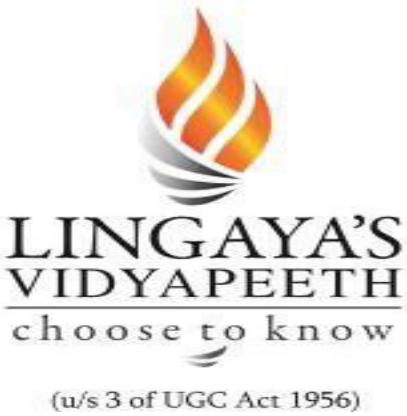


# SYLLABUS

## BACHELOR OF SCIENCE- CHEMISTRY

(THREE YEAR FULL TIME PROGRAMME)

(SIX SEMESTER COURSE)

Year 2021-2024

**Department of Chemistry**

**School of Basic & Applied Science**

# Lingaya's Vidyapeeth, Faridabad

**Deemed to be university (u/s of UGC act 1956) (Approved By UGC, MHRD, AICTE, BCI, PCI & ACI)**

## SCHEME OF EXAMINATION

## (Continuous Assessment and End-Semester Examination)

## Theory Courses

| **Sub-component** | **Weightage** |
|---|---|
| MID-Semester Examination | **25** |
| Assignment/Quiz/Tutorial/Viva-voce (**ABQ)** | **15** |
| End-Semester Examination | **60** |

## Practical Components/Practical Courses

| **Examination** | **Sub-component** | **Weightage** | **Total** |
|---|---|---|---|
| Internal examination | Viva-voce + Continuous lab performance | **20+20** | **40** |
| End-Semester Practical Exam (External examination) | Viva-voce + Practical Exam + Practical record file | **20+25+15** | **60** |

**LINGAYA'S VIDYAPEETH, FARIDABAD**
**PROGRAMME STRUCTURE**
**B.Sc. Chemistry**

| B.Sc. H. Chemistry | Course No. | Course Code | Course Name | Credit/week |
|---|---|---|---|---|
| I (Odd) | 1. | BS-101 | Electricity and Magnetism | 3+1+0 = 4 |
| | 2. | BS-103 | Algebra | 3+1+0 = 4 |
| | 3. | BS-105 | Inorganic Chemistry-I | 3+1+0 = 4 |
| | 4. | BS-151 | Physics Laboratory-I | 0+0+3 = 2 |
| | 5. | BS-155 | Chemistry Laboratory-I | 0+0+3 = 2 |
| | 6. | HSS-107 | English and Communication Skills | 3+0+0 = 3 |
| | | | Total | 19 |
| II (Even) | 7. | BS-102 | Statistical Physics | 3+1+0 = 4 |
| | 8. | BS-104 | Calculus | 3+1+0 = 4 |
| | 9. | BS-106 | Organic Chemistry-I | 3+1+0 = 4 |
| | 10. | BS-152 | Physics Laboratory-II | 0+0+3 = 2 |
| | 11. | BS-156 | Chemistry Laboratory-II | 0+0+3 = 2 |
| | 12. | CE-108 | Environmental Science & Ecology | 2+0+0 = 2 |
| | | | Total | 18 |
| III (Odd) | 13. | BCH-201 | Inorganic Chemistry-II | 4+0+0 = 4 |
| | 14. | BCH-203 | Organic Chemistry-II | 4+0+0 = 4 |
| | 15. | BCH-205 | Physical Chemistry –I | 4+0+0 = 4 |
| | 16. | BCH-207 | Industrial Chemistry-I | 4+0+0 = 4 |
| | 17. | BCH-251 | Chemistry-Laboratory-III | 0+0+3 = 2 |
| | | | Total | 18 |
| IV (Even) | 18. | BCH-202 | Inorganic Chemistry-III | 4+0+0 = 4 |
| | 19. | BCH-204 | Organic Chemistry-III | 4+0+0 = 4 |
| | 20. | BCH-206 | Physical Chemistry-II | 4+0+0 = 4 |
| | 21. | BCH-208 | Industrial Chemistry-II | 4+0+0 = 4 |
| | 22. | BCH-252 | Chemistry-Laboratory-IV | 0+0+3 = 2 |
| | | - | Total | 18 |
| V (Odd) | 23. | BCH-301 | Separation Techniques in Chemistry | 4+0+0 = 4 |
| | 24. | BCH-303 | Organic Spectroscopy | 4+0+0 = 4 |
| | 25. | BCH-305 | Quantum and Photochemistry | 4+0+0 = 4 |
| | 26. | BCH-307 | Green Chemistry | 4+0+0 = 4 |
| | 27. | BCH-309 | Chemistry of Pesticides & Cosmetics | 4+0+0 = 4 |
| | 28. | BCH-351 | Chemistry-Laboratory-V | 0+0+3 = 2 |
| | | | Total | 22 |
| VI (Even) | 29. | BCH-302 | Bioinorganic and Organometallic Chemistry | 4+0+0 = 4 |
| | 30. | BCH-304 | Polymer Chemistry | 4+0+0 = 4 |
| | 31. | BCH-306 | Fuel Chemistry | 4+0+0 = 4 |
| | 32. | BCH-308 | Physical Spectroscopy | 4+0+0 = 4 |
| | 33. | BCH-352 | Project | 0+0+22 = 11 |
| | | | Total | 27 |
| Total Credits | | | | 122 |

**PROGRAM OUTCOMES (PO'S)**

PO-1: Identify and resolve complex scientific issues in national and local level.

PO-2: Analyze and interpret data using analytical instruments to investigate chemical problems.

PO3: To solve chemical problems, choose, plan, and implement suitable experiment techniques, as well as instrumentation handling.

PO-4: Recognize and use contextual multidisciplinary information to evaluate societal, health, safety, and global problem that are important to research practices.

PO-5: Adopt scientific ideas about environmental use and long-term sustainability.

PO6: Enhance skills for future employability through activities such as seminar, communication skills, industrial visit, and internship.

PO-7: Recall the chemistry courses that are available for competitive test.

PO8: The students attain sound knowledge in the areas of organic, inorganic, physical, pharmaceutical chemistry and material for pursing higher education and research.

**PROGRAM SPECIFIC OUTCOMES (PSO'S)**

**PSO1:** To gain an understanding of various principles of organic, inorganic, and physical chemistry as well as their biological implications and applications in every day life.

**PSO2**: Chemistry for industries: planning, conducting experiment, and confidently handling equipment.

# SEMESTER-I

# BS-101: Electricity and Magnetism

(Semester I)

| | | | | | |
|---|---|---|---|---|---|
| L+T+P | : | **4+0+0** | Mid-Sessional exam | : | **15** |
| Credits: | : | **4** | ABQ | : | **25** |
| Contact hours | : | **52** | End-semester exam | : | **60** |

**Course objectives:**

Learn the mathematical methods to solve the problems involving electric potential and fields.

**COURSE OUTCOMES:**

CO1: Master the mathematical tools to find electric potential and fields.
CO2: Learning of important theorems as Gauss theorem.
CO3: Calculating the electric fields around conductors.
CO4: The use of Coulomb's law and Gauss' law for the electrostatic force.

| Unit | Contents | Lecture/Tutorials/Tutorials |
|---|---|---|
| **I** | Vector Calculus : Differentiation of vectors, scalar and vector fields, conservative fields and potentials, line integrals, gradient of a scalar field, divergence of a vector field and divergence theorem, curl of a vector field and its physical significance, Stokes' theorem, combination of grad, div and curl. | 8 |
| **II** | Electric field and electric potential: Electric field: Electric field lines. Electric flux. Gauss' Law with applications to charge distributions with spherical, cylindrical and planar symmetry. Conservative nature of Electrostatic Field. Electrostatic Potential. Laplace's and Poisson equations. The Uniqueness Theorem. Potential and Electric Field of a dipole. Force and Torque on a dipole.<br>Electrostatic energy of system of charges. Electrostatic energy of a charged sphere. Conductors in an electrostatic Field. Surface charge and force on a conductor. Capacitance of a system of charged conductors. Parallel-plate capacitor. Capacitance of an isolated conductor. Method of Images and its application to: (1) Plane Infinite Sheet and (2) Sphere. | 14 |
| **III** | Dielectric properties of matter: Electric Field in matter. Polarization, Polarization Charges. Electrical Susceptibility and Dielectric Constant. Capacitor (parallel plate, spherical, cylindrical) filled with dielectric. Displacement vector D. Relations between E, P and D. Gauss' Law in dielectrics. | 10 |
| **IV** | Magnetic field: Magnetic force between current elements and definition of Magnetic FieldB. Biot-Savart's Law and its simple applications: straight wire and circular loop. Current Loop as a Magnetic Dipole and its Dipole Moment (Analogy with Electric Dipole). Ampere's Circuital Law and its application to (1) Solenoid and (2) Toroid. Properties of B: curl and divergence. Vector Potential. Magnetic Force on (1) point charge (2) current carrying wire (3) between current elements. Torque on a current loop in a uniform Magnetic Field. | 10 |
| **V** | Electromagnetic induction & ballistic galvanometer: Faraday's Law. Lenz's Law. Self Inductance and Mutual Inductance. Energy stored in a Magnetic Field. Behavior of various substances in magnetic fields. Magnetic permeability and susceptibility and their interrelation. Orbital motion of | 10 |

| | | |
|---|---|---|
| | electrons and diamagnetism. Electron spin and paramagnetic. Ferromagnetism. Domain theory of ferromagnetism, magnetization curve, hysterics loss, ferrites. | |

**TEXT BOOKS/REFERENCE BOOKS:**


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


| Pos COs | PO1 | PO2 | PO3 | PO4 | PSO1 | PSO2 | PSO3 | PSO4 |
|---|---|---|---|---|---|---|---|---|
| CO1 | 1 | 3 | - | 1 | 2 | 2 | 1 | 1 |
| CO2 | 1 | 3 | 1 | - | 1 | 2 | 1 | 1 |
| CO3 | 1 | 3 | - | 3 | 1 | 2 | 2 | - |
| CO4 | 2 | 3 | - | 1 | 2 | 1 | - | - |

# BS-103: Algebra
(Semester I)

| | | | | | |
|---|---|---|---|---|---|
| L+T+P | : | **4+0+0** | Mid-Sessional exam | : | **15** |
| Credits: | : | **4** | ABQ | : | **25** |
| Contact hours | : | **52** | End-semester exam | : | **60** |

**OBJECTIVES:**
The objective of this subject is to make connections and build relationships between Algebra and arithmetic, geometry, and probability and statistics and the course will enhance research, inquiry and analytical thinking abilities of students.

