reduction, neutralization and displacement reactions. **Atomic Structure** Idea of de Broglie matter waves, Heisenberg uncertainty principle, atomic orbitals, Schrodinger wave equation (no derivation), significance of Ψ and Ψ^2, quantum numbers, shapes of s, p, d orbitals. Aufbau principle, Hund's multiplicity rule and Pauli exclusion principle. Electronic configurations of the elements and ions. **Periodic Properties:** Classification of elements on the basis of s, p, d, f subshells. Periodic properties- atomic and ionic radii, ionization energy, electron affinity and electro negativity-definition-trends in periodic table and factors affecting them. **Structure and Bonding:** Hybridization in organic molecules, bond length and bond angles, bond energy, localized and delocalized chemical bond, van der Waals interactions, resonance, hyperconjugation, inductive and mesomeric and field effects, hydrogen bonding in organic compounds. Tautomerism in organic compounds.	16 24
II	**Valuation of Analytical Data**: Significant figures, absolute and relative errors, terms of mean and median, precision and accuracy in chemical analysis, determining accuracy of methods, improving accuracy of analysis (data treatment for series involving relatively few measurements, linear least squares curve fitting), standard deviation, confidence limits, rejection of measurements (F-test and Q-test) numerical problems related to evaluation of analytical data. **Energetics**:-First law of thermodynamics, Internal energy, Enthalpy, Heat of reaction, heat of formation, heat of combustion, heat of neutralization, heat of fusion, heat of vaporization. Hess's law of heat summation. Second law of thermodynamics, Entropy, Free energy, Criterion of spontaneity. **Chemical Bonding–I:** Types of bonding: Ionic bond, Covalent Bond, Co-ordinate bond. Hydrogen bond and metallic bond. Directional characteristics of covalent bond. Lattice energy and solvation energy and solubility of ionic solids. Born-Haber cycle. Fajan's rule. Percentage ionic character from dipole moment and electronegativity difference. Metallic bond- free electron model,	24

	valence bond and band theories. Valence bond theory and its limitations. VSEPR Theory: various types of hybridization and shapes of simple inorganic molecules and ions (BeF_2, BF_3, CH_4, PF_5, SF_6, IF_7, H_2O, NH_3, XeF_2, XeF_4, BF_4^-, PF_6^-, $SnCl_6^{2-}$). **Reactivity of Organic compounds**: Curved arrow notation, drawing electron movements with half- headed and double headed arrows, homolytic and heterolytic bond breaking. Types of reagents of organic reactions (nucleophiles and electrophiles). Elementary reactions and concerted reactions. Types of reactions and reaction intermediates (carbocations, carbanions, free radicals). **Colloidal State:** Definition and classification of colloids. Difference between lyophobic and lyophilic sols. Kinetic, optical and electrical properties of sols, stability of colloids, protective action of colloids-gold number, coagulation of colloid-Hardy-Schulze law. Liquids in liquids (emulsions): Types of emulsions, preparation and Emulsifiers. Liquids in solids, (gels) classification, preparation and properties. General applications of colloids. Colloidal electrolytes.	

Intended Outcome:

After studying this course students will able to:

i. Prepare solutions in different case.
ii. Balance chemical equation.
iii. Write electronic configuration of various elements and their ions
iv. Understanding variation of different parameters in periodic table.
v. Conceptualize structure and bonding
vi. Predict type of Hybridization and shape inorganic molecules and ions
vii. Evaluate the analytical data
viii. Apply Law's of thermodynamics to calculate heat of reaction, heat of formation etc.
ix. Classify and identify colloids and their properties.

Reference Books:

1. *Basic Inorganic Chemistry.* F.A. Cotten. G. Wilkinson and P.L.. Gaus. Wiley.
2. *Organic Chemistry.* Morrison and Boyd, Prentice Hall.
3. *Fundamentals of Organic Chemistry.* Solomons, John Wiley.
4. *Principles of Physical Chemistry*: Puri & Sharma Shobhanlal nagin chand & Co

Text Books:

1. Introductory Chemistry by Nivaldo J. Tro, 5Th Edition, Pearson
2. Basic Chemistry by K.C. TimberLake, 4th Edition, Pearson.

BCHC 1901: CHEMISTRY LAB - 1

Credits: 02 **Semester I** **L–T–P : 0–0–4**

Objective: This course aims to expose the students to the experimental aspects of chemical science.

1. **A.** Prepare a solution N/10 HCl Solution.
   B. Standardize the prepared HCl solution by titrating it against N/20 NaOH solution using phenolphthalein as an internal indicator.
2. **A.** Prepare a standard solution of ferrous ammonium sulphate solution of strength N/30 approximately.
   B. Find out the strength of given ferrous ammonium sulphate solution by titrating it against $KMnO_4$ solution as an intermediate solution.
3. **A.** Preparation of Hypo solution
   B. Prepare a standard solution of copper sulphate of strength N/40 approximately.
   C. Find out the strength of given copper sulphate solution iodometerically by titrating it against Hypo solution as an intermediate solution using starch as an internal indicator.
4. Analyze the following acid radicals in the given salts:
   i) Cl^-, Br^-, I^- (combination),
   ii) NO_3^-, NO_2^- (combination),
   iii) BO_3^{3-}, PO_4^{3-} and removal of interfering radical.
5. Analyze the following acid radicals in the given salts:
   i) CO_3^{2-} , SO_3^{2-} (combination),
   ii) SO_4^{2-}, SO_3^{2-}, S^{2-} (combination),
   iii) CH_3COO^-, NO_2^-, F^-, $C_2O_4^{2-}$ and removal of interfering radical.
6. Analyze the following basic radicals in the given salts: Hg_2^{2+}, Ag^+, Pb^{2+}, Hg^{2+}, Cu^{2+},Cd^{2+}, Bi^{3+}
7. Analyze the following basic radicals in the given salts: As^{3+}, Sb^{3+}, Sn^{2+}, Sn^{4+}, Al^{3+}, Fe^{3+}, Cr^{3+}
8. Analyze the following basic radicals in the given salts: Zn^{2+}, Mn^{2+}, Co^{2+}, Ni^{2+}
9. Analyze the following basic radicals in the given salts: Ba^{2+}, Sr^{2+},Ca^{2+}, Mg^{2+}, NH_4^+
10. Analyze the given inorganic mixture containing two acidic and two basic radicals.
11. To determine the relative viscosity of a given liquid with respect to water at room temperature by Ostwald`s viscometer.

Note:

- The mixture may contain more than one basic radicals of same group.
- If the mixture contains any interfering radical then basic radicals of beyond second group may be given.
  The mixture will not contain more than one interfering radical, if present.

Intended Outcome:

After studying this course students will able to:

i. Prepare standard and working solutions used in an experiment.
ii. Analyze acid and basic radicals individually or in mixture.
iii. Identify acid and basic radicals from ternary and quaternary mixture
iv. Determine the relative viscosity of a given liquid with respect to water
v. Estimate the concentration of ferrous and copper ions from given sample.

Reference Books:

1. Practical Physical Chemistry, B. Viswanathan, P. S. Raghavan, Viva Books Private Limited.
2. Practical Chemistry, Pandey O.P./ Bajpai D.N. & Giri S. S. Chand Limited
3. College Practical Chemistry, V K Ahluwalia, Sunita Dhingra, Sunita Dhingra, Universities Press, Hydrabad.

BPHS 0005: ANCILLARY PHYSICS COURSE – I

Credits: 03 **Semester I** **L–T–P : 3–0–0**

Objective: This course aims to expose the students to the

Module No.	Content	Teaching Hours (Approx.)
I	**wave motion** Type of mechanical wave, wave length, frequency and wave number, progressive harmonic wave, differential equation of wave motion, energy density of plane progressive wave, superposition of wave, beats, propagation of longitudinal and transverse vibration along string, modes of vibration, Fourier's theorem, La'place correction of Newton's formula, group velocity and phase velocity	14
II	**Simple Harmonic Motion** Periodic and harmonic motion, simple harmonic motion, energy of harmonic oscillator, average value of kinetic and potential energy of H.O. mass spring system, two body harmonic oscillator, oscillation of diatomic molecule, time period of pendulum of large amplitude. Kapler's laws and its applications, equation of orbit, anharmonic motion.	14
III	**Damped and forced Harmonic Motion** Frictional effects-(damping), damped harmonic oscillator, power dissipation, quality factor (Q), example of damped H.O, driving (forced) harmonic oscillator, sharpness of resonance, phase of driving Oscillator, Velocity resonance, half width of resonance curve, power absorption. **S**uperposition principle, driving L-C-R circuit, parallel resonance circuit, example and application.	16

Intended Outcome:

After studying this course students will able to:

i.
ii.
iii.
iv.
v.

Reference Books/ Text Books

1. Physics Part –1, Resanick and Halliday, Wiley Publication.
2. Mechanics, D.S. Mathur, S. Chand & Co., New Delhi.
3. Concept in Physics Vol. I: H.C.Verma, Bharati Bhawan Pub. & Dis-New Delhi.
4. Mechanics: R.K.Shukla and Anchal Srivastava, New Age International (P) Ltd.
5. Classical Mechanics: J.C Upadhyay, Himalaya Publishing House, New Delhi.

BPHS 0805: PHYSICS LAB - I

Credits: 01 **Semester I** **L–T–P : 0–0–2**

Objective: This course aims to expose the students to the

1. Determination of modulus of rigidity and Poisson's ratio of material of a wire using Searle's method.
2. Determination of Young's modulus of material of metallic bar by bending of beam method.
3. Determination of modulus of rigidity and using Borton's apparatus.
4. Determination of viscosity of liquid using Poiseuille's method.
5. Determination of acceleration due to gravity using compound pendulum.
6. Determination of internal resistance of micro ammeter and conversion of micro ammeter into voltmeter, milliammeter and Ohmmeter.
7. Determination of resistance per unit length and an unknown resistance using C. F. Bridge.
8. To determine specific resistance of wire by Carey Foster Bridge.
9. Determination of absolute capacity of a condenser.
10. To study variation of magnetic field along the axis of Helmholtz Galvanometer and to determine reduction factor.
11. Determination of Energy band gap in a semiconductor diode
12. To study series and parallel resonant L. C. R. circuit.
13. Calibrations of ammeter by potentiometer
14. Calibrations of Voltmmeter by potentiometer

Intended Outcome:

After studying this course students will able to:

i.
ii.
iii.
iv.
v.

Reference Books/ Text Books

1. B.Sc. Practical Physics, S. Chand & Company Ltd.
2. B.Sc Practical Physics, C.L.Arora, S. Chand & Company Ltd.
3. Pratical Physics, R.K.Shukla and Anchal Srivastava, New Age International (P) Ltd.

BMAS 0504: APPLIED MATHEMATICS FOR CHEMISTS

Course Objectives: To make the students understand the concepts of matrices, differentiation, integration and ordinary differential equations by giving more emphasis to their applications in the field of chemistry.

Credits: 03 **Semester I** **L–T–P: 3–1–0**

Module No.	Contents	Teaching Hours (Approx.)
I	**Matrices**: Introduction, Inverse by elementary transformations, Rank by Echelon form, Solution of system of linear equations by elementary transformations and Cramer's rule, Eigen values and Eigen vectors, Cayley-Hamilton theorem. **Differential Calculus**: Introduction, Differentiation of elementary functions, Rules of differentiation, Successive differentiation.	20
II	Expansion of functions of one variable, Integration of elementary functions, Methods of integration. **Ordinary Differential Equations:** Introduction, Solution of ODEs of I order and I degree in variable separable and linear forms, Exact differential equations, Solution of n^{th} order linear differential equations with constant coefficients, Applications to problems in Chemistry.	20

Learning Outcomes:

After studying these topics, the student will be able to

- Find rank, Eigen values and Eigen vectors of a given matrix
- Solve the systems of linear equations
- Learn the concepts of differentiation and integration and to use them in different problems
- Solve the ordinary differential equations and know their applications in chemistry

Text Books:

- M. Goyal and N. P. Bali, A Text Book of Engineering Mathematics, Laxmi Publication, Delhi, 2014.
- M. K. Jain, S. R. K. Iyengar and R. K. Jain, Advanced Engineering Mathematics, Narosa Publishing House, New Delhi, 2002.

Reference Books:

- W. E. Boyce and R. D. Prima, Elementary Differential Equations, John Wiley & Sons, 2009.
- G. B. Thomas and R. Finney, Calculus & Analytic geometry, Addison Wesley, USA, 1995.

BELH 0007: ENGLISH LANGUAGE SKILLS - I

Credits: 03 **Semester I** **L–T–P : 3–0–0**

Objective: Keeping in mind the diverse set of students (as far as their mother tongues are concerned) in the undergraduate programmes of the University, this course focuses on communication activities in functional and situational contexts. It encourages students to develop the four skills: reading, writing, listening and speaking. This course also proposes scope for the participants to learn the art of speaking English as standard Indian English speaker without the interference of their mother tongues.

Module No.	Content	Teaching Hours
I	**Grammar**: Parts of Speech: Noun, Pronoun, Adjective, Adverb, Verb; Sentence **Vocabulary**: Word Formation using prefixes & suffixes **Reading:** Study of Text: "The Eyes are not Here" by Ruskin Bond; Comprehension of a given passage from the text **Speaking**: Describing self, persons, places & objects	12
II	**Grammar**: Tense; Prepositions, Articles, Subject – Verb Agreement **Vocabulary**: Words often confused **Writing:** Developing a story from given clues **Speaking:** Speaking on need based topics like talking about habits, daily routine, Introducing self & others, likes and dislikes etc.	12
III	**Communication**: What is communication? Process of communication; Types and barriers of Communication **Error corrections**: Related to the grammar topics covered in module I & II. **Vocabulary**: Synonyms & Antonyms **Study of Text**: "The Lament" by Anton P. Chekov. Comprehension of a given passage from the text **Speaking:** Role Play and Small Talk	12

Intended Outcome: At the end of the course, the participant should be able to

- read articles on subjects of general interest
- review grammar and vocabulary so that one is able to speak & write with more accuracy
- learn the vocabulary and phrases that are widely used.
- practice speaking in groups & communicate in real-life situations.

Prescribed Text: *An Anthology of Short stories,* Ed. RP Singh, Oxford University Press, New Delhi

References:

1. Wren & Martin**,** High School English Grammar and Composition**,** S.Chand & Co. Ltd., New Delhi.
2. Allen, W., Living English Structure, Pearson Education, New Delhi.
3. Collins English Dictionary, Harper Collins Publication Ltd.
4. Longman Dictionary of Contemporary English, Pearson Longman, England.
5. Murphy, Raymond, Intermediate English Grammar, Cambridge University Press.
6. Norman Lewis, Word Power Made Easy, Goyal Publications & Distributers, Delhi.
7. Mohan, Krishan & N.P. Singh, Speaking English Effectively, Macmillan India Ltd., New Delhi.

Audio-Visual Material: Material available in the language Lab.

BCSO 0005: FUNDAMENTALS OF COMPUTER

(Open Elective)

Credits: 02 **Semester I** **L–T–P : 2–0–0**

Objective: This course on fundamental of computers and data handling would ensure that the students get first-hand exposure to the fundamentals of computers and get acquainted with handling of the same.