**Course Outcomes:**
CO1: Find the inverse of a square matrix.
CO2: Solving the matrix equation Ax = B using row operations and matrix operations.
CO3: Find the determinant of a product of square matrixes, of the transpose of a square matrix and of the inverse of an invertible matrix.
CO4: Find the characteristics equation, Eigen values and corresponding eigen vectors of a given matrix.

| Unit | Contents | Lecture/Tutorials |
|---|---|---|
| **I** | Polar representation of complex numbers, nth roots of unity, De Moivre's theorem for rational indices and its applications. | 10 |
| **II** | Equivalence relations, Functions, Composition of functions, Invertible functions, One to one correspondence and cardinality of a set, Well-ordering property of positive integers, Division algorithm, Divisibility and Euclidean algorithm, Congruence relation between integers, Principles of Mathematical Induction, statement of Fundamental Theorem of Arithmetic. | 11 |
| **III** | Systems of linear equations, row reduction and echelon forms, vector equations, the matrix equation Ax=b, solution sets of linear systems, applications of linear systems, linear independence. | 11 |
| **IV** | Introduction to linear transformations, matrix of a linear transformation, inverse of a matrix, characterizations of invertible matrices. | 10 |
| **V** | Subspaces of Rn, dimension of subspaces of Rn and rank of a matrix, Eigen values, Eigen Vectors and Characteristic Equation of a matrix, special matrices | 10 |

**TEXT BOOKS/REFERENCE BOOKS:**
1. Titu Andreescu and Dorin Andrica, Complex Numbers from A to Z, Birkhauser, 2006.
2. Edgar G. Goodaire and Michael M. Parmenter, Discrete Mathematics with Graph Theory, 3rd Ed., Pearson Education (Singapore) P. Ltd., Indian Reprint, 2005.
3. David C. Lay, Linear Algebra and its Applications, 3rd Ed., Pearson Education Asia, Indian Reprint, 2007

| POs / COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 2 | 2 | 2 | 2 | - | - | 1 | 1 | 1 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| CO2 | 2 | 2 | 2 | 2 | 1 | - | - | - | 2 | - |
| CO3 | 2 | 3 | 1 | 2 | 1 | - | - | 1 | 2 | 1 |
| CO4 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | - | 2 | - |

## BCH-105 : INORGANIC CHEMISTRY
(Semester I)

| | | | | | |
|---|---|---|---|---|---|
| L+T+P | : | **4+0+0** | Mid-Sessional exam | : | **15** |
| Credits: | : | **4** | ABQ | : | **25** |
| Contact hours | : | **52** | End-semester exam | : | **60** |

**Course Objectives:**

1. To understand the shapes of different orbitals.
2. To understand different principles for filling electrons.
3. To understand how to draw energy diagrams.
4. To understand how to calculate bond order.
5. To understand how to calculate lattice energy through Born Haber Cycle

**Course outcomes:**

CO1. Student will evaluate the periodic properties of elements.
CO2. To learn and explain electronic structure of an atom.
CO3. To learn, understand and relate the quantum numbers and atomic orbital's.
CO4. Students can understand the chemical bonding and molecular structure in molecules.

| Unit | Contents | Lecture/Tutorials/Tutorials |
|---|---|---|
| **I** | **Atomic Structure:** Bohr's theory; its limitations and atomic spectrum of hydrogen atom; de Broglie equation, Heisenberg's Uncertainty Principle and its significance, Schrödinger's wave equation, significance of ψ and ψ2. Quantum numbers and their significance. Sign of wave functions. Exclusion Principle, Hund's rule of maximum multiplicity, Aufbau's principle and its limitations. | 9 |
| **II** | **Periodicity of Elements I:** s, p, d, f block elements, the long form of periodic table; Discussion of following properties with reference to s and p-block elements: Effective nuclear charge, shielding or screening effect, Slater rules, variation of effective nuclear charge in periodic table. Atomic radii (van der Waals) Ionic and crystal radii; Covalent radii (octahedral and tetrahedral) | 12 |
| **III** | **Periodicity of Elements II:** Ionization enthalpy; Successive ionization enthalpies and factors affecting ionization energy; Applications of ionization enthalpy; Electron gain enthalpy; trends of electron gain enthalpy. Electro negativity, Pauling's/Mulliken's/Allred Rachow's and Mulliken-Jaffé's electronegativity scales; Variation of electronegativity with bond order, partial charge, hybridization. | 11 |
| **IV** | **Chemical Bonding and Molecular Structure:** Ionic bond: General characteristics, types of ions, size effects, radius ratio rule and its limitations. Packing of ions in crystals. Born-Landé equation; Born-Haber cycle and its application, Covalent bond: Lewis structure, Valence Bond theory, Bent's rule, concept of resonance energy, Molecular orbital theory. Molecular orbital diagrams of diatomic and simple polyatomic molecules; VSEPR theory, covalent character in ionic compounds, polarizing power and polarizability. Ionic character; Semiconductors and insulators, defects in solids. | 13 |
| **V** | **Oxidation-Reduction**: Redox reactions, Standard Electrode Potential and its application to inorganic reactions, Oxidation state, rules for the determination of oxidation states, electrochemical series, applications of electrochemical series. | 7 |

**TEXTBOOKS/REFERENCE BOOKS:**


1. Lee, J.D., Concise Inorganic Chemistry, 5th edn, Blackwell Science, London.
2. Douglas, B.E. and McDaniel, D.H., *Concepts & Models of Inorganic Chemistry,*Oxford,1970
3. Atkins, P.W. & Paula, J. *Physical Chemistry*, 10th Ed., Oxford University Press, 2014.
4. J. March and M. B. Smith, March's Advanced Organic Chemistry: Reactions, Mechanisms, and Structure, 6th Edition, Wiley, 2007.


| POs<br>Cos | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 1 | 1 | - | - | 1 | - | 3 | 3 | 3 | 1 |
| CO2 | 1 | 2 | - | - | 1 | - | 3 | 3 | 3 | 1 |
| CO3 | 1 | 2 | - | - | - | - | 3 | 3 | 3 | 2 |
| CO4 | 1 | - | 1 | 3 | 1 | - | 3 | 3 | 3 | 2 |

# BS:151 Physics Laboratory-I
(Semester I)

| | | | | | |
|---|---|---|---|---|---|
| L+T+P | : | **0+0+3** | Viva-voce + Continuous lab performance | : | **40** |
| Credits: | : | **2** | | | |
| Contact hours | : | **13** | Viva-voce + Practical exam + Practical record file | : | **60** |

**LEARNING OBJECTIVES:**

The objective of the course General Physics Laboratory is to expose the students of B.Sc. class to experimental techniques in electronics, so that they can verify some of the things read in theory here or in earlier classes and develop confidence to handle sophisticated equipment.

**COURSE OUTCOMES:**

CO1: Experimental knowledge of Katter's pendulum.
CO2: Understanding of modulus of rigidity.
CO3: Experimental knowledge coefficient of viscosity.
CO4: Knowledge of gravitation force and its value by using bar pendulum.

| S. No. | Practical Description |
|---|---|
| **1.** | Use of Vernier callipers, Screw gauge, Spherometer, Barometer, Sphygmomanometer, Lightmeter, dry and wet thermometer, TDS/conductivity meter and other measuring instruments based on applications of the experiments. Use of Plumb line and Spirit level. |
| **2.** | Determination of 'g' by Kater's pendulum. |
| **3.** | To study the variation of time period with distance between centre of suspension and centre of gravity for a bar pendulum and to determine: (i) Radius of gyration of the bar about an axis through its C.G. and perpendicular to its length. (ii) The value of g in the laboratory. |
| **4.** | Determination of modulus of rigidity by (i) dynamic method Maxwell's needle/Torsional pendulum (ii) Forced torsional oscillations excited using electromagnet |
| **5.** | Determination of coefficient of viscosity of a given liquid by Stoke's method. Study its temperature dependence. |
| **6.** | To study moment of inertia of a flywheel. |
| **7.** | Determination of modulus of rigidity by static method |
| **8.** | To determine the Young's modulus by (i) bending of beam using traveling microscope/laser, (ii) Flexural vibrations of a bar. |
| **9.** | To study one dimensional collision using two hanging spheres of different materials |
| **10.** | Determination of height (of inaccessible structure) using sextant. |
| **11.** | Measurement of charge and current sensitivity and CDR of Ballistic Galvanometer |
| **12.** | Determine a high resistance by leakage method using Ballistic Galvanometer. |
| **13.** | To determine self-inductance of a coil by Rayleigh's method. |
| **14.** | To determine the mutual inductance of two coils by Absolute method. |
| **15.** | To study the Motion of Spring and calculate (a) Spring constant, (b) g and (c) Modulus of rigidity. |
| **16.** | To determine Coefficient of Viscosity of water by Capillary Flow Method (Poiseuille's method). |
| **17.** | To determine the value of g using Bar Pendulum. |
| **18.** | To determine the height of a building using a Sextant. |

**TEXTBOOK/REFERENCE BOOKS:**


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

| POs<br>COs | PO1 | PO2 | PO3 | PO4 | PSO1 | PSO2 | PSO3 | PSO4 |
|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 3 | - | - | 2 | 2 | 3 | 3 |
| CO2 | 1 | 1 | 1 | 1 | - | 2 | 1 | - |
| CO3 | 2 | 3 | 2 | 1 | 3 | 3 | 1 | - |
| CO4 | 2 | 2 | 1 | - | 2 | 1 | - | - |

## BS-155: CHEMISTRY LABORATORY-I
(Semester I)

| | | | | | |
|---|---|---|---|---|---|
| L+T+P | : | **0+0+3** | Viva-voce + Continuous lab performance | : | **40** |
| Credits: | : | **2** | | | |
| Contact hours | : | **13** | Viva-voce + Practical exam + Practical record file | : | **60** |

**OBJECTIVES:**
The objective of the course Laboratory is to expose the students of B.Sc. class to experimental techniques in electronics, so that they can verify some of the things read in theory here or in earlier classes and develop confidence to handle sophisticated equipment.

## Course Outcomes:

**CO1.** Students will learn the concept of normality and molarities for titration.
CO2. Determination of Carbonate, bicarbonate and alkali in various samples.
CO3. To learn the concept of Crystallization for purification of sample.

| S. No. | Practical Description |
|---|---|
| **1** | **Titrimetric Analysis:**<br>Calibration and use of apparatus<br>Preparation of solutions of different Molarity/Normality of titrants |
| **2** | Estimation of carbonate and hydroxide present together in mixture. |
| **3** | Determination of viscosity of (i) ethanol (ii) amyl alcohol and (iii) aqueous solution of sugar at room temperature |
| **4** | Estimation of free alkali present in different soaps/detergents |
| **5** | Determine the surface tension of given solution using drop number method. |
| **6** | **Preparation and purification through crystallization or distillation and ascertaining their purity through melting or boiling point**:<br>(i) Phenyl benzoate from phenol and benzoyl chloride<br>(ii) M-dinitrobenzene from nitrobenzene (use 1:2 conc. $HNO_3$ - $H_2SO_4$ mixture if fuming $HNO_3$ is not available).<br>(iii) Picric acid<br>(iv) Aspirin from salicylic acid |
| **7** | Crystallization and decolourization of impure naphthalene from ethanol. |

**Reference Books:**

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

| POs<br>COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 1 | 2 | 3 | 2 | 2 | 2 | 2 | 3 | 3 | 3 |
| CO2 | 1 | 2 | 3 | 1 | 2 | 1 | 2 | 3 | 3 | 3 |
| CO3 | 1 | 2 | 3 | 1 | 3 | 2 | 3 | 3 | 3 | 3 |

# SEMESTER-II

# BS-102: Statistical Physics

(Semester II)

| | | | | | |
|---|---|---|---|---|---|
| L+T+P | : | **4+0+0** | Mid-Sessional exam | : | **15** |
| Credits: | : | **4** | ABQ | : | **25** |
| Contact hours | : | **52** | End-semester exam | : | **60** |

**OBJECTIVES:**

The main objective of this course is to familiarize students with Statistical Physics that are essential for solving advanced problems in Statistical an thermodynamics.

**Course Outcomes:**

CO1: Understanding of basics of Statistical Physics.
CO2: Use of the Maxwell- Boltzmann statistics.
CO3: Use of the Bose-Einstein and Fermi-Dirac Statistics.
CO4: Understanding the ensembles..

| Unit | Contents | Lecture/Tutorials/Tutorials |
|---|---|---|
| **I** | Basic Ideas of Statistical Physics: Introduction, Basic ideas of probability and their applications, Macrostates and microstates, Effect of constraints on the system. | 11 |
| **II** | Distribution of n particles in two compartments, deviation from the state of maximum probability, Equilibrium state of a dynamic system, distribution of N distinguishable particles in unequal compartments, Division into cells, Phase space and its division into cells. | 10 |
| **III** | Maxwell-Boltzmann Statistics: Phase space and its division into cells. Three kinds of statistics and their basic approach. Maxwell-Boltzmann Statistics for an ideal gas: Volume in phase space, values of $\alpha$ and $\beta$. Experimental verification and graphical depiction of Maxwell-Boltzmann distribution of molecular speeds | 11 |
| **IV** | Isolated System: Micro canonical Ensemble, Closed System : Canonical Ensemble, Open System : Grand Canonical Ensemble Bose-Einstein Statistics : Need for quantum statistics, Bose-Einstein statistics and its application to Black body radiation, photon gas, deductions from Planck's law. | 11 |
| **V** | Fermi-Dirac Statistics: Fermi-Dirac statistics and its application to electron gas, Fermi energy, comparison of M.B., B.E. and F.D. statistics | 9 |

**TEXTBOOKS/REFERENCE BOOKS:**


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

6. Statistical and Thermal Physics, S. Lokanathan and R.S. Gambhir. 1991, Prentice Hall.
7.

| POs<br>COs | PO1 | PO2 | PO3 | PO4 | PSO1 | PSO2 | PSO3 | PSO4 |
|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 3 | - | - | 2 | 2 | 3 | 3 |
| CO2 | 1 | 1 | 1 | 1 | - | 2 | 1 | - |
| CO3 | 2 | 3 | 2 | 1 | 3 | 3 | 1 | - |
| CO4 | 2 | 2 | 1 | - | 2 | 1 | - | - |

# BS-104: Calculus

(Semester II)

| | | | | | |
|---|---|---|---|---|---|
| L+T+P | : | **4+0+0** | Mid-Sessional exam | : | **15** |
| Credits: | : | **4** | ABQ | : | **25** |
| Contact hours | : | **52** | End-semester exam | : | **60** |

**OBJECTIVES:**

The objective of this subject is to understand the major problems of differential and integral calculus and to appreciate how calculus allows us to solve important practical problems in an optimal way.

**Course Outcomes:**

CO1: Calculate limits, derivatives and indefinite integrals of various algebraic and trigonometric functions of a single variable.

CO2: Use the fact that the derivative is the slop of the tangent line to the curve at a given Point.

CO3: Use the properties of limits and the derivative to analyze graphs of various functions of a single variable

CO4: Apply derivative tests in optimization problems appearing in social sciences, physical sciences, life and a host of other disciplines.

| Unit | Contents | Lecture/Tutorials |
|---|---|---|
| **I** | Limit & Continuity: The real line and its geometrical representation; e-δ treatment of limit and continuity; Properties of limit and classification of discontinuities; Properties of continuous functions. | 11 |
| **II** | Differentiability: Successive differentiation; Leibnitz Theorem; Statement of Rolle's Theorem; Mean Value Theorem; Taylor and Maclaurin's Theorems; Indeterminate forms. | 10 |
| **III** | Applications of Differentiation: Asymptotes; Concavity, convexity and points of inflection; Curvature; Extrema; elementary curves, tangent and normal in parametric form; Polar Coordinates. | 11 |
| **IV** | Partial Differentiation: Limits and continuity of functions of two variables; Partial derivatives; Taylor's theorem and Maclaurin's Theorem for function of two variable; Maxima and minima for function of two variable. | 10 |
| **V** | Double and triple integrals; Change of order in double integrals. Application of Integration: length of a curve; Arc length as a parameter; Evoute & Envelope; Volumes and surface areas of solids of revolution. | 10 |

**TEXTBOOKS/REFERENCE BOOKS:**


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

| POs<br>COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 2 | 2 | 2 | 2 | 1 | 1 | - | 3 | 2 |
| CO2 | 2 | 2 | 2 | 1 | 1 | 1 | - | 1 | 3 | 2 |
| CO3 | 3 | 2 | 2 | 1 | 1 | - | - | 1 | 3 | 2 |
| CO4 | 2 | 2 | 1 | 1 | 1 | - | - | 1 | 3 | 2 |

Structure, 6th Edition, Wiley, 2007.

## BS-106 : ORGANIC CHEMISTRY
(Semester II)

| | | | | | |
|---|---|---|---|---|---|
| L+T+P | : | **4+0+0** | Mid-Sessional exam | : | **15** |
| Credits: | : | **4** | ABQ | : | **25** |
| Contact hours | : | **52** | End-semester exam | : | **60** |

**Course Objectives:**

1. To gain the knowledge of general organic chemistry such as hybridization, electronic displacements and intermediates etc.
2. Differentiate chiral and achiral molecules.
3. Identify the stereo centers in a molecule and assign the configuration as R or S.

**Course Outcomes:**

CO1.To understand the general organic chemistry such as hybridization and electronic displacements

CO2.To learn the involvement of reactive intermediates and understand their structure and reactivity.

CO3. Identify the stereo centers in a molecule and assign the configuration as R or S.

CO4. Students will able to understand the chemistry on Carbon-carbon sigma and pi bonds.

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| Unit | Contents | Lecture/Tutorials/Tutorials |
|---|---|---|
| **I** | **Basics Of Organic Chemistry-I:** Organic Compounds: Classification, and Nomenclature, Hybridization, Shapes of molecules, Influence of hybridization on bond properties. Electronic Displacements: Inductive, electromeric, resonance and mesomeric effects, hyperconjugation and their applications; Dipole moment; Organic acids and bases; their relative strength. | 13 |
| **II** | **Basics Of Organic Chemistry-II:** Homolytic and Heterolytic fission with suitable examples. Curly arrow rules, formal charges; Electrophiles and Nucleophiles; Nucleophlicity and basicity; Types, shape and their relative stability of Carbocations, Carbanions, Free radicals and Carbenes. Introduction to types of organic reactions and their mechanism: Addition, Elimination and Substitution reactions. | 10 |
| **III** | **Stereochemistry:** Fischer Projection, Newmann and Sawhorse Projection formulae and their interconversions; Geometrical isomerism: cis–trans and, syn-anti isomerism E/Z notations with C.I.P rules. Optical Isomerism: Optical Activity, Specific Rotation, Chirality/Asymmetry, Enantiomers, Molecules with two or more chiral-centres, Distereoisomers, meso structures, Racemic mixture and resolution. Relative and absolute configuration: D/L and R/S designations. | 13 |
| **IV** | **Chemistry of Aliphatic Hydrocarbons: (i) Carbon-Carbon sigma bonds:** Chemistry of alkanes: Formation of alkanes, Wurtz Reaction, Wurtz-Fittig Reactions, Free radical substitutions: Halogenation -relative reactivity and selectivity. | 9 |
| **V** | **Chemistry of Aliphatic Hydrocarbons (ii) Carbon-Carbon pi bonds:** Mechanism of E1 and E2 reactions. Saytzeff and Hofmann eliminations. Electrophilic additions their mechanisms (Markownikoff/ Anti Markownikoff addition), mechanism of oxymercuration-demercuration, hydroboration-oxidation, ozonolysis, reduction (catalytic and chemical), syn and anti-hydroxylation (oxidation). Diels-Alder reaction.. | 9 |

**TEXTBOOKS/REFERENCE BOOKS:**


1. Morrison, R. N. & Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. Pearson Education).
2. Kalsi, P. S. Stereochemistry Conformation and Mechanism; New Age International, 2005


| POs<br>Cos | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 1 | 1 | 1 | - | 1 | - | 3 | 3 | 3 | 1 |
| CO2 | 1 | 2 | - | - | 1 | - | 3 | 3 | 2 | 1 |
| CO3 | 1 | 2 | 1 | - | - | - | 3 | 3 | 2 | 2 |
| CO4 | 1 | - | 1 | 3 | 1 | - | 3 | 3 | 3 | 2 |

# BS-152: Physics Laboratory-II

(Semester II)

| | | | | | |
|---|---|---|---|---|---|
| L+T+P | : | **0+0+3** | Viva-voce + Continuous lab performance | : | **40** |
| Credits: | : | **2** | | | |
| Contact hours | : | **13** | Viva-voce + Practical Exam + Practical record file | : | **60** |

**LEARNING OBJECTIVES:**

The objective of the course General Physics Laboratory is to expose the students of B.Sc. class to experimental techniques in electronics, so that they can verify some of the things read in theory here or in earlier classes and develop confidence to handle sophisticated equipment.

**COURSE OUTCOMES:**

CO1: Understanding of resolving power of prism, telescope, and diffraction grating.
CO2: Experimental knowledge of Newton's ring method.
CO3: Experimental knowledge of resolving power.
CO4: Understanding of the electrical and thermal conductivity.

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

**TEXTBOOKS/REFERENCE BOOKS:**


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


| POs<br>COs | PO1 | PO2 | PO3 | PO4 | PSO1 | PSO2 | PSO3 | PSO4 |
|---|---|---|---|---|---|---|---|---|
| CO1 | 2 | 3 | 2 | 1 | 2 | 2 | 3 | 3 |
| CO2 | 1 | 3 | 1 | 1 | 1 | 2 | 1 | - |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| CO3 | 1 | 3 | 3 | - | 3 | 2 | 3 | - |
| CO4 | 2 | 3 | - | - | 2 | 1 | - | - |

## BCH-156: CHEMISTRY LABORATORY-II
(Semester II)

| | | | | | |
|---|---|---|---|---|---|
| L+T+P | : | **0+0+3** | Viva-voce + Continuous lab performance | : | **40** |
| Credits: | : | **2** | | | |
| Contact hours | : | **52** | Viva-voce + Practical Exam + Practical record file | : | **60** |

**LEARNING OBJECTIVES:**
The objective of the course is understood the preparation and qualitative and quantitative determination of metal ions.

**COURSE OUTCOMES:**
CO1. To learn the concept of inorganic Complex compound.
CO2. To understand the analytical methods for determination of metal ions by spectrophotometric methods. .
CO3. To understand the concept of thermodynamic parameters.

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

**TEXTBOOKS/REFERENCE BOOKS:**


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


| POs<br>COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 1 | 2 | 3 | 2 | 2 | 2 | 2 | 3 | 3 | 3 |
| CO2 | 1 | 2 | 3 | 1 | 2 | 1 | 2 | 3 | 3 | 3 |
| CO3 | 1 | 2 | 3 | 1 | 3 | 2 | 3 | 3 | 3 | 3 |

# SEMESTER-III

| BCH-201: INORGANIC CHEMISTRY-II (Semester III) | | | | | |
|---|---|---|---|---|---|
| L+T+P | : | **4+0+0** | Mid-Sessional exam | : | **15** |
| Credits: | : | **4** | ABQ | : | **25** |
| Contact hours | : | **52** | End-semester exam | : | **60** |

**OBJECTIVES:**

The course deals with the chemical and physical properties and their reactions of Group I to V$^{th}$ element.

**Course Outcomes:**

CO1. To learn about the chemical and physical properties of Alakli metals and compounds of S-block elements.

CO2. To know about the alkaline earth metals and their diagonal relationship with s-block metals and their applications.

CO3. Students will understand the physical and chemical properties of the Boron family.

CO4. Students will understand the physical and chemical properties of the Carbon and Nitrogen family.

| Unit | Contents | Lecture/Tutorials |
|---|---|---|
| **1.** | **Group I Elements:** Hydrogen: Isotopes (separation method not needed). Ortho and para hydrogen, Hydrides and their classification. Alkali metals: Chemical properties of the metals: reaction with water, air, nitrogen; uses of s-block metals and their compounds, Compounds of s-block metals: oxides, hydroxides, peroxides, superoxides. | **12** |
| **2.** | **Group II Elements:** *Alkaline earth metals*: Comparative study of these elements with special reference to their hydrides, oxides, hydroxide and halides. Diagonal relationship, solvation and Complexes of *s*-block metals including their applications in biosystems | **12** |
| **3.** | **Group III Elements:** Comparative study of physical and chemical properties of these elements with special reference to their oxides, hydrides, halides and nitirides. Preparation and properties of boric acids (ortho & meta boric acids) and borax, borax bead test. Boron Hydrides, structure and bonding in diboranes, borazine, borohydrides. | **8** |
| **4** | **Group IV Elements**: Comparative study of physical and chemicals properties of these elements with special references to their oxides, hydrides, nitrides, sulphides and carbides, fluorocarbons, study of silicates (structural aspects only), silicones, allotropy, inert pair effect, metallic and nonmetallic character, catenation and hetero catenation**.** | **10** |
| **5.** | **Group V Elements:** Comparative study of the physical and chemical properties of these elements with special reference to their hydrides, oxides, halides, oxyhalides and sulphides, Oxoacids of nitrogen: nitrous acid, nitric acid, hyponitrous acid, hydrazoic acid, pernitric acid; oxoacids of phosphorusorthophosphorous acid, metaphosphorous acid, hypophosphorous acid; orthophosphoric acid, di-, tri-, and tetrapolyphosphoric acids. | **10** |

**TEXTBOOKS/REFERENCE BOOKS:**

1. Cotton, F.A.G.; Wilkinson & Gaus, P.L. Basic Inorganic Chemistry 3rd Ed.; Wiley India,

2. Huheey, J. E.; Keiter, E.A. & Keiter, R.L. Inorganic Chemistry, Principles of Structure and Reactivity 4th Ed., Harper Collins 1993, Pearson, 2006.