Module No.	Content	Teaching Hours
I.	**Computer fundamentals:** Definition of computer, characteristics of computer, generation of computers, classification of computers, block diagram of computers. **Software and hardware:** Application and system software, Hardware-I/O devices, CPU components, storage devices. **Understanding of Word processor:** Opening and closing of word document, text creation and manipulation, formatting of text, table handling, spell check, printing of word document.	9
II.	**Number System:** Bit, Byte, Binary, Decimal, Hexadecimal and Octal number systems and their inter-conversions. **Translator:** Assembler, compiler, interpreter, linker and loader **Introduction to Operating system:** definition, functions, CUI and GUI based operating systems. **Introduction to spreadsheet:** manipulation of cells, formulas and functions, printing of spreadsheet.	9
III.	**Introduction to Computer Network:** definition, advantages, network topologies, communication media. **Making Presentation:** creating presentation, preparation of slides, slide show, taking printouts of presentation. **Internet and its applications:** E-mail-sending and receiving emails, file attaching with email, WWW, web browsers, search engine, internet and applications. **Cybercrime:** Introduction and its types.	8

Intended Outcome:

After completion of course, student will be able to:

- Familiar with the basic knowledge of computer.
- Able to use M.S. Office (M.S. Word, M.S. Power point, M.S. Excel and M.S. Access) and Internet efficiently.

Reference Books:

- Anita Goel, “Computer fundamentals”, Pearson Education.
- Peter Nortron, “Inside PC”, TMH, New Delhi.
- Alexis Leon, Methews Leon, (1999), “Fundamentals of Information Technology”, Vikas Publishing, New Delhi.

Text Book:

- P.K. Sinha, (2008), “Computer fundamentals”, BPB Publisher, New Delhi, 4th edition.

BCSO 0074: FUNDAMENTALS OF COMPUTER LAB

(Open Elective)

Credits: 01 **Semester I** **L–T–P : 0–0–2**

Objective: To provide hands-on experience in Microsoft Office tools.

Module No.	Content	Lab Hours
I	**Word Processing (MS Word)** • **Introduction to MS Word:** Menu Bar, Menus, Submenus, Tool Bar, Tools, Customizing Toolbar, Hiding Toolbar etc., Creating and Saving Documents, Working with an Existing Document, Auto Text, Auto Complete and Auto Correct. • **Formatting a Document:** Change the Appearance of Text & Paragraph, Copy, Paste and Paste Special Functions, Creating and Modifying a List, Page Break Options and Orientation, Changing the Look of Documents with Styles. • **Using Tables and Columns:** Table Creation and Modification Giving Stress to Auto-Fit, Auto-Format and Table Sort. Working with Data in Table Giving Stress to Formulas, Presenting Text in Columns, Object Linking and Embedding, Inserting and Sizing Graphics, Hyperlink Envelopes & Label Creation, Grammar & Spell Check, Previewing and Printing Documents. **MS Excel** • **Introduction to Electronic Spreadsheet and Microsoft Excel:** Creating and Formatting a Worksheet, Features of Excel, Inserting and Formatting Data in a Worksheet, Working with an Existing Data List, Auto Fill, Fill Series and Auto - complete Options, Formatting Cells; Sorting & Filtering Data, Conditional Formatting, Formulas and Functions (Details Usage of Important Data Functions Like Sum, If, Average etc.); Interlinking Worksheets and Files, Setting Filters and Performing Calculations on Filtered Data etc **Presentation (Power Point Presentation)** • **Introduction to Power Point:** Creating A Presentation: Features of Power Point - Editing Master Slides, Viewing and Editing a Presentation, Inserting, Sorting, Hiding and Deleting Slides, Inserting Pictures. Clip Art and Movies in a Slide: Creating and Enhancing a Table, Slide Layouts, Modifying the Slides and Title Master, Adding Transition and Animation Effect, Hyper Linking Slides & Files • **Internet and its applications:** E-mail-sending and receiving emails, file attaching with email.	24

Intended Outcome: After completion of Lab, student will be able to:

- Effectively use Microsoft Office tools such as MS Word, MS Excel and Power Point Presentation.

SEMESTER - II

BCHC 0003: ORGANIC CHEMISTRY - I

Credits: 04 **Semester II** **L–T–P : 3–2–0**

Objective: This course aims to expose the students to the general organic chemistry and set a base to understand aliphatic and aromatic hydrocarbons.

Module No.	Content	Teaching Hours (Approx.)
I	**Dynamics of Organic Reactions:** Types of organic reactions, energy considerations, detailed study of reaction intermediates (carbocation, carbanion, free radical, carbene, nitrene and arynes). Methods of determination of reaction mechanism (product analysis, intermediates, isotope effects kinetic and stereochemical studies). **Stereochemistry of Organic compounds II: Configurational Analysis :** Optical isomerism - optical activity in molecules with one and more than one stereogenic centers, optical activity in molecules lacking of any chiral centre (allenes, spiranes alkyledenes and biphenyls) R/S, and D/L nomenclature. Geometric isomerism- geometric isomerism in alkenes, acyclic, oximes and alicyclic compounds and their E & Z system of nomenclature. Conformational analysis - conformational analysis of ethane and n-butane. Difference between configuration and conformation.	16
II	**Alkanes**: Nomenclature, general methods of synthesis (with detailed study of Wurtz reaction, Kolbe reaction, Corey-House reaction and decarboxylation of carboxylic acids), physical and chemical properties of alkanes with special reference to free radical halogenations of alkanes: orientation, reactivity and selectivity. **Alkenes**: Nomenclature, general methods of synthesis (with special reference to dehydration of alcohols and dehydrohalogenation of alkyl halides). Hofmann elimination and Saytzeff rule, physical properties and relative stabilities of alkenes. Chemical reactions of alkenes-(hydrogenation, electrophilic and free radical additions, hydroboration-oxidation, oxymercuration reduction. Epoxidation, ozonolysis, hydration, hydroxylation and oxidation with $KMnO_4$ and polymerisation). Industrial applications of ethylene and propene. Markovnikov's and antiMarkovnikov's rule **Alkynes**: Nomenclature, general methods of synthesis, chemical reactions of alkynes (addition, substitution, oxidation, polymerisation and isomerisation reactions) acidity of alkynes. Industrial applications of ethyne.	16
III	**Arenes:** Nomenclature of benzene derivatives. Structure of benzene: Kekule structure, resonance structure, Huckels rule, stability and carbon-carbon bond lengths in benzene, MO diagram of benzene Energy profile diagrams. General methods of synthesis of benzene and homologues. Physical and Chemical properties of benzene and its homologues: Rules for aromatic substitution reactions. Aromatic electrophilic substitution reactions (mechanism of nitration, halogenation, sulphonation, mercuration and Friedel-Crafts reaction), addition reactions, oxidation reaction. Activating and deactivating substituents in benzene. Orientation. Ortho/para ratio.	16

Intended Outcome:

After studying this course students will able to:

i. Name simple and complex organic compounds of family alkane, alkene, alkyne, and aromatic compounds.
ii. Apply the concept of product analysis, intermediates, isotope effects kinetic and stereochemical studies to determine the reaction mechanism.
iii. Identify the reaction intermediates such as carbocation, carbanion, free radical, carbene, nitrene and arynes formed during a chemical reaction.
iv. Propose mechanism for aromatic electrophilic substitution reactions of aromatic compounds.
v. Design the mechanistic route for synthesis of various hydrocarbons
vi. Apply Huckel's rule to predict the aromaticity of organic compounds
vii. Synthesize derivatives of alkane, alkene, alkyne, and aromatic compounds

Reference Books

1. *Organic Chemistry*, I L Finar, Pearson Education, New Delhi
2. *Organic Chemistry*, Solomons and Fryhle, Wiley Student Edition, New Delhi.
3. *Organic Chemistry*, Morrison and Boyd, Pearson Education, New Delhi.

Text Book :

1. *Organic chemistry* (Vol. I)- S M Mukherji, S P Singh and R P Kapoor, New Age Publishers, New Delhi.
2. Advanced organic Chemistry, Jagdamba Singh and Jaya Singh, Pragati Publishers.

BCHC 1004: GENERAL CHEMISTRY-II

Credits: 04 **Semester II** **L–T–P : 3–2–0**

Objective: This course aims to expose the students to the general concepts of chemistry.

Module No.	Content	Teaching Hours (Approx.)
I	**IUPAC** Nomenclature of simple Organic (aliphatic and aromatic) Compounds **Organic Reaction Mechanisms I: Substitution Reactions** (Nucleophilic SN1 and SN2), free radical and electrophilic), addition reactions (electrophilic and free radical) and their mechanisms. Energy profile diagrams and transition state (general considerations). Elimination Reactions, Elimination versus substitution reactions. **Nuclear chemistry:-**Radioactivity: Types and properties of radiations (α, β, and γ rays), Fajan's Soddy group displacement law, rate of radioactivity decay, half life and average life. Artificial radioactivity, stability of nuclei with respect to proton-neutron ratio. Nuclear fusion & nuclear fission. Packing fraction. Carbon dating. Applications of radioactivity. Isotopes and Isobar. **Gaseous State:** Gas laws. Velocity of Gas, average velocity, root mean square velocity, and most probable velocity, Postulates of kinetic theory of gases, derivation of kinetic gas equation and explanation of gas laws from it, deviation of real gases from ideal behavior, van der Waals equation of states, isotherms of CO_2, critical constants and their calculations.	16
II	**Stereochemistry of Organic Compounds-I** Concept of isomerism. Types of isomerism, Configurational isomerism : Optical isomerism- elements of symmetry, molecular chirality, enantiomers, stereogenic centre, optical activity, properties of enantiomers, chiral molecules , diastereomers, threo and erythro diastereomers, meso compounds, Resolution of enantiomers, inversion, retention and racemisation. **Electrochemistry I:** Electrochemical Cells: Galvanic cells, reversible and irreversible cells, experimental determination of emf of a cell. Relation between free energy and emf of reversible cell. Standard hydrogen electrode. Single electrode potential (derivation of Nernst equation) and its measurement. Standard electrode potential. Calculation of emf of reversible cell from electrode potentials. Types of reversible electrodes, Concentration cells. **Chemical equilibrium:** Law of mass action, equilibrium constant, relation between K*p* & K*c*, Le Chatelier's principle (effect of concentration, temperature and pressure on equilibrium) **Acids and Bases:** Arrhenius, Brönsted-Lowry, Lewis acid-base concept, Pearson, HSAB concept.	16

Intended Outcome:

After studying this course students will able to:

i. Assign the Nomenclature of simple Organic (aliphatic and aromatic) Compounds

ii. Propose the mechanism for substitution, elimination and addition reactions.
iii. Differentiate SN1 and SN2, E1 and E2, SN and E reaction.
iv. Predict the absolute configuration of organic compounds
v. Derive Nernst equation, average velocity, root mean square velocity, and most probable velocity
vi. Evaluate packing fraction and proton-neutron ratio
vii. Apply Fajan's Soddy group displacement law to identify product in a radioactive change.
viii. Compute the emf of reversible cell from electrode potentials.

Reference Books/ Text Books :

1. Concise Inorganic Chemistry. J.D. Lee. ELBS. John Wiley.
2. Organic Chemistry. Morrison and Boyd, Prentice Hall.
3. Essentials of Physical Chemistry: Bahl & Tuli S.Chand & Co.
4. *Principles of Physical Chemistry:* Puri & Sharma Shobhanlal Nagin chand & Co

Text Books:

1. Introductory Chemistry by Nivaldo J. Tro, 5Th Edition, Pearson
2. Basic Chemistry by K.C. TimberLake, 4th Edition, Pearson.

BCHC 1902: CHEMISTRY LAB-II

Credits: 02 **Semester II** **L–T–P : 0–0–4**

Objective: This course aims to expose the students to impart hands on expertise on experiments.

1. i) To prepare a solution of N/20 potassium dichromate.

   ii) Find out the strength of given $K_2Cr_2O_7$ solution by titrating it against ferrous ammonium sulphate solution as standard solution and using potassium ferricyanide as an external indicator.
2. i) Prepare a standard solution of potassium dichromate of strength N/30 approximately.

   ii) Find out the strength of given potassium dichromate solution iodometrically by titrating it against hypo solution as an intermediate solution using starch as an internal indicator.
3. Find out the chloride ion content in the given water sample by titrating it against N/40 $AgNO_3$ solution using K_2CrO_4 as an internal indicator (Argentometric titration).
4. To determine temporary, permanent and total hardness in a given sample of water by titrating it against standard EDTA solution (N/20) using Eriochrome Black-T as an internal indicator.
5. To prepare Chrome alum $K_2SO_4Cr_2(SO_4)_3.24H_2O$.
6. To prepare Ferrous ammonium sulphate (Mohr`s salt) $FeSO_4.(NH_4)_2SO_4.\ 6H_2O$.
7. To prepare Tetra ammine copper (II) sulphate monohadrate $[Cu(NH_3)_4]SO_4.H_2O$.
8. To separate the metal ions by paper chromatography.
9. Identification of functional group in a given organic compound. (C=C, CHO, R-CO-R, -COOH, ester).
10. Identification of functional group in a given organic compound. (Phenol, alcohol, carbohydrate, $-NH_2$, $-NO_2$, amide).
11. To determine the relative surface tension of a given liquid with respect to water at room temperature by stalagmometer.

Intended Outcome:

After studying this course students will able to:

i. Prepare standard and working solutions used in an experiment.
ii. Synthesize Chrome alum, Ferrous ammonium sulphate and Tetra ammine copper(II) sulphate monohadrate.
iii. Analyze acid and basic radicals individually or in mixture.
iv. Separate the metal ions by paper chromatography
v. Identify functional group in a given organic compound
vi. Determine the relative surface tension of a given liquid with respect to water at room temperature by stalagmometer.
vii. Estimate the chloride ion content and hardness in a given sample of water.

Reference Books:

1. Practical Chemistry, Pandey O.P./ Bajpai D.N. & Giri S. S. Chand Limited
2. College Practical Chemistry, V K Ahluwalia, Sunita Dhingra, Sunita Dhingra, Universities Press, Hydrabad.
3. Practical Physical Chemistry, B. Viswanathan, P. S. Raghavan, Viva Books Private Limited.

BPHS 1006: ANCILLARY PHYSICS COURSE - II

Credits: 04 **Semester II** **L–T–P : 4–0–0**

Objective: This course aims to expose the students to the

Module No.	Content	Teaching Hours (Approx.)
I	**(Interference) :** Young's experiment, Coherent source, theory of interference fringes, Fresnel biprism, determination of wavelength, Newton's ring,Conditions for sustained interference, Theory of interference, Lloyd's mirror, Achromatic fringes. Interference in parallel and wedge shaped films, Colour of thin films. Newton's rings and Michelson interferometer and their applications. Multiple beam interference in parallel film and Fabry-Perot interferometer. .	16
II	**(Diffraction) :** Frenel's and Fraunhoffer diffraction,Zone plate, diffraction due to straight edge. Fraunhoffer diffraction due to single and double slits, Missing order in double slits and maximum number of order with gratting, plane transmission grating, angular half width of principal maxima Resolving and dispersive power of grating, telescope andMicroscope.	14
III	**(Polarization):** Polarized light and its mathematical representation, Production of polarized light by reflection,refraction and scattering. Polarization by double refraction and Huygen's theory, Nicol prism,Retardation plates, Production and analysis of circularly and elliptically polarized light. Opticalactivity and Fresnel's theory, Biquartz polarimeter.Basic concepts of Laser, Eisenstein's coefficient.	14

Intended Outcome:

After studying this course students will able to:

i. .