3. Sharpe, A.G. Inorganic Chemistry, 4th Indian Reprint (Pearson Education) 2005.

5. Basolo, F. & Pearson, R. Mechanisms of Inorganic Reactions: Study of Metal Complexes in Solution 2nd Ed., John Wiley & Sons Inc; NY.

| POs Cos | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 1 | 1 | 1 | - | 1 | - | 3 | 3 | 3 | 1 |
| CO2 | 1 | 1 | - | - | 1 | - | 3 | 3 | 2 | 1 |
| CO3 | 1 | 2 | 2 | - | - | - | 3 | 3 | 3 | 2 |
| CO4 | 1 | - | 1 | 2 | 1 | - | 3 | 3 | 3 | 2 |

## BCH-203: ORGANIC CHEMISTRY-II
(Semester III)

| | | | | | |
|---|---|---|---|---|---|
| L+T+P | : | **4+0+0** | Mid-Sessional exam | : | **15** |
| Credits: | : | **4** | ABQ | : | **25** |
| Contact hours | : | **52** | End-semester exam | : | **60** |

**OBJECTIVES:**

The present curriculum enhances the knowledge of organic chemistry of students; they should aware with various types of mechanism to the organic molecules.

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**LEARNING OUTCOMES:**

CO1. To learn about the chemistry of Nucleophilic substitution reaction to alkyl and aryl halides.

CO2. To know about the preparation, properties and chemical reactions of phenols, ethers and epoxides.

CO3. To learn about the Nucleophilic addition reaction to the carbonyl compounds and related mechanism.

CO4. To know about the carboxylic acid derivatives and Sulphur containing compounds.

| S. No | Contents | Lecture/Tutorials |
|---|---|---|
| 1 | **Chemistry of Halogenated Hydrocarbons:** *Alkyl halides:* Nucleophilic substitution reactions – $S_N1$and $S_N2$ mechanisms. *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. | **12** |
| 2 | **Alcohols, Phenols, Ethers and Epoxides:** *Alcohols:* preparation, properties and relative reactivity of $1^{\circ}$, 2°, 3° alcohols, Preparation and properties of glycols: Oxidation by periodic acid and lead tetraacetate, Pinacol-Pinacolone rearrangement, *Phenols:* Preparation and properties; Ring substitution reactions, Reimer–Tiemann and Kolbe's–Schmidt Reactions, Fries and Claisen rearrangements. *Ethers and Epoxides:* Preparation and reactions with acids. Reactions of epoxides with alcohols, ammonia derivatives and $LiAlH_4$. | **14** |
| 3 | **Carbonyl Compounds:** Structure, reactivity and preparation; Nucleophilic additions, Nucleophilic addition-elimination reactions with ammonia derivatives; Mechanisms of Aldol and Benzoin condensation, Knoevenagel condensation, Claisan-Schmidt, Perkin, Cannizzaro and Wittig reaction, Beckmann and Benzil-Benzilic acid, Michael addition. Active methylene compounds: Keto-enol tautomerism | **10** |
| 4 | **Carboxylic Acids and their Derivatives:** Preparation, physical properties and reactions of mono-carboxylic acids: Typical reactions of dicarboxylic acids, hydroxy and unsaturated acids: succinic/phthalic, lactic, citric, maleic and fumaric acids. Preparation and reactions of acid chlorides, anhydrides, esters and amides; Claisen condensation, Dieckmann and Reformatsky reactions, Hofmann-bromamide degradation and Curtius rearrangement. | **9** |
| 5 | **Sulphur containing compounds:** Preparation and reactions of thiols, thioethers and sulphonic acids. | **7** |

**TEXTBOOKS/REFERENCE BOOKS:**


1. Inczedy, J. Analytical applications of complex equilibria Halsted Press: New York, NY (1976).
2. Ringbom, A. Complexation in Analytical Chemistry Wiley: New York (1963).

| POs<br>Cos | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 1 | 2 | - | - | 1 | - | 3 | 3 | 3 | 1 |
| CO2 | 1 | 1 | - | - | 1 | - | 3 | 3 | 2 | 1 |
| CO3 | 1 | 1 | 2 | - | - | - | 3 | 3 | 3 | 2 |
| CO4 | 1 | - | 1 | 2 | 1 | - | 3 | 3 | 3 | 2 |

| BCH-205: PHYSICAL CHEMISTRY-I (Semester III) | | | | | |
|---|---|---|---|---|---|
| L+T+P | : | **4+0+0** | Mid-Sessional exam | : | **15** |
| Credits: | : | **4** | ABQ | : | **25** |
| Contact hours | : | **52** | End-semester exam | : | **60** |

**OBJECTIVES:**

The objective of the course is to understand the thermo chemistry, Chemical equlilibrium and colligative properties of the solution.

**Course Outcomes:**

CO1. To know about the concept of heat of the reactions.

CO2. To understand the laws of thermodynamics.

CO3. Students will understand chemical equilibrium, Formulation of equilibrium law, and equilibrium law for ideal gases.

CO4. To know about the colligative properties of the solution.

| Unit | Contents | Lecture/Tutorials |
|---|---|---|
| **1.** | **Thermochemistry:** Exothermic and endothermic reactions, Heats of reactions, standard states, relation between heat of reaction at contant volume (qv) and at contant pressure (qp), Heat capacity, relation between Cp and Cv, enthalpy of formation, heat of solution and dilution, heat of neutralization, bond dissociation energy, bond energy and its calculation, concept of lattice energy.. | **14** |
| **2.** | **Thermodynamics I:** System, surroundings, intensive and extensive properties, isolated, closed and open systems; thermodynamic processes, state and path functions. First law of thermodynamics: Concept of heat (q), work (w), internal energy (U), and statement of first law; concept of carnot cycle, calculations of q, w, U and H for reversible, irreversible and free expansion of gases under isothermal and adiabatic conditions. Second Law: Spontaneous process, Criteria of spontaneity, Calculation of entropy change for reversible and irreversible processes. | **10** |
| **3.** | **Thermodynamics II:** Third Law: Statement of third law, concept of residual entropy, calculation of absolute entropy from heat capacity data.Gibbs free energy and spontaneity; free energy and work function, variation of free energy with temperature and pressure. Gibbs-Helmholtz equation, Clausius-Clapeyron equation and Maxwell relations. | **9** |
| **4** | **Chemical Equillibrium-I:** Reversible and irreversible reactions, Characteristics of chemical equilibrium, Formulation of equilibrium law, equilibrium law for ideal gases, relation between Kp and Kc and Kx. | **9** |
| **5.** | **Solutions and Colligative Properties:** Methods of expressing concentrations of solutions, Dilute solution, colligative properties, Raoults law, and relative lowering of vapour pressure, molecular weight determination. Osmosis, Law, determination of molecular weight from osmotic pressure. Abnormal molar mass, degree of dissociation and association of solutes. | **10** |

**TEXTBOOKS/REFERENCE BOOKS:**

1. Physical Chemistry, G. M. Barrow, International Student Edition, McGrawHill.

2. Physical Chemistry through Problems, S. K. Dogra and S. Dogra Wiley EasternLtd.

3. Physical Chemistry, P. W. Atkins, & J. de Paula, 10th Ed., Oxford University Press(2014).

| POs Cos | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 1 | 2 | 2 | 1 | 3 | - | 3 | 3 | 3 | 3 |
| CO2 | 1 | 2 | 2 | 1 | 3 | - | 3 | 3 | 3 | 3 |
| CO3 | 2 | 2 | 2 | 1 | 3 | - | 3 | 3 | 3 | 3 |
| CO4 | 2 | 3 | 3 | 2 | 3 | - | 3 | 3 | 3 | 3 |

| BCH-207: INDUSTRIAL CHEMISTRY-I (Semester III) | | | | | |
|---|---|---|---|---|---|
| L+T+P | : | **4+0+0** | Mid-Sessional exam | : | **15** |
| Credits: | : | **4** | ABQ | : | **25** |
| Contact hours | : | **52** | End-semester exam | : | **60** |

**OBJECTIVES:**

The objective of the course to understand the environmental pollution causes and their remediation to make eco and pollution less environment.

**Course Outcomes:**

CO1. To know about the hazardousness and their remediation of industrial gases.
CO2. To know about the different biogeological cycles and chemical nature of air pollutants.
CO3.To know about the global warming and Greenhouse gases.
CO4. To understand the source of energy.

| Unit | Contents | Lecture/Tutorials |
|---|---|---|
| **1.** | **Industrial Gases and Inorganic Chemicals:** Industrial Gases: Large scale production, storage and hazards in handling of the following gases: oxygen, nitrogen, argon, neon, helium, hydrogen, carbon monoxide, chlorine, fluorine, sulphur dioxide and phosgene. Inorganic Chemicals: Manufacture, application and hazards in handling the following chemicals: hydrochloric acid, nitric acid, sulphuric acid, caustic soda, common salt, borax, bleaching powder, hydrogen peroxide, potash alum, potassium dichromate and potassium permanganate. | **12** |
| **2.** | **Environment and its segments-I:** Ecosystems. Biogeochemical cycles of carbon, nitrogen and sulphur. Air Pollution: Major regions of atmosphere. Chemical and photochemical reactions in atmosphere. Air pollutants: types, sources, particle size and chemical nature; Photochemical smog: its constituents and photochemistry. | **12** |
| **3.** | **Environment and its segments-II:** Environmental effects of ozone, major sources of air pollution. pollution by gases. Methods of estimation of CO, NOx, SOx and control procedures .Effects of air pollution on living organisms and vegetation. Greenhouse effect and Global warming, Ozone depletion by oxides of nitrogen, chlorofluorocarbons and Halogens, removal of sulphur from coal. | **10** |
| **4.** | **Water Pollution:** Hydrological cycle, water resources, aquatic ecosystems, Sources and nature of water pollutants, Techniques for measuring water pollution, Impacts of water pollution on hydrological and ecosystems. Industrial effluents and their treatment; Sludge disposal; Industrial waste management, Water treatment and purification (reverse osmosis, electro dialysis, ion exchange). Water quality parameters for waste water, industrial water and domestic water. | **8** |
| **5** | **Energy & Environment:** Sources of energy: Coal, petrol and natural gas. Nuclear Fusion/Fission, Solar energy, Hydrogen, geothermal, Tidal and Hydel, etc. Nuclear Pollution: Disposal of nuclear waste, nuclear disaster and its management. Biocatalysis: Introduction to biocatalysis: Importance in "Green Chemistry" and Chemical Industry. | **10** |

**TEXTBOOKS/REFERENCE BOOKS:**

1. E. Stocchi: Industrial Chemistry, Vol-I, Ellis Horwood Ltd.UK.
2. R.M. Felder, R.W. Rousseau: Elementary Principles of Chemical Processes, Wiley Publishers, New Delhi.
3. J.A. Kent: Riegel'sHandbook of Industrial Chemistry, CBS Publishers, New Delhi.

| POs<br>Cos | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 1 | 2 | - | - | 3 | - | 2 | 1 | 3 | 1 |
| CO2 | 2 | 1 | - | - | 3 | - | 2 | 1 | 2 | 1 |
| CO3 | 2 | 1 | 2 | - | 3 | - | 3 | 2 | 3 | 2 |
| CO4 | 2 | - | 1 | 2 | 3 | - | 3 | 2 | 3 | 2 |

## BCH-251: CHEMISTRY LABORATORY-III
(Semester III)

| | | | | | |
|---|---|---|---|---|---|
| L+T+P | : | **0+0+2** | Viva-voce + Continuous lab performance | : | **40** |
| Credits: | : | **2** | | | |
| Contact hours | : | **52** | Viva-voce + Practical Exam + Practical record file | : | **60** |

**LEARNING OBJECTIVES:**
Students will get the knowledge of titration and estimation and preparation of Inorganic compounds.