Reference Books/ Text Books

*****1. Physical Optics: B. K. Mathur and T. P. Pandya.
*2. A textbook of Optics: N. Subrahmanyam, Brijlal and M. N. Avadhanulu.
*3. Geometrical and Physical Optics: Longhurst.
*4. Introduction to Modern Optics: G. R. Fowels.
*5. Optics: P. K. Srivastav

BPHS 1806: PHYSICS LAB - II

Credits: 02 **Semester II** **L–T–P : 0–0–4**

Objective: This course aims to expose the students to the

1. Determination of Stefan's constant.
2. Determination of temperature coefficient of resistant of material of a given coil.
3. Determination of thermal conductivity of a card board by Lee's Disk method.
4. PN junction diode and Zener diode characteristics.
5. To draw input and output characteristic of p-n-p transistor.
6. Construction of two-input 'OR' and 'AND' gates using diode logic and preparation of their truth tables.
7. Determination of self inductance of a coil by Anderson's bridge.
8. Determination of focal length of combination of lenses and nodal distance using nodal slide assembly.
9. Determination of specific rotation of Cane Sugar by polarimeter.
10. Determination of Wave Length of sodium yellow line Fresnal's biprism.
11. Determination of Wave Length of Mercury Line by diffraction grating.
12. Determination of Wave Length of sodium yellow line by Newton's rings.
13. To determine Diameter/thickness of thin wire by diffraction method.
14. To determine the plank's constant by Wein's radiation formula using an LDR of Photo Cell.

Intended Outcome:

After studying this course students will able to:

i. .

Reference Books/ Text Books

1. Physical Optics: B. K. Mathur and T. P. Pandya.
2. Optics: P. K. Srivastav
3. B.Sc. Practical Physics, S. Chand & Company Ltd.
4. B.Sc Practical Physics, C.L.Arora, S. Chand & Company Ltd.
5. Practical Physics, R.K.Shukla and Anchal Srivastava, New Age International (P) Ltd.

BMAS 0505: STATISTICS AND NUMERICAL METHODS

Course Objectives: To make the students understand the concepts of statistics and numerical methods by giving more emphasis to their applications in chemistry.

Credits: 04 **Semester II** **L–T–P: 3–1–0**

Module No.	Contents	Teaching Hours (Approx.)
I	**Statistics I:** Importance of Statistics, Measures of central tendency and Dispersion, Moments, Skewness and Kurtosis by method of moments, Introduction to Probability, Addition and Multiplication theorems of probability. **Statistics II:** Binomial and Poisson distributions, Sampling, Statistical hypotheses, Level of significance, Student's t-test.	20
III	Chi-square test as a test of independence. Correlation and Regression between two variables, Fitting of straight line by method of least squares. **Numerical Methods:** Errors & its types, Bisection and Newton Raphson method, Finite differences, Missing term technique, Interpolation by Newton's forward and divided difference formulae, Numerical integration by trapezoidal and Simpson's rules.	20

Learning Outcomes:

After studying these topics, the student will be able to

- Fit the straight line to a given data and determine regression lines
- Know probability distributions and the characteristics of frequency distributions
- Solve the problems based on numerical integration
- Learn the concept of sampling and test the hypothesis by Student's t-test

Text Books:

- M. Goyal and N. P. Bali, A Text Book of Engineering Mathematics, Laxmi Publication, Delhi, 2014.
- S. C. Gupta and V. K. Kapoor, Fundamentals of Statistics, Sultan Chand & Sons, Delhi, 2014.

Reference Books:

- B. S. Grewal, Higher Engineering Mathematics, Khanna Publishers, New Delhi, 2014.
- G. C. Beri, Business Statistics, TMH, New Delhi, 2015.

BCSK 1006: INTRODUCTION TO PROGRAMMING

Credits: 03 **Semester II** **L–T–P : 3–0–0**

Objective: Students will get an insight of the fundamentals of Computer Programming, Problem solving using Computers.

Module No.	Content	Teaching Hours
I.	**Algorithm and flowchart:** Introduction, Features, symbols, sequential, conditional and iterative algorithms and flowcharts. **Basics of C:** Overview, Structure of a C program, Identifier, Keywords, Variables, Data types, Formatted Input and output. **Operators and Expression:** Assignment, Unary, Arithmetic, Relational, Logical, Bitwise, Conditional, Special operators and their precedence & Associativity.	9
II.	**Type Conversion:** Type Promotion in expression, Conversion by Assignment, Truncation and Casting Arithmetic expression. **Decision and Case Control Structure:** if, if-else, nested if-else, Decisions using switch, switch versus if-else ladder, goto. **Loop Control Structure:** For loop, while loop, do-while loop, nesting of loops, break, and continue. **Arrays:** Introduction, one dimensional and two dimensional Array, Declaration, Initialization.	9
III.	**Operations on Arrays**: Insertion, Deletion, Linear Search & Bubble Sort. **String:** Introduction, One dimensional and two dimensional Array - Declaration, Initialization **Operations on String:** Length, Copy, Reverse, Concatenate, Compare with & without built-in functions. **Functions:** function types, array passing to a function. **Introduction to storage class:** auto, register, static and extern in single file.	8

Intended Outcome:

After completion of course, the student will be able to:

- Familiar with the concepts related to structured programming constructs
- Design an algorithmic solution for a given problem and as well C program for a given algorithm.
- Demonstrate their knowledge of, and ability to apply, programming fundamentals in different programming languages.

Text Book:

- Yashavant P. Kanetkar, (2007), "Let us 'C'", BPB Publication, 8th edition.

Reference Books:

- Peter Vander Linden, Schaum's, "Outline of theory and problems of programming with C ," TMH.
- Balagurusamy E., "Computing Fundamentals and C Programming", TMH
- Vander Linden, "Expert C programming", PHI.

BCSO 0075: PROGRAMMING LAB
(Open Elective)

Credits: 01 **Semester II** **L–T–P : 0–0–2**

Objective: The objective is to provide a study of the C programming language.

Module No.	Content	Lab Hours
I	Introduction to Linux environment Basic programs using input/ output functions Operators, their precedence and associativity • Arithmetic Operators on Integers • Arithmetic Operators on Floating point numbers • Relational Operators • Ternary Operators • Formatted Input and Output Decision Control • if statement, else statement, if else if ladder, Switch-Case Statement Programming based on loops • for loop, while loop, do while loop, Nested loops Use of special control statement • break, continue Programming based on Array • One dimensional Array, Two dimensional Array Programming based on string • Programming based on functions	24

Outcome: On Completion of this course, students are able to:

- Write, compile and debug programs in C language.
- Use different data types in a computer program.
- Design programs involving decision structures, loops and functions.

BCHS 0201: ENVIRONMENTAL STUDIES

Credits: 02 **Semester III/IV** **L-T-P: 2-0-0**

Objective: *To create awareness towards various environmental issues like global warming, urbanization, pollutions, ozone layer depletion etc; their causes and remedial steps for protecting impacted society.*

Module No.	Content	Teaching Hours
I	**Basics of Environmental Studies**: Environmental Studies: Introduction, Scope and Importance Environment: Concept, Natural and Anthropogenic Environment Natural Environment: Structure & Function of Atmosphere, Hydrosphere, Lithosphere and Biosphere Ecology and Ecosystem: Definitions Types, Structure & Functions of Ecosystem. Natural Resources: Introduction, Classification, Concept of Conservation Present Status and related to Water Resources, Forest Resources and Mineral Resources.	9
II	**Current Environmental Problems:** Energy Resources: Introduction, Classification, Energy Use Patterns, Energy Crisis, Alternative Energy Resources Present Status and Major Issues Related to Fossil Fuels, Hydroelectricity, Nuclear Energy, Solar Energy and Biomass Energy. Effects of Human Activities on Environment: Effect of Agriculture, Housing, Mining, Transportation and Industries Environment Pollution: Causes, Effects and Control of Air Pollution, Water Pollution, Land Pollution and Noise Pollution Introduction and Management of Solid Wastes and Hazardous Wastes Global Environmental Challenges: Global Warming, Ozone Layer Depletion, Acid Rain, Urbanization, Overpopulation and Biodiversity Depletion.	9
III	**Environmental Protection:** Environmental Protection: Role of Citizens, Role of Government, Initiatives by NGOs, Contribution of International Agencies and Conventions Approaches to Environmental Protection: Public Awareness, Environmental Education, Environmental Ethics, Environmental Laws and Environmental Economics Tools and Strategies: Environmental Impact Assessment, Ecological Footprints and Sustainable Development Efforts towards Environmental Protection in India	8

Intended Outcomes

Students will be able

1. *To recognize the environmental issues pertaining to daily life; gain awareness for the need of environmental education for sustainable development.*
2. *To acquire knowledge in ecological perspective and value of environment, biotic components, ecosystem process: energy, food chain, water cycle etc.*
3. *To interpret water quality standards and parameters, assessment of water quality, air pollution, pollutants, acid rain, global climate change and green house gases.*
4. *To appreciate the concept of green energy and alternate energy resource for future energy demand.*
5. *To classify the variety of social issues associated with environmental deterioration involving human components including legislative tool such as population, ethics and urban settlements.*
6. *To contribute to create awareness among generation to come and society at large.*

Text Book:

- Deswal & Deswal, "**Environment and Ecology"** Dhanpat Rai & Co.

Reference Books:

- Benny Joseph, "**Environmental Studies"** Tata McGraw-Hill Education.
- AK De, "**Environmental Studies**" New Age International Publisher, New Delhi.
- Shashi K. Singh and Anisha Singh, "**Environmental Science & Ecology**" A.B. Publication.
- Agarwal and Sangal, "**Environment & Ecology.**" Krishna's Educational Publisher's Meerut

SEMESTER - III

BCHC 0005: PHYSICAL CHEMISTRY - II

Credits: 04 **Semester III** **L–T–P : 3–2–0**

Objective: This course aims to develop understanding and conceptual basis of Thermodynamics and Phase Equilibria.

Module No.	Content	Teaching Hours (Approx.)
I	**The First Law of Thermodynamics** The first law of thermodynamics, Internal energy, State functions, exact and inexact differentials, Euler reciprocal relation, The cyclic rule, Enthalpy, Heat capacity, Relation between Cp and Cv, Expansion of an ideal gas and changes in thermodynamic properties: (Isothermal expansion, Adiabatic expansion), Final temperatures in reversible and irreversible adiabatic expansions, Comparison of isothermal and adiabatic, Expansions, Reversible isothermal expansion of a real gas, Joule–Thomson effect, Joule–Thomson coefficient in an ideal gas Joule–Thomson coefficient in a real gas, Zeroeth law of thermodynamics, Absolute temperature scale. Change of internal energy in a chemical reaction, Change of enthalpy in a chemical reaction, Exothermic and endothermic reactions, Relation between heats of reaction at constant, volume and at constant pressure, Standard enthalpy changes of reactions, Determination of enthalpies of reactions**,** Variation of enthalpy of a reaction with temperature. The Kirchhoff equation**.**	16
II	**The Second Law of Thermodynamics** Limitations of the first law : Need for the second Law, Spontaneous or irreversible processes, Cyclic process, Carnot cycle, The second law of thermodynamics, Carnot theorem, Concept of entropy, Entropy change in an isothermal expansion of an ideal gas, Entropy changes in reversible and irreversible processes, Entropy changes accompanying changes of phase, Calculation of entropy changes of an ideal gas with change in *P*, *V* and *T*, Entropy of mixing of ideal gases Standard entropies Physical significance of entropy Work and free energy functions Variation of free energy with *T* and *P*, Maxwell's relations Criteria for reversible and irreversible processes. The Third Law of Thermodynamics.	16
III	**Phase Equilibria** Phase Components, Degree of freedom, Conditions for equilibrium between phases, The Gibbs phase rule, The Derivation of the phase rule One–component systems, Water system, Carbon dioxide system, Sulphur system, Two–component systems (Lead–silver system). Bismuth–cadmium system.	16

Intended Outcome:

After studying this course students will able to:

i. Derive the Relation for Cp and Cv, Joule–Thomson coefficient, Kirchhoff equation, phase rule etc.
ii. Understand the laws of thermodynamics and various phase systems.
iii. Calculate work of expansion, compression. entropy changes in reversible and irreversible processes and enthalpy of a reaction
iv. Apply Maxwell's relations and Criteria for reversible and irreversible processes.
v. Deduce laws of thermodynamics, Cyclic Rule, Carnot theorem and Gibbs phase rule
vi. Evaluate entropy change, enthalpy change, Gibb's free energy change in various theromodynamic process.

Reference Books:

1. *A text book of Physical Chemistry*: S. Glasstone McMillian

Text Book

1. *Essentials of Physical Chemistry*: Bahl & Tuli S.Chand & Co.
2. *Principles of Physical Chemistry*: Puri & Sharma Shobhanlal nagin chand & Co

BCHC 0006: ORGANIC CHEMISTRY - II

Credits: 04 **Semester III** **L–T–P : 3–2–0**

Objective: This course aims to provide the knowledge and base of general organic chemistry and application in cyclic organic compounds, organic compounds of halogen, O, S and N.

Module No.	Content	Teaching Hours (Approx.)
I	**Cycloalkane;** Nomenclature of Cycloalkanes, Bicyclic Compounds, Nomenclature of Bicyclic Compounds, Synthesis of Cycloalkanes, Physical Properties of Cycloalkanes, Reaction of Cycloalkanes, Cyclopropane: Bent or Banana Bonds, Cycloalkanes: Ring Strain, Baeyer-Strain Theory Conformation analysis of alkanes: Relative stability: Energy diagrams of cyclohexane: Chair, Boat and Twist boat forms; Relative stability with energy diagrams. **Cycloalkenes**, Methods of Preparation of Cycloalkenes, Conformation of Cycloalkenes, Chemical Reactions of Cycloalkenes. **Dienes:** Nomenclature and Classification, Methods of Preparation of Conjugated Dienes, Structure and Stability of 1, 3-butadiene, Chemical Reactions of Dienes	16
II	**Alkyl halides and Aryl halides:** Preparation, including preparation from diazonium salts. nucleophilic aromatic substitution; SNAr, Benzyne mechanism Relative reactivity of Alkyl, allyl/benzyl, vinyl and aryl halides towards nucleophilic substitution reactions. Organometallic compounds of Mg and Li – Use in synthesis of organic compounds. **Sulphur containing compounds:** Preparation and reactions of thiols, thioethers and sulphonic acids.	16
III	**Alchols, Phenols, Ethers and epoxide:** **Alcohols:** Naming, preparation, properties and relative reactivity of 1^0, 2^0, 3^0 alcohols, Bouvaelt-Blanc Reduction; Preparation and properties of glycols: Oxidation by periodic acid and lead tetraacetate, Pinacol- Pinacolone rearrangement; **Phenols:** Preparation and properties; Acidity and factors effecting it, Ring substitution reactions, Reimer – Tiemann and Kolbe's – Schmidt Reactions, Fries and Claisen rearrangements with mechanism; **Ethers and Epoxides:** Preparation and reactions with acids. Reactions of epoxides with alcohols,ammonia derivatives and LiAlH4	16

Intended Outcome:

After studying this course students will able to:

i. Name, simple or complex cycloalkane, Cycloalkane dienes, alkyhalide, and containing compounds.
ii. Draw conformations of Cycloalkanes
iii. Cyclic organic compounds, alkyl and anzl halidz, 0 and s –containing compounds.
iv. Propose Mechanism for organic reactions.
v. Design the mechanistic route for working of oxidizing and reducing agent.

Reference Books

1. *Organic Chemistry*, I L Finar, Pearson Education, New Delhi
2. *Organic Chemistry*, Solomons and Fryhle, Wiley Student Edition, New Delhi.
3. *Organic Chemistry*, Morrison and Boyd, Pearson Education, New Delhi.

Text Book :

1. Organic chemistry (Vol. I)- S M Mukherji, S P Singh and R P Kapoor, New Age Publishers, New Delhi.
2. Advanced organic Chemistry, Jagdamba Singh and Jaya Singh, Pragati Publishers.

BCHC 0007: INORGANIC CHEMISTRY - I

Credits: 04 **Semester III** **L–T–P : 3–2–0**

Objective: This course aims to build fundamental of chemistry of s, p and d block elements.

Module No.	Content	Teaching Hours (Approx.)
I	**Chemistry of s-block elements:** The general trends in the chemistry of s-block elements; describe the trends in physical and chemical properties of group 1 & 2 elements. Anomalous behavior of Li and Be. Manufacturing process, properties and industrial applications of sodium and calcium compounds– NaOH, Na_2CO_3, $NaHCO_3$, $CaCO_3$, $Ca(OH)_2$, Plaster of Paris, Portland Cement and Microcosmic salt. Biological significance of Na, K, Ca and Mg elements.	16
II	**Chemistry of p-block elements:** The general trends in the chemistry of p-block elements; describe the trends in physical and chemical properties of group 13-17 elements, Anomalous behavior of boron. Allotropes of carbon. a) Group trends with reference to electronic configuration, size, and oxidation states and in compounds such as hydrides, oxides, oxyacids, halides and complexes. b) Preparation, properties, bonding, stereochemistry and uses of following except where specific aspects are mentioned- i) Borax, Orthoboric acid, Diboranes and Boron nitrides its oxidizing behaviour. ii) CO, SiO_2, Silicones, Silicates, Zeolites. iii) Hydrazine, hydroxylamine and hydrazoic acid, phosphazenes. iv) Peracids of sulphur and halogens and their applications.	16
III	**Chemistry of Elements of First Transition Series:** General characteristic properties of 3d series elements – ionic radii, oxidation states, complexation tendency, magnetic behavior and electronic spectral properties. Binary compounds (hydrides, carbides and oxides) of the elements of the first transition series and complexes with respect to relative stability of their oxidation states, coordination number and geometry. **Chemistry of Elements of Second and Third Transition Series** General characteristics, comparative treatment, spectral properties and stereochemistry	16

Intended Outcome:

After studying this course students will able to:

i. Understand the general trends of periodic properties of s, p, and d block elements.
ii. Identify the applications of compounds of s, p, and d block elements.
iii. Predict the hybridization, shapes and structure of oxides, oxy acids, halides, silicates and other inorganic compounds of s, p, and d block elements
iv. Compare the trends of properties of first, second and third transition series.
v. Predict the magnetic behavior of compounds of 3d, 4d and 5d series.
vi. Highlight the anomalous behavior of elements of s, p, and d block elements
vii. Synthesize inorganic compounds of s, p, and d block elements.

Reference Books:

1. *Concise Inorganic Chemistry* J. D. Lee, 5th Edition (1996), Chapman & Hall, London.
2. *Selected Topics in Inorganic Chemistry* Wahid U. Malik, G. D. Tuli, R. D. Madan, Publisher, S. Chand, 2006.
3. *Inorganic Chemistry* Puri Sharma & kalia S.Chand & Co.

Text Books :

1. *Modern Inorganic Chemistry* R. C. Aggarwal ,1st Edition (1987), Kitab Mahal, Allahabad.
2. *Basic Inorganic Chemistry*, F. A. Cotton, G. Wilkinson, and Paul L. Gaus, 3rd Edition (1995) Wiley.
3. *Advance Inorganic Chemistry* Vol I & II by Gurdeep Raj Krishna Publications media (P) Ltd.

BCHE 0001: ANALYTICAL CHEMISTRY - I

Credits: 04 **Semester III** **L–T–P : 3–2–0**

Objective: to provide the basis of theory, principle and applications of analytical techniques.

Module No.	Content	Teaching Hours (Approx.)
I	**Theory of Volumetric and Gravimetric Analysis** Introduction, Titrimetric analysis, classifications of reactions in titrimetric analysis, standard solutions, preparation of standard solutions, primary and secondary standards, Indicators, theory of indicators, Acid–base titrations in non-aqueous media, Redox titrations **Gravimetric Analysis**, Impurities in precipitates, Gravimetric calculations, precipitation equilibria (Solubility product, common ion effect, stoichiometry), organic precipitation	16
II	**Complexometric equilibria** Introduction, Titration curves, Types of EDTA titrations, Methods of End Point Detection: a)Indicators (b) Instrumental methods of End point detection (Spectrophotometric, Amperometric, Potentiometric, High frequency titrator), Types of Complexometric Titrations (a) Direct Titration (b) Back Titration (c) Replacement titration (d) Indirect Titration (e) Applications of Complexometric Titrations	16
III	**Distillation:** Basic principle, types (continuous, batch, vacuum, steam, and fractional distillation) and applications. **Solvent extraction techniques:** Basic principles, different types of extraction, selection of solvents avoiding emulsion formation.	16

Intended Outcome:

After studying this course students will able to:

i. Understand theory and principles of volumetric, gravimetric and complexometric analysis
ii. Prepare the standard and working solutions for different analysis.
iii. Analyze the data of volumetric and gravimetric**,** complexometric titrations
iv. Draw the titration curves obtained from different analytical procedures
v. Apply the principle of distillation in analytical methods
vi. Extract the solvent using Solvent extraction techniques for the synthesis of organic and inorganic compounds.

Reference Books:

1. R. L. Pecsok, L. D. Shields, T. Cairns and L.C. McWilliam, Modern Methods of Chemical Analysis, (1976), John Wiley & Sons, New York.
2. D. A. Skoog, Principles of Instrumental Analysis, 5th Edition (1998), Saunders College of Publishing, Philadelphia, London.
3. H. A. Strobel, Chemical Instrumentation: A Schematic Approach, 2nd Edition (1973), Addison Wesley, Reading, Mass.

Text Books

1. D. A. Skoog and D. M. West, Fundamental of Analytical Chemistry, 7th Edition (1996), Saunders College Publishing, Philadelphia, Holt, London.
2. Analytical chemistry, G. D. Christian, Sixth Edition, Wiley publications

BCHC0903: CHEMISTRY LAB - III

(PHYSICAL 1)

Credits: 02 **Semester III** **L–T–P : 0–0–4**

Objective: This course aims to have practical exposure and hand on expertise on experiments of physical chemistry.

(A) Acid- Base Titrations

(i) **a.** Preparation of samples

b. Estimation of carbonate and hydroxide present together in mixture.

(ii) **a**. Preparation of samples

b. Estimation of carbonate and bicarbonate present together in a mixture.

(iii) **a.** Preparation of samples

b. Estimation of free alkali present in different soaps/detergents

(B) Oxidation- Reduction Titrimetry

(i) **a.** Standardization of $KMnO_4$ solution

b. Estimation of Fe(II) and oxalic acid using standardized KMnO4 solution.

(ii) **a.** Standardization of NaOH solution

b. Estimation of oxalic acid and sodium oxalate in a given mixture.

(iii) **a.** Preparation and Standardization of $K_2Cr_2O_7$

b. Estimation of Fe (II) with $K_2Cr_2O_7$ using diphenylamine as internal indicator

(iv) **a.** Preparation and Standardization of $K_2Cr_2O_7$

b. Estimation of Fe (II) with $K_2Cr_2O_7$ using anthranilic acid as internal indicator

(v) **a.** Preparation and Standardization of $K_2Cr_2O_7$

b. Estimation of Fe (II) with $K_2Cr_2O_7$ using external indicator.

(C) 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.

(D) **Argentometric titrations**

Estimation of Cl^- (i) By Mohr's method, (ii) By Vohlard's method, (iii) By Fajan's method.

NOTE: All the safety measures or steps for the all the respective experiments must be taken care strictly

Intended Outcome:

After studying this course students will able to:

i. Prepare standard and working solutions used in an experiment.
ii. Estimate the carbonate, bi-carbonate and hydroxide ion in a given sample.
iii. Determine the ferrous ion using redox titrimetry.
iv. Quantify copper, arsenite and antimony using Iodo / Iodimetric Titrations
v. Evaluate Cl^- by Mohr's method, Vohlard's method and Fajan's method

Reference text:

1. Vogel, A.I. A Textbook of Quantitative Inorganic Analysis, ELBS.
2. Practical Chemistry, Pandey O.P./ Bajpai D.N. & Giri S. S. Chand Limited
3. College Practical Chemistry, V K Ahluwalia, Sunita Dhingra, Sunita Dhingra, Universities Press, Hydrabad.
4. Practical Physical Chemistry, B. Viswanathan, P. S. Raghavan, Viva Books Private Limited.

BCHC0904: CHEMISTRY LAB - IV

Credits: 02 **Semester III** **L–T–P : 0–0–4**

Objective: This course aims to have practical exposure and hand on expertise on experiments of organic chemistry.

1. **a.** Checking the calibration of the thermometer
   b. determine the melting point of few organic compounds
2. Purification of organic compounds by crystallization using the following solvents:
   a. Water
   b. Alcohol
   c. Alcohol-Water
3. **a.** Determination of the melting points of above compounds and unknown organic compounds using Kjeldahl method.
   b. Determination of the melting points of above compounds and unknown organic compounds using electrically heated melting point apparatus
4. Effect of impurities on the melting point – mixed melting point of two unknown organic compounds
5. Determination of boiling point of liquid compounds. (Boiling point lower than and more than 100° C by distillation and capillary method)
6. Chromatography

a. i) Preparation of samples
   ii) Separation of a mixture of two amino acids by ascending and horizontal paper chromatography

b. i) Preparation of samples
   ii) Separation of a mixture of two sugars by ascending paper chromatography

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

d. i) Preparation of sugar solution
   ii) identification of the monosaccharides present in the given mixture
   iii) Separation of monosaccharides present in the given mixture (glucose & fructose) by paper chromatography. Report the Rf values.

NOTE: All the safety measures or steps for the all the respective experiments must be taken care strictly

Intended Outcome:

After studying this course students will able to:

i. Check the calibration of the thermometer to determine the melting point of organic compounds
ii. Determine of the melting points using Kjeldahl method and boiling point of liquid compounds by distillation and capillary method
iii. Prepare standard and working solutions used in paper chromatography.
iv. Separate mixture of organic compunds by paper chromatography

Reference text:

1. Vogel, A.I. A Textbook of Practical Organic Chemistry.
2. Practical Chemistry, Pandey O.P./ Bajpai D.N. & Giri S. S. Chand Limited
3. College Practical Chemistry, V K Ahluwalia, Sunita Dhingra, Sunita Dhingra, Universities Press, Hydrabad.

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BCHC0905: CHEMISTRY LAB - V

(Inorganic 1)

Credits: 02 **Semester III** **L–T–P : 0–0–4**

Objective: This course aims to have practical exposure and hand on expertise on experiments of inorganic chemistry.

Inorganic preparations:

(i) **a.** Preparation of Cuprous Chloride, Cu_2Cl_2
b. Re-crystallization of prepared compounds
(ii) **a.** Preparation of Manganese (III) phosphate, $MnPO_4.H_2O$
b. Re-crystallization of prepared compounds
(iii) **a.** Preparation of Aluminium Potassium sulphate $KAl(SO_4)_2.12H_2O$ (Potash alum)
b. Re-crystallization of prepared compounds
(iv) a. Preparation of Chrome alum
b. Re-crystallization of prepared compounds

Complexometric Titrations

i. **a.** Complexometric estimation of Mg^{2+} using EDTA
b. Complexometric estimation of Zn^{2+} using EDTA
ii. **a.** Standardization of EDTA solution
b. Estimation of total hardnesss of water samples
iii. **a.** Standardization of EDTA solution
b. Estimation of Ca^{2+} in solution by (substitution method) using EBT as indicator
iv**) a.** Standardization of EDTA solution
b. Estimation of Ca/Mg in drugs and Biological samples

Paper Chromatographic: separation of Ni (II) and Co(II); Cu(II) and Cd (II)C

NOTE: All the safety measures or steps for the all the respective experiments must be taken care strictly

Intended Outcome:

After studying this course students will able to:

i. Check the calibration of the thermometer to determine the melting point of organic compounds
ii. Determine of the melting points using Kjeldahl method and boiling point of liquid compounds by distillation and capillary method
iii. Prepare Cu2Cl2, MnPO4.H2O, Potash alum, Chrome alum
iv. Separate mixture of inorganic salts by paper chromatography
v. Estimate Ca/Mg in drugs and Biological samples, hardness of water, Zn^{2+} in a given sample.

Reference/text books:

1. Vogel, A.I. A Textbook of Quantitative Inorganic Analysis, ELBS
2. Practical Chemistry, Pandey O.P./ Bajpai D.N. & Giri S. S. Chand Limited
3. College Practical Chemistry, V K Ahluwalia, Sunita Dhingra, Sunita Dhingra, Universities Press, Hydrabad.

SEMESTER - IV

BCHC 0008: PHYSICAL CHEMISTRY – III

Credits: 04 **Semester IV** **L–T–P : 3–2–0**

Objective: This course aims to develop understanding and conceptual basis of Electrochemistry and Solid State.

Module No.	Content	Teaching Hours (Approx.)
I	**Electrochemistry Part I: Introduction (**Electrolytic conductance, Specific conductance, Equivalent conductance, Molar conductance, Variation of molar conductance with dilution, Ionic mobility), Hittorf's theoretical device, Transport number, Determination of transport numbers, Hittorf's method, Moving boundary method, Kohlrausch's law, Calculation of molar ionic conductance, Relation between molar Ionic conductance and ionic mobility, Determination of ionic mobility, Applications of Kohlrausch's law, Diffusion and ionic mobility, Applications of conductance measurements, Conductometric titrations, Precipitation titrations, Ostwald's dilution law, Debye–Hückel theory of strong electrolytes.	16
II	**Electrochemistry Part II:** Concentration cells- Electrode and Electrolyte–concentration cells, Types of electrolyte concentration cells, Concentration cells without transference, Concentration cells with transference, Liquid junction potential, Fuel cells. Applications of EMF measurements.	16
III	**The Solid State:** Difference between crystalline and amorphous, solids, Symmetry in crystal systems, Point groups and space groups, Space lattice and the unit cell, Bravais lattices, Seven crystal systems, Lattice energy of an ionic crystal, Law of rational indices, Miller indices, Interplanar spacing in a crystal system, X–ray diffraction, The Bragg equation, Imperfections in a crystal, Point defects, Schottky defects, Frenkel defects, Colour centres, Line defects: Dislocations, Imperfections due to transient atomic displacement.	16

Intended Outcome:

After studying this course students will able to:

i. Determine the Electrolytic conductance, Specific conductance, Equivalent conductance, Molar conductance, Variation of molar conductance with dilution, Ionic mobility and transport numbers etc.
ii. Derive the expression for Ionic conductance and ionic mobility.
iii. Understand the Debye–Hückel theory of strong electrolytes.
iv. Identify the point groups, space groups, space lattice, unit cell, Bravais lattices and seven crystal systems
v. Calculate Miller indices and Interplanar spacing in a crystal system
vi. Deduce Kohlrausch's law, Ostwald's dilution law, Law of rational indices

Reference Books:

1. *A text book of Physical Chemistry*: S. Glasstone McMillian

Text Book

1. *Essentials of Physical Chemistry*: Bahl & Tuli S.Chand & Co.
2. *Principles of Physical Chemistry*: Puri & Sharma Shobhanlal nagin chand & Co

BCHC 0009: ORGANIC CHEMISTRY – III

Credits: 04 **Semester IV** **L–T–P : 3–2–0**

Objective: To impart fundamental and applications of Carbonyl and Nitrogen Containing Compounds.