**Course Outcomes:**
**CO1.** Estimation of Cu(II) and chlorine through Iodometric Titration.
CO2. Synthesis of inorganic and organic compound.
CO3. Determination of kinetics of reaction.

| S. No. | Practical Description |
|---|---|
| 1. | Estimation of Cu(II) and $K_2Cr_2O_7$ using sodium thiosulphate solution(Iodimetrically). |
| 2. | Estimation of available chlorine in bleaching powder iodometrically. |
| 3. | **Inorganic Preparations:**<br>Cuprous chloride,$Cu_2Cl_2$<br>Preparation of Manganese(III) phosphate,$MnPO_4.H_2O$.<br>Preparation of Aluminium potassium sulphate $K_2SO_4.Al(SO_4)_2.12H_2O$ (Potash alum) or Chromealum. |
| 4. | Acetylation of aniline |
| 5. | Benzolyation of β-naphthol |
| 6. | Synthesis of Salicylic acid by green approach |
| 7. | To determine the order of the reaction between thiosulphate and HCl w.r.t. thiosulphate |
| 8. | pH metric titration of (i) strong acid vs. strong base, (ii) weak acid vs. strong base. |
| 9. | Determination of dissolved oxygen inwater |
| 10. | Measurement of chloride, sulphate and salinity of water samples by simple titration. |
| 11. | Preparation of borax/ boricacid |

| POs<br>COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 1 | 2 | 3 | 2 | 2 | 2 | 2 | 3 | 3 | 3 |
| CO2 | 1 | 2 | 3 | 1 | 2 | 1 | 2 | 3 | 3 | 3 |
| CO3 | 1 | 2 | 3 | 1 | 3 | 2 | 3 | 3 | 3 | 3 |

# SEMESTER-IV

## BCH-202: INORGANIC CHEMISTRY-III
(Semester IV)

| | | | | | |
|---|---|---|---|---|---|
| L+T+P | : | **4+0+0** | Mid-Sessional exam | : | **15** |
| Credits: | : | **4** | ABQ | : | **25** |
| Contact hours | : | **52** | End-semester exam | : | **60** |

**OBJECTIVES:**
The course deals with detail study of hydrides, oxides, halides and sulphides of Group V, VII, VII elements along with the theoretical principles of qualitative analysis of cations and anions..

**Course Outcomes:**
CO1. To know about the physical and chemical properties of d-block elements.
CO2. To know about the physical and chemical properties of halogen family.
CO3. Explanation of physical properties uses and shapes of Noble gases molecules.
CO4. To learn about the principle of qualitative analysis of cations and anions.

| Unit | Contents | Lecture/Tutorials |
|---|---|---|
| **1.** | **Group V Elements**: Comparative study of the physical and chemical properties of these elements with special reference to their hydrides, oxides, halides, oxyhalides and sulphides, Oxoacids of nitrogen: nitrous acid, nitric acid, hyponitrous acid, hydrazoic acid, pernitric acid; oxoacids of phosphorus orthophosphorous acid, metaphosphorous acid, hypophosphorous acid; orthophosphoric acid, di-, tri-, and tetrapolyphosphoric acids. | **12** |
| **2.** | **Group VI Elements:** Comparative study of physical and chemical properties of these elements with special reference to their hydrides, oxides, halides and oxyhalides. Detailed study of oxyacids, peroxyacids and thio-oxyacids of sulphur (with special emphasis on their structure). | **8** |
| **3.** | **Group VII Elements**: Comparative study of physical and chemical properties with special reference to their electron affinity, electronegativity, bond dissociation energy, oxidation number, oxidizing power, reactivity, hydrides, oxides and oxyacids, peroxyacids, strength of oxoacids.. Interhalogens, polyhalides (with special emphasis on their structures), pseudo-halogens -structure and properties. | **12** |
| **4** | **Noble Gases:** Occurrence and uses, rationalization of inertness of noble gases, Clathrates; preparation and properties of XeF2, XeF4 and XeF6; Nature of bonding in noble gas compounds (Valence bond treatment and MO treatment for XeF2). Molecular shapes of noble gas compounds (VSEPR theory). | **10** |
| **5.** | **Theoretical Principles In Qualitative Analysis:** Basic principles involved in analysis of cations and anions and solubility products, common ion effect. Principles involved in separation of cations into groups and choice of group reagents. Interfering anions (fluoride, borate, oxalate and phosphate) and need to remove them after Group II | **10** |

**TEXTBOOKS/REFERENCE BOOKS:**

1. Cotton, F.A.G.; Wilkinson & Gaus, P.L. Basic Inorganic Chemistry 3rd Ed.; Wiley India,
2. Huheey, J. E.; Keiter, E.A. & Keiter, R.L. Inorganic Chemistry, Principles of Structure and Reactivity 4th Ed., Harper Collins 1993, Pearson, 2006.
3. Sharpe, A.G. Inorganic Chemistry, 4th Indian Reprint (Pearson Education) 2005.

| POs<br>Cos | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 1 | 1 | 1 | - | 2 | - | 3 | 2 | 3 | 2 |
| CO2 | 2 | 1 | - | - | 2 | - | 3 | 2 | 3 | 2 |
| CO3 | 2 | 1 | 2 | - | 1 | - | 3 | 2 | 3 | 3 |
| CO4 | 2 | - | 1 | 2 | 2 | - | 3 | 2 | 3 | 3 |

## BCH-204: ORGANIC CHEMISTRY-III
(Semester IV)

| | | | | | |
|---|---|---|---|---|---|
| L+T+P | : | **4+0+0** | Mid-Sessional exam | : | **15** |
| Credits: | : | **4** | ABQ | : | **25** |
| Contact hours | : | **52** | End-semester exam | : | **60** |

**OBJECTIVES:**

This course introduces basic features, structural aspects as well as applications of organic compounds such as amino acid, protein, nucleic acid, carbohydrates, lipid, oil and detergents

**Course Outcomes:**

CO1. Explain the classification and separation of amino acids, peptides and Proteins.

CO2. To understand the components of nucleic acids and its biological role.

CO3. To know about the biological importance, classification and structure of carbohydrates and lipids.

CO4. Explanation of mode of action and uses of detergents.

| Unit | Contents | Lecture/Tutorials |
|---|---|---|
| **1.** | **Amino Acids, Peptides and Proteins Amino acids:** Peptides and their classification:α-Amino Acids – stereochemistry, Synthesis, chromatographic separation, ionic properties and reactions. Zwitterions, pKa values, isoelectric point and electrophoresis. Resolution of racemic aminoacids, 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.Primary Secondary and tertiary structure of proteins. | **11** |
| **2.** | **Nucleic Acids:** Components of nucleic acids, Nucleosides and nucleotides; Structure, synthesis and reactions of: Adenine, Guanine, Cytosine, Uracil and Thymine;Structure of polynucleotides. DNA and RNA – Base pair formation and double helical structure.Comparison of structural stability**.** | **09** |
| **3.** | **Carbohydrates:** Occurrence, classification and their biological importance;Monosaccharides: Constitution and absolute configuration of glucose and fructose, epimers and anomers, mutarotation, Haworth projections and conformational structures; Interconversions of aldoses and ketoses; Disaccharides – Structure elucidation of maltose, lactose and sucrose.; Polysaccharides – Elementary treatment of starch, cellulose and glycogen. | **12** |
| **4** | **Lipids**: Introduction to oils and fats; common fatty acids present in oils and fats,Saturated and unsaturated fatty acids.Classification of unsaturated fatty acids. Melting and boiling point of fatty acids. Hydrogenntion and Free radical reactions of fats and oils; Saponification value, acid value, iodine number; Reversion and rancidity | **11** |
| **5.** | **Fats, Oil and Detergents:** Occurrence, chemical composition and importance, hydrogenated oils, Rancidity, acid value, saponification and iodine numbers, difference between toilet and washing soaps, comparison of soap and detergents, classification and principle of cleansing action of detergents | **9** |

**TEXTBOOKS/REFERENCE BOOKS:**


1. Atkins P. W. and De Paula J., Physical Chemistry, (tenth edition) Oxford University Press, 2014.
2. Poole, C.P. & Owens, F.J. Introduction to Nanotechnology John Wiley 2003).
3. Rohatgi-Mukherjee K. K. Fundamentals of Photochemistry, New age (revised second edition).

| POs<br>Cos | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 1 | 1 | 1 | - | 2 | - | 2 | 2 | 3 | 2 |
| CO2 | 2 | 1 | - | - | 2 | - | 2 | 2 | 3 | 2 |
| CO3 | 2 | 1 | 2 | - | 1 | - | 2 | 2 | 3 | 3 |
| CO4 | 2 | - | 1 | 2 | 2 | - | 2 | 2 | 3 | 3 |

| BCH-206: PHYSICAL CHEMISTRY-II<br>(Semester IV) | | | | | |
|---|---|---|---|---|---|
| L+T+P | : | **4+0+0** | Mid-Sessional exam | : | **15** |
| Credits: | : | **4** | ABQ | : | **25** |
| Contact hours | : | **52** | End-semester exam | : | **60** |

**OBJECTIVES:**

The objective of the course is to provide the depth knowledge about the catalysis, conductance, concentration cells, Chemical and ionic equilibrium.

**Course Outcomes:**

CO1. To know about the mechanism of catalyzed reactions viz. Michaelis- Menten mechanism.

CO2. To learn about the laws of conductance.

CO3. To know about the electrodes functions of concentration cells.

CO4. To understand the relationship between chemical and ionic equilibrium constants.

| Unit | Contents | Lecture/Tutorials |
|---|---|---|
| **1.** | **Catalysis**: Types of catalyst, specificity and selectivity, mechanisms of catalyzed reactions at solid surfaces; effect of particle size and efficiency of nanoparticles as catalysts. Enzyme catalysis, Michaelis-Menten mechanism, acid-base catalysis. | **6** |
| **2.** | **Conductance**: Arrhenius theory of electrolytic dissociation. Conductivity, equivalent and molar conductivity and their variation with dilution for weak and strong electrolytes. Molar conductivity at infinite dilution. Kohlrausch law of independent migration of ions. Debye-Huckel-Onsager equation. Ionic velocities, mobilities and their determinations, transference numbers and their relation to ionic mobilities, determination of transference numbers using Hittorf and Moving Boundary methods. Applications of conductance measurement. | **10** |
| **3.** | **Concentration cells:** Difference between chemical cells and concentration cells, liquid junction potential, its derivation, Electrode concentration cells without liquid junction potential, electrolyte concentration cells without liquid junction potential, concentration cells with liquid junction potential. | **9** |
| **4** | **Chemical Equillibrium-II:** Equilibrium law for ideal gases, relation between Kp and Kc and Kx. Reaction quotient, factors affecting the equilibrium constant. Equilibrium between gases and solids, equilibrium constant for a system of real gases, equilibrium constant of reactions in solution. Thermodynamic treatment of equilibrium constant. Variation of equilibrium constant with temperature, pressure and concentration, effect of inert gas on reaction equilibrium, Le – Chatelier's principle.. | **12** |
| **5.** | **Ionic Equilibria:** Strong, moderate and weak electrolytes, degree of ionization, factors affecting degree of ionization. Acid-base concept. Dissociation constants of weak acids and weak bases. Ionization constant and Ionic product of water. The pH scale, Buffer solutions, Calculations of pH values of buffer mixtures, Derivation of Henderson equation and its applications, buffer capacity and buffer action. Salt hydrolysis, Determination of hydrolysis constant, degree of hydrolysis and pH for different salts. Relation between Kh, Ka and Kb. Solubility and solubility product of sparingly soluble salts – Applications of | **13** |

| | | |
|---|---|---|
| | solubility product principle and Common ion effect. | |

**TEXTBOOKS/REFERENCE BOOKS:**


1. Essentials of Physical Chemistry, B.S. Bahl, G.D.Tuli and ArunBahl, S. Chand & CompanyLtd.
2. Physical Chemistry, P. W. Atkins, & J. de Paula, 10th Ed., Oxford University Press (2014).


| POs<br>Cos | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 1 | 1 | 1 | - | 2 | - | 2 | 3 | 3 | 2 |
| CO2 | 2 | 1 | - | - | 2 | - | 2 | 3 | 2 | 2 |
| CO3 | 2 | 1 | 2 | - | 1 | - | 2 | 2 | 3 | 3 |
| CO4 | 2 | - | 1 | 2 | 2 | - | 3 | 2 | 3 | 3 |

| BCH-208: INDUSTRIAL CHEMISTRY-II<br>(Semester IV) | | | | | |
|---|---|---|---|---|---|
| L+T+P | : | **4+0+0** | Mid-Sessional exam | : | **15** |
| Credits: | : | **4** | ABQ | : | **25** |
| Contact hours | : | **52** | End-semester exam | : | **60** |

**OBJECTIVES:**

The objective of the course is to have the knowledge of classification and manufacturing of the industrial chemicals, fertilizers and surface coating materials.