Module No.	Content	Teaching Hours (Approx.)
I	**Carbonyl Compounds:** Naming, Structure, reactivity and preparation; Nucleophilic additions, Nucleophilic addition-elimination reactions with ammonia derivatives with mechanism; Mechanisms of Aldol and Benzoin condensation, Knoevenagel condensation, Claisan-Schmidt, Perkin, Cannizzaro and Wittig reaction, Beckmann and Benzil-Benzilic acid rearrangements, haloform reaction and Baeyer Villiger oxidation, α-substitution reactions, oxidations and reductions (Clemmensen, Wolff-Kishner, LiAlH4, NaBH4, MPV, PDC and PGC); Addition reactions of unsaturated carbonyl compounds: Michael addition. **Active methylene compounds:** Keto-enol tautomerism. Preparation and synthetic applications of diethyl malonate and ethyl acetoacetate:	16
II	**Carboxylic Acids and their Derivatives:** Naming, 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; Comparative study of nucleophilic sustitution at acyl group - Mechanism of acidic and alkaline hydrolysis of esters, Claisen condensation, Dieckmann and Reformatsky reactions, Hofmann-bromamide degradation and Curtius rearrangement	16
III	**Nitrogen Containing Functional Groups:** Naming, Preparation and important reactions of nitro and compounds, nitriles and isonitriles Amines: Effect of substituent and solvent on basicity; Preparation and properties: Gabriel phthalimide synthesis, Carbylamine reaction, Mannich reaction, Hoffmann's exhaustive methylation, Hofmann-elimination reaction; Distinction between 1^0, 2^0 and 3^0 amines with Hinsberg reagent and nitrous acid; Diazonium Salts: Preparation and their synthetic applications.	16

Intended Outcome:

After studying this course students will able to:

i. Name simple and complex organic compounds containing carbonyl groups.
ii. Apply various reactions such as condensation, oxidation and reduction to design new organic compounds.
iii. Propose mechanism for synthetic routes for various organic compounds.
iv. Design the synthesis of O- and N- containing organic compounds
v. Differentiate 1^0, 2^0 and 3^0 amines and alcohols
vi. Identify the name of a reaction and its mechanistic routes.

Reference Books

1. *Organic Chemistry*, I L Finar, Pearson Education, New Delhi
2. *Organic Chemistry*, Solomons and Fryhle, Wiley Student Edition, New Delhi.
3. *Organic Chemistry*, Morrison and Boyd, Pearson Education, New Delhi.

Text Book :

1. Organic chemistry (Vol. I)- S M Mukherji, S P Singh and R P Kapoor, New Age Publishers, New Delhi.
2. Advanced organic Chemistry, Jagdamba Singh and Jaya Singh, Pragati Publishers.

BCHC 0010: INORGANIC CHEMISTRY – II

Credits: 04 **Semester IV** **L–T–P : 3–2–0**

Objective: To impart fundamental and applications of Coordination Chemistry, Lanthanoids & actinoids and Bioinorganic Chemistry.

Module No.	Content	Teaching Hours (Approx.)
I	**Coordination Chemistry** Werner's theory, valence bond theory (inner and outer orbital complexes), Electro-neutrality 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, IUPAC nomenclature of coordination compounds, isomerism in coordination compounds. Optical activity of metal complexes and complexes with chiral ligands. Circular dichroism and optical rotarory dispersion spectra of the metal complexes. Chelate effect, polynuclear complexes, Labile and inert complexes.	16
II	**Lanthanoids and actinoids**: electronic configuration, oxidation states, colour, spectral and magnetic properties, lanthanide contraction, separation of lanthanides (ion-exchange method only). **Theoretical principles:** Theoretical principles and chemistry involved in qualitative analysis of mixture of cations and anions including interfering and insolubles.	16
III	**Bioinorganic Chemistry:** Metal ions present in biological systems, classification of elements according to their action in biological system. Geochemical effect on the distribution of metals. Sodium / K-pump, carbonic anhydrase and carboxypeptidase. Excess and deficiency of some trace metals. Toxicity of metal ions (Hg, Pb, Cd and As), reasons for toxicity, Use of chelating agents in medicine. Iron and its application in bio-systems.	16

Intended Outcome:

After studying this course students will able to:

i. Understand the crystal properties, Δo, Δt, size effect of CFSE for coordination complexes.
ii. Differentiate inner and outer sphere coordination complexes.
iii. Assign IUPAC nomenclature of coordination compounds
iv. Predict the nature, optical and spectral properties of coordination compounds
v. Highlight the chemistry of Lanthanoids and actinoids in terms of electronic, magnetic and spectral properties.
vi. Analyze the mixture of cation and anion in organic salt.
vii. Identify the toxicity and use of heavy metals.
viii. Classify the elements in biological system.

Reference Books:

1. *Concise Inorganic Chemistry* J. D. Lee, 5th Edition (1996), Chapman & Hall, London.
2. *Selected Topics in Inorganic Chemistry* Wahid U. Malik, G. D. Tuli, R. D. Madan, Publisher, S. Chand, 2006.
3. *Inorganic Chemistry* Puri Sharma & kalia S.Chand & Co.

Text Books :

1. *Modern Inorganic Chemistry* R. C. Aggarwal ,1st Edition (1987), Kitab Mahal, Allahabad.
2. *Basic Inorganic Chemistry*, F. A. Cotton, G. Wilkinson, and Paul L. Gaus, 3rd Edition (1995) Wiley.
3. *Advance Inorganic Chemistry* Vol I & II by Gurdeep Raj Krishna Publications media (P) Ltd.

BCHE 0002: ANALYTICAL CHEMISTRY - II

Credits: 04 **Semester IV** **L–T–P : 3–2–0**

Objective: To impart fundamental and applications of various spectroscopy techniques like UV-VIS, IR, NMR and MS.

Module No.	Content	Teaching Hours (Approx.)
I	**Spectroscopy Introduction:** Electromagnetic radiation, regions of spectrum, Basic features of spectroscopy. **UV-Vis Spectroscopy/spectrophotometry** Introduction, Principle & theory of UV-Vis spectroscopy, Instrumentation of UV-Visible Spectro-photometer. Absorption laws (Beer-Lambert law), molar absorptivity, presentation and analysis of UV spectra, types of electronic transitions, effect of conjugation, Solvent effect. Concept of chromophore and auxochrome. Woodward-Fieser rules, calculation of λmax of simple conjugated dienes and α,β-unsaturated ketones. Applications of UV Spectroscopy in structure elucidation of simple organic compounds. **Infrared (IR) absorption spectroscopy:** Principle, theory and Instrumentation of FT-IR spectrophotometer. Molecular vibrations, Hooke's law, Degrees of freedom.	16
II	**NMR Spectroscopy:** Principle of nuclear magnetic resonance, Interpretation of the NMR spectrum (number of signals, peak areas, equivalent and nonequivalent protons positions of signals and chemical shift, shielding and deshielding of protons, proton counting, splitting of signals and coupling constants, magnetic equivalence of protons). Discussion of PMR spectra of simple and complex organic molecules Simple problems on PMR spectroscopy for structure determination of organic compounds. ^{13}C, ^{15}P, ^{19}F NMR Spectroscopy applications. Nuclear Overhauser Experiment.	16
III	**Mass Spectrometry** Introduction – basic theory, instrumentation, process of introducing the sample into mass spectrometer. Methods of generation of positively charged ions, electron ionization method, chemical ionization, FD and fast atom bombardment (FAB) techniques. Mass spectrum, base peak, molecular and parent ion, Mass to charge ratio (M/Z), relative intensity, fragment ions, even electron rule, nitrogen rule, matastable ions, McLafferty rearrangement and ortho effect. Application in structure Elucidation of Organic compounds, Determination of molecular weight and molecular formula using mass spectrometry	16

Intended Outcome:

After studying this course students will able to:

i. Understand the theory and principle of various spectroscopic techniques such as UV-VIS, IR, NMR and MS.
ii. Apply Woodward-Fieser rules to calculate of λmax of organic compounds .
iii. Elucidate the structure of organic compounds Interpret the spectra obtained in various spectroscopic techniques such as UV-VIS, IR, NMR and MS.
iv. Predict the no. of signals in NMR Spectra, no. of vibration in IR Spectra, molecular ion and other fragmented ions in MS spectra.
v. Determine molecular weight and molecular formula using mass spectrometry

Reference /Text Books:

1. Introduction to Spectroscopy by Donald L. Pavia, Cengage Publications.
2. Elementary Organic Spectroscopy by YR Sharma, S. Chand Publications.

BCHE 0005: FUEL CELL TECHNOLOGY

Credits: 04 **Semester IV** **L–T–P : 3–2–0**

Objective: This course aims to develop basic and advanced knowledge of fuel cell technology.

Module No.	Content	Teaching Hours (Approx.)
I	Overview of fuel cells: Basic Chemistry of Fuel Cells, Low and high temperature fuel cells, anode and cathode reactions , Oxidation reduction reaction, Hydrogen oxidation, Methanol oxidation, Methanol tolerance and its importance. Fuel cell thermodynamics - heat, work potentials, prediction of reversible voltage, fuel cell efficiency. Two and four electron process. and mechanism	16
II	Fuel cell reaction kinetics - electrode kinetics, overvoltages, Tafel equation, charge transfer reaction, exchange currents, electrocatalysis - design, activation kinetics, Fuel cell charge a n d mass transport - flow field, transport in electrode and electrolyte. Rotating disk electrocatalysis, rotating ring electrode disk electrocatalysis and their chemistry.	16
III	Balance of plant; Hydrogen production from renewable sources and storage; safety issues, cost expectation and life cycle analysis of fuel cells. Recent advances and challenges in fuel cell research and a directional material designs.	16

Intended Outcome:

After studying this course students will able to:

i. Understand the theory and principle of fuel cells.
ii. Design the mechanism for electrode reactions in fuel cells.
iii. Predict fuel cell efficiency, heat energy, Gibbs free energy of fuel cells.
iv. Draw the core structure of hydrogen plant as a renewable source of energy.
v. Design and develop the electrode material for fuel cells.
vi. Investigate the kinetics of electrode reactions in fuel cells

Reference Books/

1. Fuel Cell Systems Explained, J. Larminie and A. Dicks (John Wiley & Sons, 2003, USA)
2. Fuel Cell Engines, M. M. Mench (John Wiley and Sons, 2008, USA)
3. Principles of Fuel Cells, X. Li (CRC Press, 2005, USA)

Text Books:

1. Concise Inorganic Chemistry. J.D. Lee. ELBS. John Wiley.
2. Fuel Cell Fundamentals, R. O'Hayre, S-W. Cha, W. Colella, F. B. Prinz (John Wiley and Sons, 2005, USA)
3. Fuel Cells: Principles and Applications, B. Viswanathan and M. A. Scibioh (Universities Press, 2006, India)
4. Fuel Cells: From Fundamental to Applications, S. Srinivasan (Springer, 2006, USA)

BCHC 0906: CHEMISTRY LAB - VI

(Physical 2)

Credits: 02 **Semester IV** **L–T–P : 0–0–4**

Objective: This course aims to have practical exposure and hand on expertise on experiments of physical chemistry.

I. To study changes in conductance in the following systems

(i) **a.** Preparation of stock solution

b. Conductometric measurement of mixture of strong acid-strong base

(ii) **a.** Preparation of stock solution

b. Conductometric measurement of mixture of weak acid-strong base

(iii) **a.** Preparation of stock solution

b. Conductometric measurement of mixture of strong acid and weak acid-strong base

II. 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, volumetrically or conductometrically.

(b) Iodide-persulphate reaction

(c) Saponification of ethyl acetate.

NOTE: All the safety measures or steps for the all the respective experiments must be taken care strictly

Intended Outcome:

After studying this course students will able to:

i. Verify Initial rate method and Integrated rate method volumetrically or conductometrically
ii. Determine of the melting points using Kjeldahl method and boiling point of liquid compounds by distillation and capillary method
iii. Prepare standard and working solutions for titrimetric analysis.
iv. Estimate the concentration of acid or base using conductometric titration

Reference / Text books:

1. Practical Physical Chemistry by Amita Dua, Ane Books India.
2. Practical Physical Chemistry. Sixth edition (Findlay, Alexander)
3. Vogel, A.I. A Textbook of Quantitative Inorganic Analysis, ELBS
4. Practical Chemistry, Pandey O.P./ Bajpai D.N. & Giri S. S. Chand Limited
5. College Practical Chemistry, V K Ahluwalia, Sunita Dhingra, Sunita Dhingra, Universities Press, Hydrabad.

BCHC 0907: CHEMISTRY LAB - VII

(Organic -2)

Credits: 02 **Semester IV** **L–T–P : 0–0–4**

Objective: To provide practical exposure and hand on expertise on experiments of organic chemistry.

1. Systematic analysis of extra elements in the given unknown compounds
2. Tests for functional groups and unsaturation
3. Qualitative analysis of the following types of unknown organic compounds:

   Carboxylic acids, Phenols, Alcohols, Aldehydes, Ketones, Esters

Organic Preparations **(**Conventional and green synthesis**)**

1. Diels-Alder reaction between anthracene and maleic anhydride
2. Reduction: nitrobenzene to azobenzene (TLC of the mixture), m-dinitrobenzene to m-nitroaniline
3. S-benzylisothiuranum salts of any one water soluble and one water insoluble acid: acetic acid, phenyl acetic acid, oxalic acid, benzoic acid, phthalic acid
4. Green method of reduction of benzophenone to benzopinacol
5. Benzoin condensation of benzaldehyde (using thiamine hydrochloride)
6. Sovent less condensation of p-toluidine with benzaldehyde/salicylaldehyde/2-hydroxy-3-methoxy benzadehyde to get Schiff's base (solventless condensation)
7. Nitration and acylation of aromatic compounds

NOTE: All the safety measures or steps for all the respective experiments must be taken care of strictly.

Intended Outcome:

After studying this course students will able to:

i. Detect extra elements in given unknown compounds
ii. Testify functional groups and unsaturation present in unknown compounds
iii. Analyze unknown organic compounds like Carboxylic acids, Phenols, Alcohols, Aldehydes, Ketones, Esters
iv. Synthesize Nitro and acylated derivatives of aromatic compounds
v. Carry out conventional and green synthesis of organic compounds

Reference/text books:

1. Vogel, A.I. A Textbook of Quantitative Inorganic Analysis, ELBS
2. Practical Chemistry, Pandey O.P./ Bajpai D.N. & Giri S. S. Chand Limited
3. College Practical Chemistry, V K Ahluwalia, Sunita Dhingra, Sunita Dhingra, Universities Press, Hydrabad.