**Course Outcomes:**

CO1. To understand the classification and manufacturing of glass, ceramics and cement.
CO2. To know about the manufacturing and types of fertilizers.
CO3. To understand the surface coating materials and alloys.
CO4. To learn about the origin, explosive properties and preparation of organic compounds.

| Unit | Contents | Lecture/Tutorials |
|---|---|---|
| **1.** | **Industrial Chemicals:** Glass: Glassy state and its properties, classification (silicate and non-silicate glasses).Manufacture and processing of glass. Composition and properties of the following types of glasses: Soda lime glass, lead glass, safety glass, borosilicate glass, fluorosilicate, coloured glass, photosensitive glass. Ceramics: Important clays and feldspar, ceramic, their types and manufacture. High technology ceramics and their applications, superconducting and semiconducting oxides, fullerenes carbon nanotubes and carbonfibre. Cements: Classification of cement, ingredients and their role, Manufacture of cement and the setting process, quick setting cements**.** | **14** |
| **2.** | **Fertilizers:** Different types of fertilizers. Manufacture of the following fertilizers: Urea, ammonium nitrate, calcium ammonium nitrate, ammonium phosphates; polyphosphate, superphosphate, compound and mixed fertilizers, potassium chloride, potassium sulphate. | **8** |
| **3.** | **Surface Coatings:** Objectives of coatings surfaces, preliminary treatment of surface, classification of surface coatings. Paints and pigments-formulation, composition and related properties. Oil paint, Vehicle, modified oils, Pigments, toners and lakes pigments, Fillers, Thinners, Enamels, emulsifying agents. Special paints (Heat retardant, Fire retardant, Eco-friendly paint, Plastic paint), Dyes, Wax polishing, Water and Oil paints, additives, Metallic coatings (electrolytic and electroless), metal spraying and anodizing. | **14** |
| **4** | **Alloys:** Classification of alloys, ferrous and non-ferrous alloys, Specific properties of elements in alloys. Manufacture of Steel (removal of silicon decarbonization, demanganization, desulphurization dephosphorisation) and surface treatment (argon treatment, heat treatment, nitriding, carburizing). Composition and properties of different types of steels. | **9** |
| **5.** | **Chemical explosives:** Origin of explosive properties in organic compounds, preparation and explosive properties of lead azide, PETN, cyclonite (RDX). Introduction to rocket propellants | **7** |

**TEXTBOOKS/REFERENCE BOOKS:**

1. E. Stocchi: Industrial Chemistry, Vol-I, Ellis Horwood Ltd.UK.
2. R.M. Felder, R.W. Rousseau: Elementary Principles of Chemical Processes, Wiley Publishers, New Delhi.
3. J.A. Kent: Riegel'sHandbook of Industrial Chemistry, CBS Publishers, New Delhi.

| POs<br>Cos | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 1 | 2 | - | - | 2 | - | 2 | 1 | 3 | 1 |
| CO2 | 2 | 1 | - | - | 2 | - | 2 | 1 | 2 | 1 |
| CO3 | 2 | 1 | 2 | - | 1 | - | 2 | 2 | 3 | 2 |
| CO4 | 2 | - | 1 | 2 | 2 | - | 3 | 2 | 3 | 2 |

## BCH-252: CHEMISTRY LABORATORY-IV
(Semester IV)

| | | | | | |
|---|---|---|---|---|---|
| L+T+P | : | **0+0+2** | Viva-voce + Continuous lab performance | : | **40** |
| Credits: | : | **2** | | | |
| Contact hours | : | **52** | Viva-voce + Practical Exam + Practical record file | : | **60** |

**OBJECTIVES:**
The students have the detailed knowledge of analysis of different element, quantitative organic compound analysis and also have the spectroscopic determination method.
CO1. Estimation of metals in a complex compound.
CO2. To learn about the preparation of Dyes.
CO3. Determination of saponification value in oil.

| S. No. | Practical Description |
|---|---|
| 1. | Estimation of iron as $Fe_2O_3$ by precipitating iron as$Fe(OH)_3$. |
| 2. | Estimation of nickel(II) using Dimethylglyoxime(DMG). |
| 3. | Acetylation of aniline |
| 4. | **Inorganic Preparations:**<br>*Cis* and *trans* $K[Cr(C_2O_4)_2(H_2O)_2]$ Potassiumdioxalatodiaquachromate(III)<br>Tetraamminecarbonatocobalt (III) ion<br>Potassiumtris (oxalato) ferrate(III) |
| 5. | **Preparation of dyes**<br>Malachite Green<br>1-2-coupling reaction<br>1-4-coupling reaction |
| 6. | Determination of cell constant |
| 7. | To determine the saponification value of an oil or a fat. |
| 8. | To determination of iodine number of an oil/ fat. |
| 9. | To determination of acid value of an oil/ fat. |
| 10. | Synthesis of hydrazones. |

| POs<br>COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 1 | 2 | 3 | 2 | 2 | 2 | 2 | 3 | 3 | 3 |
| CO2 | 1 | 2 | 3 | 1 | 2 | 1 | 2 | 3 | 3 | 3 |
| CO3 | 1 | 2 | 3 | 1 | 3 | 2 | 3 | 3 | 3 | 3 |

# SEMESTER-V

| BCH-301: SEPARATION TECHNIQUES IN CHEMISTRY (Semester V) | | | | | |
|---|---|---|---|---|---|
| L+T+P | : | **4+0+0** | Mid-Sessional exam | : | **15** |
| Credits: | : | **4** | ABQ | : | **25** |
| Contact hours | : | **52** | End-semester exam | : | **60** |

**OBJECTIVES:**
The course deals with the different types of chromatography and their applications.

**Course Outcomes:**

**CO1.** To understand the basic definition and introduction of principles of different types of chromatography.

CO2. To learn about the superiority of thin layer over paper chromatography and applications of paper and Thin layer chromatography.

CO3. Students will understand the experimental application of column chromatography.

CO4. Students will understand the experimental application of Solvent extraction Technology.

| Unit | Contents | Lecture/Tutorials |
|---|---|---|
| **1.** | **Chromatography**: Definition, general introduction on principles of chromatography, paper chromatography, TLC etc. a. Paper chromatographic separation of mixture of metal ion (Fe3+ and Al3+). Column, ion-exchange chromatography etc. Determination of ion exchange capacity of anion / cation exchange resin (using batch procedure if use of column is not feasible). | **10** |
| **2.** | **Paper Chromatography:** Classification of chromatography, Paper chromatography: Types of paper chromatography, Experimental details and applications. | **8** |
| **3.** | **Thin-Layer Chromatography:** History and origin of Thin-Layer Chromatography (TLC), Superiority of TLC over paper chromatography, Principle, apparatus, and experimental techniques of TLC, Factor affecting $R_f$ value, Applications and limitations of TLC. | **10** |
| **4.** | **Column Chromatography:** Introduction and principle of column chromatography, apparatus, adsorbents, solvents and experimental procedure, Factors affecting column efficiency, Applications of Column chromatography. | **12** |
| **5** | **Solvent Extraction:** Introduction, Principle of solvent extraction, Efficiency of extraction, Experimental details and applications of solvent extraction. | **8** |

**TEXTBOOKS/REFERENCE BOOKS:**


1. G.D. Christian, *Analytical Chemistry*, John Wiley andSons.
2. D. Harvey, *Modern Analytical Chemistry*, McGrawHill.
3. H.A. Strobel, *Chemical Instrumentation: A Systematic approach*, Addison-Wesley Publishing Company.
4. D. A. Skoog, F.J. Holler, S. R. Crouch, *Instrumental Analysis*, Cengage Learning India Private Limited.


| POs Cos | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 1 | 1 | 2 | 2 | - | - | 3 | 3 | 3 | 1 |
| CO2 | 1 | 2 | 3 | 2 | - | - | 3 | 3 | 3 | 1 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| CO3 | 1 | 2 | 2 | 2 | 2 | - | 3 | 3 | 3 | 2 |
| CO4 | 1 | 2 | 3 | 3 | 1 | - | 3 | 3 | 3 | 2 |

| BCH-303: ORGANIC SPECTROSCOPY (Semester V) | | | | | |
|---|---|---|---|---|---|
| L+T+P | : | **4+0+0** | Mid-Sessional exam | : | **15** |
| Credits: | : | **4** | ABQ | : | **25** |
| Contact hours | : | **52** | End-semester exam | : | **60** |

**OBJECTIVES:**

This course introduces the fundamentals of spectroscopy and its application for identifying the organic molecules.

**Course Outcomes:**

CO1. Students will be able to identify the UV-visible spectroscopy and applications to the organic molecule.

CO2. Students will be able to understand IRspectroscopy and Fingerprint region and its significance.

CO3. Students will understand the principle of NMR spectroscopy and its application for the determination of organic molecules.

CO4. Students will understand the principle of mass spectroscopy and its application for the determination of molecules.

| Unit | Contents | Lecture/Tutorials |
|---|---|---|
| **1.** | **UV-Visible:** General principles Introduction to absorption and emission spectroscopy. UV Spectroscopy: Types of electronic transitions, λ max, Chromophores and Auxochromes, Bathochromic and Hypsochromic shifts, Intensity of absorption; Application of Woodward Rules for calculation of λ max for the following systems: α,β unsaturated aldehydes, ketones, carboxylic acids and esters; Conjugated dienes: alicyclic, homoannular and heteroannular; Extended conjugated systems (aldehydes, ketones and dienes); distinction between cis and trans isomers. | **11** |
| **2.** | **IR Spectroscopy :** Fundamental and non-fundamental molecular vibrations; IR absorption positions of O, N and S containing functional groups; Effect of H-bonding, conjugation, resonance and ring size on IR absorptions; Fingerprint region and its significance; application in functional group analysis**.** | **09** |
| **3.** | **NMR Spectroscopy-I:** Basic principles of Proton Magnetic Resonance, chemical shift and factors influencing it; Spin – Spin coupling and coupling constant; Anisotropic effects in alkene, alkyne, aldehydes and aromatics, Interpretation of NMR spectra of simple compounds. Applications of IR, UV and NMR for identification of simple organic molecules. | **12** |
| **4** | **NMR Spectroscopy-II:** 13C NMR Spectroscopy Difficulties and solution for recording, 13C- NMR spectra recording of 13C NMR spectra scale solvent signals and their positions, multiplicity, 13C1H coupling constant- proton coupled and decoupled 13C spectra broad bands decoupling off resonance technique. Chemical shifts in 13C spectra- calculation in internal and terminal substituted compounds, aromatic compounds | **11** |
| **5.** | **Mass Spectroscopy:** Introduction, instrumentation, mass spectrum, determination of molecular formula, parent peak and base peak, recognition of molecular ion peak, fragmentation pattern of alkanes, alkenes and benzene. | **9** |

**TEXTBOOKS/REFERENCE BOOKS:**

1. Kalsi, P. S. Textbook of Organic Chemistry 1st Ed., New Age International (P) Ltd. Pub.
2. Billmeyer, F. W. Textbook of Polymer Science, John Wiley & Sons, Inc.Gowariker,

3. Finar, I. L. Organic Chemistry (Volume 2: Stereochemistry and the Chemistry of Natural Products), Dorling Kindersley (India) Pvt. Ltd. (PearsonEducation).

| POs<br>Cos | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 1 | 1 | 2 | 2 | - | - | 3 | 3 | 3 | 1 |
| CO2 | 1 | 2 | 3 | 2 | - | - | 3 | 3 | 3 | 1 |
| CO3 | 1 | 1 | 2 | 2 | 2 | - | 3 | 3 | 3 | 2 |
| CO4 | 1 | 2 | 3 | 3 | 1 | - | 3 | 3 | 3 | 2 |

| BCH-305: QUANTUM AND PHOTOCHEMISTRY (Semester V) | | | | | |
|---|---|---|---|---|---|
| L+T+P | : | **4+0+0** | Mid-Sessional exam | : | **15** |
| Credits: | : | **4** | ABQ | : | **25** |
| Contact hours | : | **52** | End-semester exam | : | **60** |

**OBJECTIVES:**

The objective of the course to understand the quantum Mechanics, angular momentum, chemical bonding and photochemistry

**Course Outcomes:**

Co1. Students will understand the elementary principles and postulates of quantum mechanics.

Co2. To learn about the concept of Schrödinger equation in Cartesian and spherical polar coordinates and rigid rotators.

CO3. To learn the concept and application of approximation method.

CO4.Students will learn different type of chemical bonding and qualitative treatment of homo and hetero-diatomic molecules.

CO5. Students will understand the laws of photochemistry and role of photochemical reaction in biological systems

| Unit | Contents | Lecture/Tutorials |
|---|---|---|
| **1.** | **Elementary Quantum Mechanics:** Postulates of quantum mechanics, quantum mechanical operators, Schrödinger equation and its application to free particle and particle in a box (rigorous treatment), quantization of energy levels, zero point energy and Heisenberg Uncertainity principle, wave functions, probability, extension to three dimensional boxes, separation of variables, degeneracy. Qualitative treatment of simple harmonic oscillator model of vibrational motion. Setting up of Schrödinger equation and discussion of solution and wave functions. Vibrational energy of diatomic molecules and zero point energy. | **14** |
| **2.** | **Angular momentum:** Rigid rotator model of rotation of diatomic molecule. Schrödinger equation in Cartesian and spherical polar coordinates (derivation not required). Separation of variables. Spherical harmonics. Qualitative discussion of solution. | **8** |
| **3.** | **Atomic structure:** Qualitative treatment of hydrogen atom and hydrogen like ions: setting up of Schrödinger equation in spherical polar coordinates, radial part, quantization of energy (only final energy expression).Average and most probable distances of electron from the nucleus. Setting up of Schrödinger equation for many electron atoms (He,Li).Need for approximate methods. | **8** |
| **4.** | **Chemical bonding:** Covalent bonding, valence bond and molecular orbital approaches, LCAO –MO treatment of H2+.Bonding and anti-bonding orbitals. Qualitative extension to H2. Comparison of LCAO –MO and VB treatments of H2(only wave functions, detailed solution not required) and their limitations. Refinements of the two approaches (configuration interaction for MO, ionic terms in VB).Qualitative treatment of LCAO-MO treatment of homonuclear and heteronuclear diatomic molecules (HF, LiH). | **12** |
| **5** | **Photochemistry:** Laws, of photochemistry, quantum yield, actinometry, examples of low and high quantum yields, photochemical equilibrium and the differential rate of photochemical reactions, photosensitised reactions, quenching. Role of photochemical 34 reactions in biochemical processes, photostationary states, chemiluminescence. | **10** |

**TEXTBOOKS/REFERENCE BOOKS:**

1. Physical Chemistry by KL Kapoor, Vol. 4, MacMillan IndiaLtd.

2. Introductory Quantum Chemistry by AK Chandra, Tata McGrawHill.

| POs Cos | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 1 | 1 | 2 | 2 | - | - | 3 | 3 | 3 | 1 |
| CO2 | 1 | 2 | 3 | 2 | - | - | 3 | 3 | 3 | 1 |
| CO3 | 1 | 1 | 2 | 2 | 2 | - | 3 | 3 | 3 | 2 |
| CO4 | 1 | 2 | 3 | 3 | 1 | - | 3 | 3 | 3 | 2 |
| CO5 | 1 | 2 | 3 | 2 | 1 | - |  | 2 | 3 | 2 |

| BCH-307: Green Chemistry (Semester V) | | | | | |
|---|---|---|---|---|---|
| L+T+P | : | **4+0+0** | Mid-Sessional exam | : | **15** |
| Credits: | : | **4** | ABQ | : | **25** |
| Contact hours | : | **52** | End-semester exam | : | **60** |

**OBJECTIVES:**

The primary objective of this course is to make students aware of how chemical processes can be designed, developed and run in a sustainable way. Student will acquire the competence to think of chemistry as a sustainable activity. To give information about the design competitive chemical products and processes that attain the highest level of the pollution-prevention hierarchy by reducing pollution at its source

**Course Outcomes:**

CO1.To learn the basic principles of green and sustainable chemistry.
CO2.They must be able to do and understand stoichiometric calculations and relate them to green process metrics.
CO3. To learn alternative solvent media and energy sources for chemical processes.
CO4. To learn about renewable requirements for the chemical industry, present and under development.

| Unit | Contents | Lecture/Tutorials |
|---|---|---|
| **1.** | **Introduction to Green Chemistry:** Twelve principles of Green Chemistry: Designing a Green Synthesis using these principles Need for Green Chemistry. Goals of Green Chemistry, Limitations/ Obstacles in the pursuit of the goals of Green Chemistry. | **12** |
| **2.** | **Principles of Green Chemistry: ;** Prevention of Waste/ byproducts; maximum incorporation of the materials used in the process into the final products , Green solvents– supercritical fluids, water as a solvent for organic reactions, ionic liquids, Energy requirements for reactions – alternative sources of energy: use of microwaves and ultrasonic energy. careful use of blocking/ protecting groups. | **12** |
| **3.** | **Designing a Chemical synthesis:** Catalysis and green chemistry, comparison of heterogeneous and homogeneous catalysis, biocatalysis, asymmetric catalysis and photocatalysis. Strengthening/ development of analytical techniques to prevent generation of hazardous substances in chemical processes.. | **8** |
| **4** | **Examples of Green Synthesis/ Reactions and some real world cases:** Green Synthesis of adipic acid, catechol, disodium iminodiacetate (alternative to Strecker synthesis). Microwave assisted reactions in water: Hofmann Elimination, methyl benzoate to benzoic acid, oxidation of toluene and alcohols; microwave assisted reactions in organic solvents Diels-Alder reaction and Decarboxylation reaction. Ultrasound assisted reactions: sonochemical Simmons-Smith Reaction. Surfactants for carbon dioxide – replacing smog producing and ozone depleting solvents with CO2.Enzymatic Inter esterification for production of no Trans-Fats and Oils, Development of Fully Recyclable Carpet: Cradle to CradleCarpeting | **10** |
| **5.** | **Future Trends in Green Chemistry:** Oxidation reagents and catalysts; Biomimetic, multifunctional reagents; Combinatorial green chemistry; Proliferation of solventless reactions; co crystal controlled solid state synthesis(C Green chemistry in sustainable development. | **10** |

**TEXTBOOKS/REFERENCE BOOKS:**

1. E. Stocchi: Industrial Chemistry, Vol-I, Ellis Horwood Ltd.UK.

2. R.M. Felder, R.W. Rousseau: Elementary Principles of Chemical Processes, Wiley Publishers, New Delhi.
3. J.A. Kent: Riegel'sHandbook of Industrial Chemistry, CBS Publishers, NewDelhi.
4. S.S. Dara: A Textbook of Engineering Chemistry, S. Chand & Company Ltd. NewDelhi.

| POs<br>Cos | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 1 | - | - | 1 | 2 | - | 2 | 2 | 3 | 2 |
| CO2 | 1 | 1 | - | 2 | 2 | - | 2 | 2 | 3 | 1 |
| CO3 | 1 | - | - | 3 | 3 | - | 2 | 2 | 3 | 2 |
| CO4 | 1 | - | 1 | 3 | 3 | - | 2 | 2 | 3 | 2 |

## BCH-309: CHEMISTRY OF PESTICIDES AND COSMETICS

(Semester V)

| | | | | | |
|---|---|---|---|---|---|
| L+T+P | : | **4+0+0** | Mid-Sessional exam | : | **15** |
| Credits: | : | **4** | ABQ | : | **25** |
| Contact hours | : | **52** | End-semester exam | : | **60** |

**OBJECTIVES:**

The objective of the course introduction and synthesis of pesticides and cosmetics and their application in industries

**Course Outcomes:**

CO1. To learn about the introduction, structure and benefits and adverse effect of pesticides.

CO2. Students will understand different classes of pesticides and their uses in agricultural industries.

CO3. To learn the synthesis of cosmetics and their analysis by complex metric titration,

CO4. To now about the role of essential oil to cosmetic industries.

| Unit | Contents | Lecture/Tutorials |
|---|---|---|
| **1.** | **Introduction to pesticides:** General introduction to pesticides (natural and synthetic), benefits and adverse effects, changing concepts of pesticides, structure activity relationship. | **8** |
| **2.** | **Synthesis and Uses of pesticides:** Synthesis and technical manufacture and uses of representative pesticides in the following classes: Organochlorines (DDT, Gammexene,); Organophosphates (Malathion, Parathion); Carbamates (Carbofuran and carbaryl); Quinones (Chloranil), Anilides (Alachlor and Butachlor). | **10** |
| **3.** | **Analysis of Cosmetics:** Major and minor constituents and their function a. Analysis of deodorants and antiperspirants, Al, Zn, boric acid, chloride, sulphate. b. Determination of constituents of talcum powder: Magnesium oxide, Calcium oxide, Zinc oxide and Calcium carbonate by complexometric titration | **8** |
| **4.** | **Synthesis of Cosmetics:** A general study including preparation and uses of the following: Hair dye, hair spray, shampoo, suntan lotions, face powder, lipsticks, talcum powder, nail enamel, creams (cold, vanishing and shaving creams), antiperspirants and artificial flavours. | **10** |
| **5** | **Essential oils and applications:** Essential oils and their importance in cosmetic industries with reference to Eugenol, Geraniol, sandalwood oil, eucalyptus, rose oil, 2-phenyl ethyl alcohol, Jasmone, Civetone, Muscone. | **10** |

**TEXTBOOKS/REFERENCE BOOKS:**


1. Cremlyn, R. *Pesticides. Preparation and Modes of Action*, John Wiley & Sons, New York, 1978.
2. Stocchi, E. *Industrial Chemistry*, Vol-I, Ellis Horwood Ltd. UK(1990).
3. Engineering Chemistry Dhanpat Rai & Sons, Delhi.
4. Industrial Chemistry, Goel Publishing House, Meerut (1996).


| POs Cos | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 1 | - | - | 1 | 2 | - | 2 | 2 | 3 | 2 |
| CO2 | 1 | 2 | - | 2 | 2 | - | 2 | 2 | 3 | 1 |
| CO3 | 1 | 2 | 2 | 3 | 3 | - | 2 | 2 | 3 | 2 |
| CO4 | 1 | 2 | 1 | 3 | 3 | - | 2 | 2 | 3 | 2 |

## BCH-351: CHEMISTRY LABORATORY-V
(Semester V)

| | | | | | |
|---|---|---|---|---|---|
| L+T+P | : | **0+0+2** | Viva-voce + Continuous lab performance | : | **40** |
| Credits: | : | **2** | | | |
| Contact hours | : | **52** | Viva-voce + Practical Exam + Practical record file | : | **60** |

**Course OBJECTIVES:**
After the completion of course students will understand the preparation of resins and cosmetic Items.