BCHC 0908: CHEMISTRY LAB - VIII

(Inorganic 2)

Credits: 02 **Semester IV** **L–T–P : 0–0–4**

Objective: To provide practical exposure and hand on expertise on experiments of inorganic chemistry.

Qualitative analysis:

Using H_2S /PTC/ Thioacetamide or any other reagent. Identification of cations and simple anions in a mixture of salts containing not more than six ions (Three cations and three anions) interfering anions using semi-micro scheme of analysis. If combination of cations or anions is given in the mixture, insoluble should be avoided. Spot tests should be carried out for final identifications wherever feasible.

Cation : Pb^{2+}, Bi^{3+}, Cu^{2+}, Cd^{2+}, As^{3+}, Sb^{3+}, Sn^{2+} or Sn^{4+}, Fe^{2+} OR Fe^{3+}, Al^{3+}, Cr^{3+},Co^{2+}, Ni^{2+}, Zn^{2+}, Mn^{2+}, Ba^{2+}, Sr^{2+}, Ca^{2+}, Mg^{2+}, NH_4^+, K^+

Anion : CO_3^{2-}, SO_3^{2-}, SO_3^{2-}, S^{2-}, $NO2^-$, CH_3COO^-, NO_3^-, Cl^-, Br^-, I^-, SO_4^{2-}, PO_4^{3-}, BO_3^{3-}, F^-, $C_2O_2^{-4}$

NOTE: All the safety measures or steps for all the respective experiments must be taken care of strictly.

Intended Outcome:

After studying this course students will able to:

i. Identify cations and simple anions in a mixture of salts
ii. Determine the quality of interfering anions using semi-micro scheme of analysis

Reference/text books:

1. Vogel, A.I. A Textbook of Quantitative Inorganic Analysis, ELBS
2. Practical Chemistry, Pandey O.P./ Bajpai D.N. & Giri S. S. Chand Limited
3. College Practical Chemistry, V K Ahluwalia, Sunita Dhingra, Sunita Dhingra, Universities Press, Hydrabad.

SEMESTER - V

BCHC 0011: PHYSICAL CHEMISTRY – IV

Credits: 04 **Semester V** **L–T–P : 3–2–0**

Objective: This course aims to develop understanding and conceptual basis of Quantum Mechanics, Surface Chemistry and Catalysis.

Module No.	Content	Teaching Hours (Approx.)
I	**Quantum Mechanics-I:** Electron and the Old Quantum Theory, Quantum theory of radiation Photoelectric effect, Comparison between Classical & Quantum mechanics (or wave mechanics), Postulates of quantum mechanics, The Schrödinger wave equation, Operators in quantum mechanics, Solution of the Schrödinger wave equation for some simple systems, Particle in a one–dimensional box, one–dimensional simple harmonic oscillator, Rigid rotor, The Schrödinger equation for hydrogen atom, Angular momentum in quantum mechanics	16
II	**Surface Chemistry** Adsorption by solids, Chemisorption, Applications of adsorption: Adsorption of gases by solids, Factors influencing adsorption. The Freundlich adsorption isotherm, The Langmuir theory of adsorption The BET theory of multilayer adsorption, Derivation of the BET equation, Types of adsorption isotherms, Adsorption from solution The Gibbs adsorption isotherm, Insoluble surface films on liquids. Modern techniques for investigating surfaces (Basic idea only): LEED, PES, STM, EXAFS and SEXAFS	16
III	**Catalysis:** Characteristics of catalytic reactions, Acid–base catalysis Enzyme catalysis Mechanism and kinetics of enzyme– catalysed reactions The Michaelis–Menten equation Effect of temperature on enzyme catalysis **The Nernst Distribution Law:** Nernst Distribution law, Thermodynamic derivation Association of the solute in one of the solvents, Dissociation of the solute in one of the solvents, Solute enters into chemical combination with, one of the solvents	16

Intended Outcome:

After studying this course students will able to:

i. Compare Classical & Quantum mechanics
ii. Determine the particle in a 1D box, simple harmonic oscillator, Rigid rotor and angular momentum in quantum mechanics
iii. Derive the expression for Schrödinger wave equation, Freundlich adsorption isotherm, and BET equation.
iv. Understand the BET theory of multilayer adsorption, Langmuir theory of adsorption Effect of temperature on enzyme catalysis.
v. Identify the types of adsorption isotherms, Mechanism and kinetics of enzyme– catalysed reactions.
vi. Deduce Nernst Distribution Law and Michaelis–Menten equation

Reference Books:

1. *A text book of Physical Chemistry*: S. Glasstone McMillian

Text Books:

1. *Essentials of Physical Chemistry*: Bahl & Tuli S.Chand & Co.
2. *Principles of Physical Chemistry*: Puri & Sharma Shobhanlal nagin chand & Co

BCHC 0012: ORGANIC CHEMISTRY - IV

Credits: 04 **Semester V** **L–T–P : 3–2–0**

Objective: To develop basic and fundamental aspects of natural products.

Module No.	Content	Teaching Hours (Approx.)
I	**Carbohydrates** Occurrence, classification and their biological importance Monosaccharides: Constitution and absolute configuration of glucose and fructose, epimers and anomers, mutarotation, determination of ring size of glucose and fructose, Haworth projections and conformational structures; Interconversions of aldoses and ketoses; Killiani-Fischer synthesis and Ruff degradation; Disaccharides – Structure elucidation of maltose, lactose and sucrose Polysaccharides – Elementary treatment of starch, cellulose and glycogen. **Nucleic Acids** Components of nucleic acids, Nucleosides and nucleotides; Structure, synthesis and reactions of: Adenine, Guanine, Cytosine, Uracil nd Thymine; Structure of polynucleotides.	16
II	**Amino acids, Peptides and Proteins** Amino acids, Peptides and their classification. α-Amino Acids - Synthesis, ionic properties and reactions. Zwitterions, pKa values, isoelectric point and electrophoresis; Study of peptides: determination of their primary structures-end group analysis, methods of peptide synthesis. Synthesis of peptides using N-protecting, C-protecting and C-activating groups - Solid-phase synthesis **Lipids:** 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.	16
III	**Alkaloids** Natural occurrence, General structural features, Isolation and their physiological action Hoffmann's exhaustive methylation, Emde's modification, Structure elucidation and synthesis of Hygrine and Nicotine. Medicinal importance of Nicotine, Hygrine, Quinine, Morphine, Cocaine, and Reserpine. **Terpenes;** Occurrence, classification, isoprene rule; Elucidation of structure and synthesis of Citral, Neral and α- terpineol.	16

Intended Outcome:

After studying this course students will able to:

i. Draw the structure of Carbohydrates, Nucleic Acids, Amino acids, Peptides and Proteins, Lipids, Alkaloids and Terpenes.
ii. Determine the ring size of glucose and fructose.
iii. Interconvert aldoses and ketoses
iv. Elucidate the structure of Carbohydrates, Nucleic Acids, Amino acids, Peptides and Proteins, Lipids, Alkaloids and Terpenes.
v. Design and propose mechanism for synthetic routes for natural products.
vi. Identify the medicinal importance of Nicotine, Hygrine, Quinine, Morphine, Cocaine, and Reserpine.

Reference Books:

1. Finar, I. L. Organic Chemistry (Volume 1), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
2. Finar, I. L. *Organic Chemistry* (*Volume 2: Stereochemistry and the Chemistry of Natural Products*), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
3. Organic Chemistry, Solomons and Fryhle, Wiley Student Edition, New Delhi.
4. Organic Chemistry, Morrison and Boyd, Pearson Education, New Delhi.

Text Books:

1. *Organic chemistry* (Vol. I)- S M Mukherji, S P Singh and R P Kapoor, New Age Publishers, New Delhi.
2. Advanced organic Chemistry, Jagdamba Singh and Jaya Singh, Pragati Publishers.

BCHC 0013: INORGANIC CHEMISTRY - III

Credits: 04 **Semester V** **L–T–P : 3–2–0**

Objective: To develop basic and fundamental aspects of Organo-metallic Compounds, Metal carbonyls, Inorganic Polymers and group theory.

Module No.	Content	Teaching Hours (Approx.)
I	**Organo-metallic Compounds:** Definition and classification of organometallic compounds, EAN rule, Organometallics in homogeneous catalysis **Metal carbonyls:** Preparation, properties, structure and bonding of mononuclear carbonyls. Π acceptor behavior of carbon monoxide, synergic effect (MO diagram of CO, NO) Carbonylate anions, ferrocene and its reactions.	16
II	**Noble Gases:** Occurrence & uses, rationalization of inertness of noble gases, Clathrates; preparation and properties of XeF2 and XeF4, XeF6; Nature of bonding in noble gas compounds (Valence bond treatment and MO treatment for XeF2). Molecular shapes of noble gas compounds (VSEPR theory). **Cages and metal clusters.**	16
III	**Inorganic Polymers:** Types of inorganic polymers, comparison with organic polymers, synthesis, structural aspects and applications of silicones and siloxanes. Borazines, silicates and phosphazenes, and polysulphates **Group Theory:** Definition of group, symmetry, point groups, representation of group, orthogonality theorem, irreducible representation, character table	16

Intended Outcome:

After studying this course students will able to:

i. Draw the structure of metal carbonyls, compounds of noble gases, Borazines, silicates and phosphazenes, and polysulphates etc.
ii. Differentiate metallic and organometallic compounds
iii. Understand the chemistry of interaction between various metals and ligands.
iv. Synthesize various organometallic compounds, Borazines, silicates and phosphazenes, and polysulphates etc.
v. Predict the spectral and magnetic properties of compounds of noble gases
vi. Identify symmetry, point groups, representation of group, orthogonality theorem, irreducible representation, character table

Reference Books:

1. *Concise Inorganic Chemistry* J. D. Lee, 5th Edition (1996), Chapman & Hall, London.
2. *Selected Topics in Inorganic Chemistry* Wahid U. Malik, G. D. Tuli, R. D. Madan, Publisher, S. Chand, 2006.
3. *Inorganic Chemistry* Puri Sharma & kalia S.Chand & Co.

Text Books :

1. Modern Inorganic Chemistry R. C. Aggarwal ,1st Edition (1987), Kitab Mahal, Allahabad.
2. Basic Inorganic Chemistry, F. A. Cotton, G. Wilkinson, and Paul L. Gaus, 3rd Edition (1995) Wiley.
3. Advance Inorganic Chemistry Vol I & II by Gurdeep Raj Krishna Publications media (P) Ltd.

BCHE 0003: ANALYTICAL CHEMISTRY - III

Credits: 04 **Semester V** **L–T–P : 3–2–0**

Objective: To develop basic and fundamental aspects of various chromatographic techniques and their application.

Module No.	Content	Teaching Hours (Approx.)
I	**Introduction to Chromatographic methods** Principles of analytical separation: Plate theory, Craig concept of counter current distribution, process optimization, Retention analysis; Resolution (Fundamental equation). **Conventional methods of Chromatography** (Thin layer, Paper, Size Exclusion)	16
II	**Gas Chromatography** Introduction, instrumentation, types of column (packed, open tubular etc.), types of detector (TCD, ID, FID, ECD, and element selective detectors), programme temperature gas chromatography, applications of GC for quantitative analysis. Internal standard method and standard addition method. **High performance liquid chromatography** Introduction, Types of liquid chromatography, high performance liquid chromatography and instrumentation, derivatization, quantitative analysis, thin layer chromatography, high performance thin layer chromatography,	16
III	**Ion chromatography:** Basic principles, separator column, suppressor columns, detectors, applications. **Ion exchange chromatography:** Introduction, ion exchange equilibria, types of ion exchange resins (strongly acidic, strongly basic, weakly acidic, weakly basic), instrumentation, and ion exchange capacity.	16

Intended Outcome:

After studying this course students will able to:

i. Understand the theory and principles of GC, HPLC, TLC, ion exchange chromatography
ii. Determine the constituents elements simultaneously in a mixture of inorganic salts.
iii. Analyze constituents of a sample of mixture
iv. Apply various chromatographic techniques for the separation of organic and inorganic compounds.
v. Check the purity of a sample mixture and active pharmaceutical ingredients
vi. Extract the mixture of compounds from the given samples.

Reference Books:

1. R. L. Pecsok, L. D. Shields, T. Cairns and L.C. McWilliam, Modern Methods of Chemical Analysis, (1976), John Wiley & Sons, New York.
2. D. A. Skoog, Principles of Instrumental Analysis, 5th Edition (1998), Saunders College of Publishing, Philadelphia, London.
3. H. A. Strobel, Chemical Instrumentation: A Schematic Approach, 2nd Edition (1973), Addison Wesley, Reading, Mass.

Text Books:

1. D. A. Skoog and D. M. West, Fundamental of Analytical Chemistry, 7th Edition (1996), Saunders College Publishing, Philadelphia, Holt, London.
2. Analytical chemistry, G. D. Christian, Sixth Edition, Wiley publications

BCHC 0909: CHEMISTRY LAB IX

(Physical Chemistry – 3)

Credits: 02 **Semester V** **L–T–P : 0–0–4**

Objective: To provide practical exposure to the experiments of Physical Chemistry

1. Determination of heat capacity of a calorimeter for different volumes using change of enthalpy data of a known system (method of back calculation of heat capacity of calorimeter from known enthalpy of solution or enthalpy of neutralization).
2. Determination of heat capacity of the calorimeter and enthalpy of neutralization of hydrochloric acid with sodium hydroxide.
3. Calculation of the enthalpy of ionization of ethanoic acid.
4. Determination of heat capacity of the calorimeter and integral enthalpy (endothermic and exothermic) solution of salts.
5. 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 for different additions of a base. Also calculate the enthalpy of neutralization of the first step.
6. Determination of enthalpy of hydration of copper sulphate.
7. Study of the solubility of benzoic acid in water and determination of ΔH.

NOTE: All the safety measures or steps for all the respective experiments must be taken care of strictly.

Intended Outcome:

After studying this course students will able to:

i. Determine the heat capacity, enthalpy of neutralization, integral enthalpy and enthalpy of hydration
ii. Calculate the enthalpy of ionization of ethanoic acid
iii. Find out solubility of benzoic acid in water
iv. Estimate the basicity/proticity of a polyprotic acid by the thermochemical method

Reference text:

1. Practical Physical Chemistry by Amita Dua, Ane Books India.
2. Practical Physical Chemistry. Sixth edition (Findlay, Alexander)
3. Vogel, A.I. A Textbook of Quantitative Inorganic Analysis, ELBS
4. Practical Chemistry, Pandey O.P./ Bajpai D.N. & Giri S. S. Chand Limited
5. College Practical Chemistry, V K Ahluwalia, Sunita Dhingra, Sunita Dhingra, Universities Press, Hydrabad.

BCHC0910: CHEMISTRY LAB - X

(Organic 3)

Credits: 02 **Semester V** **L–T–P : 0–0–4**

Objective: To provide practical exposure and hand on expertise to the experiments of organic Chemistry

I. Tests for functional groups
II. Qualitative analysis of following types of unknown organic compounds
   1. Carbohydrates
   2. Primary, secondary and tertiary amines
   3. Nitro compounds
   4. Amides
   5. Aryl halides
   6. Hydrocarbons
III. Identification of the functional groups, C-C and C-N triple bonds, sp^3, sp^2 and sp hybridized C-H bonds by IR spectroscopy (IR spectra to be provided)

IV. ***Estimation of:***
1. Phenol and aniline by bromination with potassium bromate-potassium bromide method
2. Glycine by formylation method
3. Saponification value of an oil/fat

NOTE: All the safety measures or steps for all the respective experiments must be taken care of strictly.

Intended Outcome:

After studying this course students will able to:

i. Detect extra elements in given unknown compounds
ii. Testify functional groups in unknown compounds
iii. Analyze unknown organic compounds like Carbohydrates, Primary, secondary and tertiary amines, Nitro compounds, Amides, Aryl halides and Hydrocarbons
iv. Identify of the functional groups, C-C and C-N triple bonds, sp^3, sp^2 and sp hybridized C-H bonds by IR spectroscopy

Reference text:

1. Vogel, A.I. A Textbook of Practical Organic Chemistry.
2. Practical Chemistry, Pandey O.P./ Bajpai D.N. & Giri S. S. Chand Limited
3. College Practical Chemistry, V K Ahluwalia, Sunita Dhingra, Sunita Dhingra, Universities Press, Hydrabad.

BCHC 0911: CHEMISTRY LAB XI

(Inorganic 3)

Credits: 02 **Semester V** **L–T–P : 0–0–4**

Objective: To provide practical exposure and hand on expertise to the experiments of inorganic Chemistry

(a) Quantitative Analysis:

The following quantitative estimations are to be carried out.

i. Estimation of nickel (II) using Dimethylglyoxime as the precipitant.

ii. Estimation of copper as CuSCN

iii. Estimation of iron as Fe2O3 by precipitating iron as $Fe(OH)_3$ through (i)

iv. Heterogeneous and (ii) Homogeneous media

v. Estimation of Al (III) by precipitating with oxine and weighing as $Al(oxine)_3$ (aluminium oxinate).

(b) Inorganic Preparations:

(i) Tetraammine copper (II) sulphate, $[Cu(NH_3)_4]SO_4\ H_2O$

(ii) Potassium trisoxalatochromate (III), $K_3[Cr(C_2O_4)_3]$

iii. Cis and trans $K[Cr(C_2O_4)_2\ (H_2O_2]$ Potassium dioxalatodiaquachromate

iv. Pentaammine carbonato Cobalt (III) ion

(a) Spectrophotometric estimation of Ferrous ions by using 1,10 phenanthroline

NOTE: All the safety measures or steps for all the respective experiments must be taken care of strictly

Intended Outcome:

After studying this course students will able to:

i. Analyze Ferrous ions by spectrophotometry
ii. Determine of the melting points using Kjeldahl method and boiling point of liquid compounds by distillation and capillary method
iii. Differentiate Heterogeneous and (ii) Homogeneous media
iv. Estimate nickel (II), copper, iron, Al (III), $^{+}$ in a given sample.

Recommended Texts:

1. Vogel, A.I. A text book of Quantitative Analysis, ELBS 1986.
2. Practical Chemistry, Pandey O.P./ Bajpai D.N. & Giri S. S. Chand Limited
3. College Practical Chemistry, V K Ahluwalia, Sunita Dhingra, Sunita Dhingra, Universities Press, Hydrabad.

SEMESTER - VI

BCHC 0014: PHYSICAL CHEMISTRY - V

Credits: 04 **Semester VI** **L–T–P : 3–2–0**

Objective: To develop basic and fundamental aspects of various molecular spectroscopy techniques and their application.

Module No.	Content	Teaching Hours (Approx.)
I	**Molecular Sepectroscopy-I:** Introduction to molecular spectroscopy, Basic features of spectrometers, Width and intenstiy of spectral lines, Molecular spectra **Rotational (microwave) spectroscopy:** Rotational (microwave) spectra of diatomic, molecules, Relative intensities of rotational spectral lines, Applications of Microwave spectroscopy, Rotational spectra of polyatomic molecules, Stark effect in microwave spectra, Other applications of microwave spectra,	16
II	**Vibrational spectroscopy:** Vibrational spectra of diatomic molecules, Rotation–vibration spectra of diatomic molecules, Vibrational spectra of polyatomic molecules, Rotation-vibration spectra of polyatomic molecules, Vibrational frequencies of different functional groups **Raman spectroscopy:** What is scattering, elastic and non elastic scattering, basics of Raman Spectroscopy	16
III	**Molecular Sepectroscopy-II** **NRF Spectroscopy** Mössbauer spectroscopy: Basic principle of NRF Mössbauer experiment, Chemical isomer shift, Nuclear quadrupole splitting, Nuclear Zeeman splitting. **Photoelectron spectroscopy (PES):** Basic principle and its applications	16

Intended Outcome:

After studying this course students will able to:

i. Understand the theory and principle of molecular spectroscopy including Rotational (microwave) spectroscopy, Vibrational spectroscopy, Raman spectroscopy, NRF Spectroscopy and Photoelectron spectroscopy .
ii. Apply Stark effect in determination of symmetry of a molecule
iii. Elucidate the structure of organic compounds.
iv. Calculate the relative intensities of rotational spectral lines
v. Interpret the Rotational spectra, rotation–vibration spectra of homo and diatomic molecules, Raman spectra, NRF and PES Spectra
vi. Predict the no. of lines in NRF Spectra, no. of vibration in Raman Spectra.
vii. Differentiate two closely related compounds on the basis of molecular spectroscopy.

Reference Books:

1. Fundamentals of molecular Spectroscopy by Walter Struve.
2. Atomic and Molecular Spectroscopy, Svanberg, Sune, Springer.

Text Book:

1. Fundamentals of Molecular Spectroscopy: *C.N. Benwell*, McGraw-Hill.

BCHC 0016: INORGANIC CHEMISTRY-IV

Credits: 04 **Semester VI** **L–T–P : 3–2–0**

Objective: To develop basic and fundamental aspects of various ESR, IR, NMR, UV-vis, NQR, MS and electron spectroscopy techniques and their application.

Module No.	Content	Teaching Hours (Approx.)
I	**ESR spectroscopy:** ESR spectra of metal complexes: Zeeman interaction and energy levels, g factor, Ligand field effects, dipolar coupling, Hyperfine coupling and A parameter, super-hyperfine coupling. Orbital moment quenching and g values, Anisotropy in g and A values. ESR spectra of multielectronic ion complexes. Zero field splitting and Kramer's degeneracy, ESR spectra of d1 to d^9 metal ions, ESR spectra of binuclear metal complexes. Some examples of biomolecules. Mössbauer spectroscopy: Introduction and principle (Splitting pattern)	16
II	**IR, and NMR spectroscopy** Infrared and studies of simple inorganic compounds and metal complexes: selection rules. Active and degenerate vibrations, effect of functionalization and symmetry change on IR. Changes in ligand vibrations on coordination with metal ion. Metal-ligand atom vibrations. Proton, fluorine and phosphorous NMR of Inorganic compounds, Diamagnetic metal complexes, contact and pseudo-contact shifts in paramagnetic complexes, Lanthanide complexes as shift reagents.	16
III	Theory, principle and application of UV-vis, NQR, MS, electron spectroscopy and microscopic techniques for characterization of Inorganic compounds.	16

Intended Outcome:

After studying this course students will able to:

i. Understand the theory and principle of various spectroscopic techniques such as UV-VIS, IR, NMR, MS, ESR and NQR
ii. Elucidate the structure of inorganic compounds on the basis of various spectroscopic techniques.
iii. Interpret the spectra obtained in various spectroscopic techniques such as UV-VIS, IR, NMR, MS, ESR and NQR.
iv. Predict the no. of signals in NMR Spectra, no. of vibration in IR Spectra, molecular ion and other fragmented ions in MS spectra and splitting pattern
v. Differentiate to closely related inorganic compounds
vi. Calculate Zero field splitting and Kramer's degeneracy in ESR Spectra.
vii. Characterize inorganic compounds on the basis of various spectroscopy.

Reference Books :

1. Infrared and Raman Spectra : Inorganic and Cooradination Compounds, K. Nakamoto, Wiley.
2. Inorganic Electronic Spectroscopy, A.P.B Leaver, Elsevier.
3. *Concise Inorganic Chemistry* J. D. Lee, 5th Edition (1996), Chapman & Hall, London.
4. *Inorganic Chemistry* Puri Sharma & kalia S.Chand & Co.

Text Books :

1. NMR, NQR, EPR and Mossbauer Spectroscopy in Inorganic Chemistry, R.V.Parish, Ellis Horwood.
2. Selected Topics in Inorganic Chemistry Wahid U. Malik, G. D. Tuli, R. D. Madan, Publisher, S. Chand, 2006.

BCHE 0007: Pericyclic, Heterocyclic and Photochemistry

Credits: 04 **Semester VI** **L–T–P : 3–2–0**

Objective: This course aims to develop basic and advanced knowledge of Pericycle Chemistry, Photochemistry and Heterocycle compounds.

Module No.	Content	Teaching Hours (Approx.)
I	**Pericyclic Chemistry:** Classification and stereochemistry of pericyclic reactions: Classification of pericyclic reactions. Woodward Hoffmann correlation diagrams. FMO and PMO approach, Electrocyclic Reactions, **cycloaddition:** Cycloaddition, antarafacial, suprofacial additions, 4n and 4n+2 systems. 2+2 addition of Ketenes, 1,3-dipolar cycloadditions & cheletropic reactions, Sigmatropic Reactions, Ene reactions	16
II	**Photochemistry:** Introduction General Principles, photochemistry of Alkenes, Dienes, and Polyenes, cis-trans Isomerization, Photoreactions of Other Alkenes. Photoisomerization of 1,3-Butadiene, Orbital Symmetry Considerations for Photochemical, Reactions of Alkenes and Dienes, Photochemical Electrocyclic Reactions Photochemical Cycloaddition Reactions, Photochemical Rearrangements Reactions of 1,4-Dienes, Photochemistry of Carbonyl Compounds, Hydrogen Abstraction and Fragmentation Reactions, Cycloaddition and Rearrangement Reactions of Cyclic, Unsaturated Ketones, Cycloaddition of Carbonyl Compounds and Alkenes, Photochemistry of Aromatic Compounds, Interpretation of Diene, and Polyene Photochemistry.	16
III	**Polynuclear Hydrocarbons: Naming of fused system** Reactions of naphthalene phenanthrene and anthracene Structure, Preparation and structure elucidation and important derivatives of naphthalene and anthracene; Polynuclear hydrocarbons. **Heterocyclic Compounds** Classification and nomenclature, Structure, aromaticity in 5-numbered and 6-membered rings containing one heteroatom; Synthesis, reactions and mechanism of substitution reactions of: Furan, Pyrrole (Paal-Knorr synthesis, Knorr pyrrole synthesis, Hantzsch synthesis), Thiophene, Pyridine (Hantzsch synthesis), Pyrimidine, Structure elucidation of indole, Fischer indole synthesis and Madelung synthesis), Structure elucidation of quinoline and isoquinoline, Skraup synthesis, Friedlander's synthesis, Knorr quinoline synthesis, Doebner-Miller synthesis, Bischler-Napieralski reaction, Pictet-Spengler reaction, Pomeranz-Fritsch reaction Derivatives of furan: Furfural and furoic acid.	16

Intended Outcome:

After studying this course students will able to:

i. Understand the basis principle of pericyclic and photochemistry.
ii. Classify the pericyclic and photochemical reactions
iii. Draw Woodward Hoffmann correlation diagrams for concerted reactions
iv. Propose Mechanism for pericyclic and photochemical reactions.
v. Design the synthesis of Heterocyclic compounds
vi. Differentiate five and six membered Heterocyclic compounds
vii. Identify the name of a reaction and its mechanistic routes of synthesis of Heterocyclic compounds
viii. Elucidate the structure of Heterocyclic compounds.

Reference Books:

1. Finar, I. L. Organic Chemistry (Volume 1), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
2. Finar, I. L. *Organic Chemistry* (*Volume 2: Stereochemistry and the Chemistry of Natural Products*), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
3. Organic Chemistry, Solomons and Fryhle, Wiley Student Edition, New Delhi.
4. Organic Chemistry, Morrison and Boyd, Pearson Education, New Delhi.

Text Books :

1. *Organic chemistry* (Vol. I)- S M Mukherji, S P Singh and R P Kapoor, New Age Publishers, New Delhi.
2. Advanced organic Chemistry, Jagdamba Singh and Jaya Singh, Pragati Publishers.

BCHE 0004: ANALYTICAL CHEMISTRY - IV

Credits: 04 **Semester VI** **L–T–P : 3–2–0**

Objective: To develop basic and fundamental aspects of various Electroanalytical and Radio-analytical techniques and their application.

Module No.	Content	Teaching Hours (Approx.)
I	**Ultra Purity and Ultra trace Analysis** Ultra purity and ultra trace analysis, laboratory dosing, purification of reagents, Pre-concentration Techniques, Methods of trace analysis such as, XRF, AAS, DCP and ICP, High purity materials for electronic industry, contamination control during analytical operations. **Electroanalytical techniques:** Physicochemical background (such as the thermodynamics and kinetics of electron and ion transfer, the electric double layer, and mass transfer by diffusion and migration). Electrochemical methods in detail including ion-selective potentiometry, cyclic voltammetry, pulse voltammetry, ion-transfer voltammetry, and impedance spectroscopy. Instrumentation (rotating disk electrodes, microelectrodes. Stripping Voltammetry.	16
II	**Radio-analytical Chemistry** Separation methods, Precipitation, solvent extraction and chromatographic methods. Activation analysis (Nuclear Active Analysis), basic principles, fast neutron activation analysis, radiochemical methods in activation analysis, Applications in Geo-chemistry, oxygen in metals. Isotope dilution analysis: Principles and applications. Sub-stoichiometric determination of traces of metals: Principles, techniques and experimental methods in the determination of As, Pb and Hg.	16
III	**Hyphenated techniques:** Theory, principle, instrumentation and applications of LC-MS, GC-MS, IR-MS, TLC-MS, NMR-MS. **Industrial Effluent treatment** (Water and air)	16

Intended Outcome:

After studying this course students will able to:

i. Understand the theory and principles of Electroanalytical and Radio-analytical techniques.
ii. Investigate the kinetics of electrode reactions
iii. Analyze the constituents elements simultaneously in a mixture of inorganic salts.
iv. Determine the traces of metals (As, Pb and Hg.) in a mixture.
v. Apply various analytical techniques for the separation of organic and inorganic compounds.
vi. Check the purity of a sample mixture and active pharmaceutical ingredients
vii. Extract the mixture of compounds from the given samples.

Reference Books:

1. L. R. Shyder and C. H. Harvath, An introduction to separation science, Wiley Interscience.
2. H. H. Willard; L. L. Merit; J. A. Dean & F. A. Settle, Instrumental Methods of Analysis (CBS), Harbor Laboratory Press; 2nd edition, 2009.

Text Books:

1. D. A. Skoog and D. M. West, Fundamental of Analytical Chemistry, 7th Edition (1996), Saunders College Publishing, Philadelphia, Holt, London.
2. Analytical chemistry, G. D. Christian, Sixth Edition, Wiley publications

BCHC 0912: CHEMISTRY LAB - XII

Credits: 03 **Semester VI** **L–T–P : 0–0–6**

Objective: To prove the exposure of hand on expertise on experiments related to analytical techniques.

Colorimetric Analysis

1. Verification of Lambert-Beer's Law
2. Determination of pK (indicator) for phenolphthalein or methyl red
3. Study the formation of a complex between ferric and thiocyanate (or salicylate) ions.
4. Study the kinetics of interaction of crystal violet with sodium hydroxide colourimetrically.
5. Analysis of the given vibration-rotation spectrum of HCl(g)
6. Record the UV spectrum of p-nitrophenol (in 1:4 ethanol:water mixture). Repeat after adding a small crystal of NaOH. Comment on the difference, if any.
7. Record the U.V. spectrum of a given compound (acetone) in cyclohexane
   (a) Plot transmittance *versus* wavelength. (b) Plot absorbance *versus* wavelength.
   (c) Calculate the energy involved in the electronic transition in different units, i.e. cm^{-1}, kJ/mol, kcal/mol & eV.

Separation Techniques

1. Solvent Extractions:
   (i) To separate a mixture of Ni^{2+} & Fe^{3+} by complexing with DMG and extracting the Ni^{2+} DMG complex in chloroform, and determine its concentration with spectrophotometry.
   (ii) Solvent extraction of zisconium with amberliti LA-1, separation from a mixture of irons and gallium.
2. Determine the pH of given aerated drinks fruit juices, shampoos and soaps.
3. Determination of Na, Ca, Li in cola drinks and fruit juices using fame photometric techniques.
4. Analysis of soil:
   (i) Determination of pH and electrical conductivity of soil. (ii) Total soluble salt
   (iii) Estimation of calcium, magnesium, phosphate, nitrate
5. Determination of chemical oxygen demand (COD).
6. Determination of Biological oxygen demand (BO)
7. Determination of ascorbic acid in lemon juice.
8. Determination of adulterants in milk

Intended Outcome:

After studying this course students will able to:

i. Verify of Lambert-Beer's Law
ii. Determine pK (of indicators), pH (of given aerated drinks fruit juices, shampoos and soaps), Na, Ca, Li (in cola drinks and fruit juices), ascorbic acid (in lemon juice) and adulterants (in milk).
iii. Analyze given vibration-rotation spectrum of HCl spectrophotometrically
iv. Separate a mixture of Ni^{2+} & Fe^{3+} by complexing with DMG
v. Extract the Ni^{2+} DMG complex in chloroform.

NOTE: <u>All the safety measures or steps for all the respective experiments must be taken care of strictly.</u>

Reference/text books:

1. Vogel, A.I. A Textbook of Quantitative Inorganic Analysis, ELBS
2. Practical Chemistry, Pandey O.P./ Bajpai D.N. & Giri S. S. Chand Limited
3. College Practical Chemistry, V K Ahluwalia, Sunita Dhingra, Sunita Dhingra, Universities Press, Hydrabad.

BCHE 051: PROJECT

Credits: 04 **Semester VI** **L–T–P : 0–0–8**

Objective: To develop the analytical and research skills through minor projects.

Description:

- Each student will do project work under the guidance of supervisor from the department of chemistry and has to submit the report after completion of the project.
- Students also have to write a review/ research article on the theme of project.

Intended Outcome:

After studying this course students will able to:

i. Develop analytical and research skills
ii. write a review/ research article

BCHE 0006: GREEN CHEMISTRY AND CORROSION SCIENCE

Credits: 04 **Semester III/IV/V/VI** **L–T–P : 3–2–0**

Objective: To develop understanding of theory and principles of green chemistry and corrosion science and their applications.

Module No.	Content	Teaching Hours (Approx.)
I	**Green Chemistry Part-I** Introduction to Green Chemistry: Need for Green Chemistry. Goals of Green Chemistry. Limitations/Obstacles in the pursuit of the goals of Green Chemistry. Twelve principles of Green Chemistry with their explanations and examples; Designing a Green Synthesis using these principles; Prevention of Waste/byproducts; maximum incorporation of the materials used in the process into the final products (Atom Economy); prevention/minimization of hazardous/toxic products; designing safer chemicals –different basic approaches.	16
II	**Green Chemistry Part –II** Selection of appropriate auxiliary substances (solvents, separation agents), green solvents, solventless processes, immobilized solvents and ionic liquids; energy requirements for reactions -use of microwaves, ultrasonic energy; selection of starting materials; careful use of blocking/protecting groups; use of catalytic reagents (wherever possible) in preference to stoichiometric reagents; designing of biodegradable products; prevention of chemical accidents; strengthening/development of analytical techniques to prevent and minimize the generation of hazardous substances in chemical processes. Green Synthesis of: BHT, methyl methacrylate, paracetamol. Hofmann Elimination, Hydrolysis (of benzyl chloride, benzamide, methylbenzoate to benzole acid). Microwave -assisted reactions in organic solvents: Esterification, Fries rearrangement, Diels Alder Reaction, Decarboxylation.	16
III	**Corrosion:** Introduction, Consequences of corrosion, Classification, Electrochemical theory of corrosion, Galvanic series, Description of galvanic, pitting stress and inter-granular corrosion, Factors affecting corrosion- nature of metal, overvoltage, relative areas of the anode and cathode, pH of the medium, temperature and polarization, Corrosion prevention- materials selection and design, Inhibitors, cathodic and anodic protection, Metallic coating-galvanizing and tinning.	16

Intended Outcome:

After studying this course students will able to:

i. Understand the theory and principles of green chemistry and corrosion science.
ii. Apply green chemistry principle for synthesis of organic and inorganic compounds .
iii. Prevent and minimize the generation of hazardous substances in chemical processes
iv. Classify different type of corrosion

v. Propose the mechanism for different type of corrosion
vi. Synthesize of BHT, methyl methacrylate, paracetamol.

Reference Books:

1. Mars J. Fontana (1987) CORROSION ENGINEERING. 3rd edition, McGraw-Hill Inc.
2. P.T. Anastes & J.K. Warmer: Oxford Green Chemistry-Theory and Practical, University Press(1998).
3. M.C. Cann & M.E.Connely: Real-World cases in Green Chemistry, American Chemical Society, Washington (2000).
4. M.A. Ryan &M. Tinnes and, Introduction to Green Chemistry, American Chemical Society, Washington (2002).

Text Books:

1. Zaki Ahmad (2006) Principles of Corrosion Engineering and Corrosion Control. Elsevier: Oxford.
2. V.K. Ahluwalia & M.R. Kidwai: New Trends in Green Chemistry, Anamalaya Publishers (2005).
3. A.S. Matlack:Introduction to Green Chemistry, Marcel Deckkar(2001).

BCHO 0101: NANOMATERIALS AND NANOTECHNOLOGY (OPEN ELECTIVE)

Credits: 04 **Semester III/IV/V/VI** **L–T–P : 3–2–0**

Objective: This course aims to expose the students:

- To impart the basic concepts of nanotechnology
- To develop understanding about application of nanomaterials.

No Pre-requisites

Module No.	Content	Teaching Hours (Approx.)
I	Introduction to nanotechnology, nanoscale, electromagnetic spectrum, top down and bottom up approach, particle size, chemistry and physics of nanomaterials, electronic phenomenon in nanostructures, optical absorption in solids, quantum effects. Nanomaterials, preparation of nanomaterials like gold, silver, different types of nano-oxides, Al2O3, TiO2, ZnO etc. Sol-gel methods, chemical vapour deposition, ball milling etc. Carbon nanotubes, preparation properties and applications like field emission displays.	16
II	Different types of characterization techniques like SEM, AFM, TEM& STM. Nanocomposites, nanofillers, high performance materials, polymer nanocomposites, nanoclays, nanowires, nanotubes, nanoclusters etc. Smart materials, self-assembly of materials, safety issues with nanoscale powders.	16
III	Nano manipulation: Micro and nanofabrication techniques, Photolithography, E-beam, FIBetc. Nanolithography: Soft lithography, photoresist materials. Introduction to MEMS, NEMS and Nano electronics. Introduction to bio nanotechnology and nanomedicines.	16

Intended Outcome:

After studying this course students will able to:

i. Understand the theory and principles of Nanotechnology and Nano Materials.
ii. Synthesize nano materials of gold, silver, different types of nano-oxides, Al2O3, TiO2, ZnO etc. Sol-gel methods, chemical vapour deposition, ball milling.
iii. Characterize nano materials using techniques like SEM, AFM, TEM& STM.
iv. Fabricate nano materials using Photolithography, E-beam, FIB
v. Determine the morphology and topology of nano materials

Reference Books/ Text Books :

1. Nanostructured materials, Jackie Y. Ying, Academic press 2001
2. Nanotechnology and nanoelectronics, W.R, Fahrner, Springer 2005
3. Nanoengineering of structural, functional and smart materials, Mark J. Schulz, Taylor & Francis 2006.
4. Hand book of Nanoscience, Engineering, and Technology, William A. Goddard, CRC press 2003.
5. Nanoelectronics and Information Technology, Rainer Waser, Wiley-VCH 2003.

BCHO 0102: TECHNOLOGY OF SURFACE COATING

Credits: 04 **Semester III/IV/V/VI** **L–T–P : 3–2–0**

Objective: This course aims to expose the students:

- To impart the basic concepts of surface coating
- To develop understanding about coatings and its constituents.

No Pre-requisites

Module No.	Content	Teaching Hours (Approx.)
I	Film formation-Film forming compositions- properties- types of polymerization in film forming compounds - drying oils - composition - manufacturing procedure. Resins - types - natural resins and its extraction - alkyd resin- manufacturing - compositions -properties - various synthetic resins -chemical constitution - manufacturing procedures - diluents - thinners - plasticizers - driers -additives -anti settling agents in surface coating	16
II	Pigments - properties - types - white pigments - properties - manufacturing procedures – red pigments, green, blue and black pigments - properties and manufacturing procedure Formulation of exterior coating – interior, decorative, industrial, special purpose, marine, bituminous and powder coatings – manufacture of various paints	16
III	Corrosion-different types, mechanism and factors influencing corrosion-corrosion prevention-inhibitors and their applications-oxidation-aging of rubber-oxidation of metals and radiation damage-factors affecting the selection of materials for engineering purposes selection of suitable materials for construction in chemical industry.	16

Intended Outcome:

After studying this course students will able to:

i. Understand the theory and principles of technology of surface coating.
ii. Classify polymerization in film forming compounds.
iii. Formulate interior and exterior coating.
iv. Manufacture resins, pigments and paints
v. select the materials for engineering purposes and construction in chemical industry
vi. Apply concepts of corrosion science to prevent the materials destruction.

Reference Books/ Text Books :

1. Payne H.F.,Organic Coating Technology, Vol.I&II, John Wiley
2. Oil&Colour Chemicals Association,Australia,Surface Coatings,Vol. I&II, Chapman &Hall
3. Wood.H.R. & Morrel.R.S.,the Chemistry and Technology of Drying Oils, Eruest Benn Ltd.
4. Noel Heaton; "Outlines of Paint Technology ", Charles Griffin and Co., Ltd., W.C.2. 1976.
5. Turner, G.P.A.; “Introduction to Paint Chemistry and Principles of Paint Technology", Oxford& IBH Pub.Co. 1980.

BCHO 0103: MATERIAL SCIENCE & ENGINEERING

Credits: 04 **Semester III/IV/V/VI** **L–T–P : 3–2–0**

Objective: This course aims to expose the students:

•To impart the basic concepts of material science

•To develop understanding about selection based on properties for various applications

No Pre-requisites

Module No.	Content	Teaching Hours (Approx.)
I	Structure of atom-present concept of atom-Rutherford's and Bohr's model-Bonding in solids Types of solids-crystalline and amorphous solids-crystal systems Bravais lattices-miller indices-coordination number-crystal defects-determination of crystal structure-X-ray diffraction-electron diffraction methods- Properties of engineering materials-mechanical properties -isotropy and anisotropy-elasticity, plasticity, toughness, resilience, tensile strength, ductility, malleability, brittleness, hardness, fatigue, creep, wear resistance, Poisson's ratio-stress-strain relation-true stress and true strain- Electrical and magnetic properties-resistivity -conductivity-ionic and electrical conductivity, semiconductors, superconductivity, insulators,	16
II	Ferroelectricity, piezoelectricity, magnetization, paramagnetism, ferromagnetism, and diamagnetism -technological properties-castability, machinability, weldability, solderability, workability, formability Non-ferrous metals and alloys-aluminium and its alloys-copper and its alloys-Non ferrous metals and alloys used for high temperature services and nuclear application Organic polymers and its properties Ceramics-classification-comparison of ceramic and non-ceramic structures-properties and application of ceramics-composite materials-classification-general characteristics.	16
III	Corrosion-different types, mechanism and factors influencing corrosion-corrosion prevention-inhibitors and their applications Oxidation-aging of rubber-oxidation of metals and radiation damage Factors affecting the selection of materials for engineering purposes selection of suitable materials for construction in chemical industry. Introduction to nanomaterials. \	16

Intended Outcome:

After studying this course students will able to:

i. Understand the chemistry of materials and their mechanical, electrical and magnetic properties
ii. Apply the XRD techniques to study structural features of materials
iii. Fabricate materials at atomic label by alloying
iv. Propose the mechanism of organic polymerization and their chemical properties
v. Identify the applications of different materials
vi. Design new materials for advanced applications.

Reference Books/ Text Books :

1. Van Vlack, Elements of Material Science
2. Khanna O.P., A Text Book of Material Science & Metallurgy
3. Hajra Choudhary, Material Science & Processes
4. Chilton &Perry, Chemical Engineers Handbook
5. Nanocomposite science and technology, Pulikel M. Ajayan, Wiley-VCH 2005

BCHO 0104: INTRODUCTION TO BIOPHYSICAL CHEMISTRY

Credits: 04 **Semester III/IV/V/VI** **L–T–P : 3–2–0**

Objective: This course aims to expose the students to the

•To impart the basic concepts of biophysical chemistry

No Pre-requisites

Module No.	Content	Teaching Hours (Approx.)
I	General account of the chemical nature of living cells. Carbohydrates: Classification, configurations and conformations, sugar derivatives, structuraland storage polysaccharides. Amino acids: General properties, peptide bond, essential and non-essential amino acids.Lipids: Classification, properties of lipid aggregates, biological significance.	16
II	Nucleic acid: Chemical structure and base composition, double helical structures, Tm, super-coiled DNA. Protein chemistry: Classification, different levels of protein structure, forces stabilizing proteinstructure, protein folding, protein modification. Vitamins, water and fat soluble vitamins, deficiency and diseases.	16
III	Enzymes: Nomenclature, apoenzyme and holoenzyme, substrate specificity, coenzymes, factorsaffecting enzyme activity, regulation of enzyme activity, enzyme inhibition, isozymes,ribozymes. Water: Structure and interactions, water as solvent, proton mobility, acid-base reactions, pH and buffers, isoelectric pH. Photometry: Basic principles of UV-Visible spectrophotometry and colorimetry, instrumentation and application. Chromatography: Ion Exchange, partition, gel filtration and affinity chromatography their principles and applications.	16

Intended Outcome:

After studying this course students will able to:

i. Understand the chemistry of living cell.
ii. Elucidate the structure of bio-molecules
iii. Predict the behavior, stability and modification of protein
iv. Apply analytical techniques to study nature of bio-molecules.
v. Investigate the mobility pH and isoelectric point of amino acids.

Reference Books/ Text Books:

1. Biophysical Chemistry by Alan Cooper, Royal Society of Chemistry, 2011
2. Biophysical Chemistry, James P. Allen, Wiley-Blackwell
3. Introduction to Biophysical Chemistry, Martin, R.B, McGraw-Hill.