**Course Outcomes:**
**CO1. Implement the studied reaction for the preparation of polymeric resins.**
**CO2. Synthesis of cosmetic materials on laboratory scale.**
**CO3. To understand the principle and operation about the spectrometric technique.**

| S. No. | Practical Description |
|---|---|
| 1. | **Preparation**<br>Phenol formaldehyde resins<br>Urea-formaldehyde. |
| 2. | Extraction of caffeine from tealeaves |
| 3. | Preparation of talcum powder. |
| 4. | Preparation of shampoo |
| 5. | Preparation of face cream. |
| 6. | Preparation of nail polish and nail polish remover. |
| 7. | **Use of enzymes as catalyst**<br>Benzoin condensation using Thiamine Hydrochloride as a catalyst instead of cyanide. |
| 8. | Synthesis of Tris(acetylacetonato) manganese(III) without the use of any buffer |
| 9. | Study the 200-500 nm absorbance spectra of $KMnO_4$ and $K_2Cr_2O_7$ (in 0.1 M $H_2SO_4$) and determine the $\lambda_{max}$ values. Calculate the energies of the two transitions in different units (J molecule$^{-1}$, kJ mol$^{-1}$,cm $^{-1}$, eV). |
| 10. | **Analysis of Carbohydrate**:<br>Reducing and non-reducing sugars<br>Carbohydrate and a non-carbohydrate<br>Aldoses and ketoses |

| POs<br>Cos | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 1 | - | - | 1 | 2 | 2 | 1 | 3 | 3 | 3 |
| CO2 | 1 | 2 | 2 | 1 | 2 | 2 | 2 | 3 | 2 | 3 |
| CO3 | 1 | 3 | 3 | 1 | 3 | 3 | 3 | 3 | 3 | 3 |

# SEMESTER-VI

## BCH-302: BIONORGANIC AND ORGANOMETTALIC CHEMISTRY

(Semester VI)

| | | | | | |
|---|---|---|---|---|---|
| L+T+P | : | **4+0+0** | Mid-Sessional exam | : | **15** |
| Credits: | : | **4** | ABQ | : | **25** |
| Contact hours | : | **52** | End-semester exam | : | **60** |

**OBJECTIVES:**

The objective of the course to understand the chemistry of Transition and Lanthanides elements along the bioinorganic systems.

**Course Outcomes:**

**CO1.** To learn about general group trend and the magnetic and catalytic properties of transition elements.

CO2. To learn about the Electronic configuration and spectral and magnetic properties and Separation of lanthanides.

CO3. Student will understand the presence and their application in various biological systems.

CO4. To learn about the definition, properties and their chemical reactions of organometallic compounds.

| Unit | Contents | Lecture/Tutorials |
|---|---|---|
| **1.** | **Transition Elements:** General group trends with special reference to electronic configuration, colour, variable valency, magnetic and catalytic properties, and ability to form complexes. Stability of various oxidation states and e.m.f. (Latimer and Bsworth diagrams).Difference between the first, second and third transition series.Chemistry of first transition series elements (Ti, V, Cr, Mn, Fe and Co in various oxidation states, excluding their metallurgy).Chemistry of Second and third transition series elements (Zr, Nb, Mo, W, Re, Ru, and Rh invarious oxidation states, excluding their metallurgy) | **11** |
| **2.** | **Lanthanoids and Actinoids:** Electronic configuration, oxidation states, colour, spectral and magnetic properties, lanthanide contraction, separation of lanthanides (ion-exchange method only). | **7** |
| **3.** | **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.<br>Toxicity of metal ions (Hg, Pb, Cd and As), reasons for toxicity, Use of chelating agents in medicine. Iron and its application in bio-systems, Haemoglobin; Storage and transfer of iron. | **12** |
| **4.** | **Reaction Kinetics And Mechanism:** Introduction, Substitution reactions in square planar complexes, Trans- effect, theories of trans effect, Thermodynamic and Kinetic stability, Kinetics of octahedral substitution, Ligand field effects and reaction rates, Mechanism of substitution in octahedral complexes | **10** |
| **5** | **Organometallic Compounds:** Definition and classification of organometallic compounds on the basis of bond type. The Grignard reagents: formation, structure and chemical reactions; Organozinccompounds: formation, structure and chemical reactions; Organolithium compounds: formation, structure and chemical reactions; Concept of hapticity of organic ligands. 18 electron rule, Ziegler- Natta Catalyst and Zeise's salt. | **12** |

**TEXTBOOKS/REFERENCE BOOKS:**

1. Huheey, J. E.; Keiter, E.A. &Keiter, R.L. Inorganic Chemistry, Principles of Structure and Reactivity, 4th Ed., Harper Collins 1993, Pearson,2006.

3. Sharpe, A.G., Inorganic Chemistry, 4th Indian Reprint (Pearson Education) 2005.

| POs Cos | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 1 | - | - | 1 | 2 | - | 2 | 2 | 3 | 2 |
| CO2 | 1 | 1 | - | 2 | 2 | - | 2 | 2 | 3 | 1 |
| CO3 | 1 | - | - | 3 | 3 | - | 2 | 2 | 3 | 2 |
| CO4 | 1 | - | 1 | 3 | 3 | - | 2 | 2 | 3 | 2 |

## BCH-304: POLYMER CHEMISTRY
(Semester VI)

| | | | | | |
|---|---|---|---|---|---|
| L+T+P | : | **4+0+0** | Mid-Sessional exam | : | **15** |
| Credits: | : | **4** | ABQ | : | **25** |
| Contact hours | : | **52** | End-semester exam | : | **60** |

**LEARNING OBJECTIVES:**

The objective of the course to understand introduction, principle and thermodynamic parameters of polymers.

**Course Outcomes:**

CO1 Students will able to understand introduction, classification and activity of polymer in chemistry

CO2. Students will understand the Basic principles of polymer molecular weight and thermal transition in polymers.

CO3. To learn about the preparation, properties and application of commercial polymers to the plastic industries.

CO4. To learn the Solubility and Thermodynamics Parameters of polymer solutions after mixing.

| Unit | Contents | Lecture/Tutorials |
|---|---|---|
| **1.** | **Introduction and History of Polymeric Materials:** Introduction to concepts and classification of polymers; a brief history of polymers, definitions and terms used in polymer literature; polymers nomenclature; importance of synthetic polymers; classification of polymers on the basis of molecular structure ,thermal properties;, chain configuration , methods of polymerization and applications | **8** |
| **2.** | **Synthesis of Polymers:** Characteristics of step growth and chain growth polymerization; mechanism of free radical polymerization ionic and step growth polymerizations; copolymers; types of copolymers; copolymer structure and monomer reactivity ratios; copolymer equation and its significance. | **10** |
| **3.** | **Molecular weights and mechanical properties of polymers:** Basic principles of polymer molecular weight- number average molecular weight; weight average molecular weight ; viscosity average molecular weight; molecular weight distribution curve; technique for measurements of molecular weights<br>Thermal transition in polymers; crystallization of polymers; degree of crystallinity; amorphous polymers; glass transition temperature (tg); measurements of tgs. | **12** |
| **4.** | **Commercial polymers:** Preparation, properties and application of thermoplastic polymers and thermoset polymers; polyethylene; polypropylene, polystyrene polystyrene; , poly(vinyl chloride); polyacrylamide; polyurethane; polyesters; alkyd resins; phenol-formaldehyde; polyamides and polysiloxanes; Additives used in plastic manufacture | **10** |
| **5** | **Polymer Solution:** Criteria for polymer solubility, Solubility parameter, Thermodynamics of polymer solutions, entropy, enthalpy, and free energy change of mixing of polymers solutions, Flory- Huggins theory, Lower and Upper critical solution temperatures. | **10** |

**TEXTBOOKS/REFERENCE BOOKS:**

1. R.B. Seymour & C.E. Carraher: Polymer Chemistry: An Introduction, Marcel Dekker, Inc. New York, 1981.

2. G. Odian: Principles of Polymerization, 4th Ed. Wiley, 2004.

3. F.W. Billmeyer: Textbook of Polymer Science, 2nd Ed. Wiley Interscience, 1971

| POs<br>Cos | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 1 | - | - | 1 | 2 | - | 2 | 2 | 3 | 1 |
| CO2 | 1 | 1 | - | 2 | 2 | - | 2 | 2 | 3 | 1 |
| CO3 | 2 | - | - | 3 | 3 | - | 2 | 3 | 3 | 2 |
| CO4 | 2 | - | 1 | 3 | 3 | - | 2 | 3 | 3 | 2 |

| BCH-306: FUEL CHEMISTRY (Semester VI) | | | | | |
|---|---|---|---|---|---|
| L+T+P | : | **4+0+0** | Mid-Sessional exam | : | **15** |
| Credits: | : | **4** | ABQ | : | **25** |
| Contact hours | : | **54** | End-semester exam | : | **60** |

**OBJECTIVES:**

The objective of the course General Physics Laboratory is to expose the students of M.Sc. class to experimental techniques in electronics, so that they can verify some of the things read in theory here or in earlier classes and develop confidence to handle sophisticated equipment.

**COURSE OUTCOMES:**

CO1. To learn about Introduction, properties, mechanism and use of of lubricants in machines.

CO2. Students will understand about renewable and non-renewable sources.

CO3. To learn about the cracking, fractional distillation of Petroleum sources.

CO4. To learn about selection of equipment for efficient utilization of fuels and upgrading of fuels to maximize energy

| Unit | Contents | Lecture/Tutorials |
|---|---|---|
| **1.** | **Lubricants & Lubricants:** Introduction, Mechanism of lubrication: fluid film, boundary lubrication and extreme pressure lubricants, Classification of lubricants: Solid, semi-solid, liquid and emulsion, synthetic lubricants and additives for lubricants. | **8** |
| **2.** | **Properties of Lubricants:** Properties of lubricants: Flash & Fire point, Saponification number, Iodine value, Acid value , Viscosity and Viscosity index, Aniline point, Cloud point and pour point, Corrosive Tendency, Specific gravity, Volatility, oiliness, Emulsification, decomposition stability and carbon residue of lubricants | **10** |
| **3.** | **Coal as Energy Resources:** Review of energy sources (renewable and non-renewable). Classification of fuels and their calorific value, Characteristics of good fuel, Comparison between solid, liquid and gaseous fuel, BOMB calorimeter, Coal, Classification of coal, Uses of coal in various industries, Selection of coal, analysis of coal, carbonization of coal. Pulverized coal and Metallurgical coal, Combustion, Analysis of fuel gas. | **12** |
| **4.** | **Petroleum:** Petroleum, Cracking, Fractionation Distillation, Cracking: Thermal & Catalytic Cracking, Refining of gasoline, Synthetic petrol and methods of polymerization for synthetic petrol, Reforming: Thermal and Catalytic reforming, Knocking, Improvement in anti knocking properties. | **10** |
| **5** | **Fuels:** Diesel Engine fuel, Kerosene & LPG as fuel, Non petroleum fuels, Natural gas, Coal gas, Oil gas Water gas/ Blue gas, Non-conventional source of energy, Biomass, Biogas. | **8** |

**TEXTBOOKS/REFERENCE BOOKS:**


1. Fuels and fuel-additives. S.P. Srivastava & Jeno Hancsok. Willey.
2. The chemistry of Hydrocarbon fuels. *Harold H. Schobert. Science Direct.*
3. The chemistry and technology of petroleum. J.G. Speight.
4. The chemistry and technology of coal. James Speight.

| POs<br>Cos | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 1 | - | 1 | 1 | 2 | - | 2 | 2 | 3 | 1 |
| CO2 | 1 | 1 | - | 2 | 2 | - | 2 | 2 | 3 | 1 |
| CO3 | 1 | - | 1 | 3 | 3 | - | 2 | 3 | 3 | 2 |
| CO4 | 1 | - | 1 | 3 | 3 | - | 2 | 3 | 3 | 2 |

## BCH-308: PHYSICAL SPECTROSCOPY
(Semester VI)

| | | | | | |
|---|---|---|---|---|---|
| L+T+P | : | **4+0+0** | Mid-Sessional exam | : | **15** |
| Credits: | : | **4** | ABQ | : | **25** |
| Contact hours | : | **52** | End-semester exam | : | **60** |

**OBJECTIVES:**
The objective of the course General Physics Laboratory is to expose the students of M.Sc. class to experimental techniques in electronics, so that they can verify some of the things read in theory here or in earlier classes and develop confidence to handle sophisticated equipment.

**Course Outcomes:**
CO1. After the end of this course, the student; will be able to Explain basic principles of IR spectroscopy and interpret IR spectroscopy.
CO2. To learn the principle of molecular spectroscopy such as Rotational, vibrational and Raman spectroscopy.
CO3. To learn the principle of Electronic spectroscopy and application to the molecules.
CO4. Students can understand basic principles of NMR spectroscopy and interpretation of elemental analysis technique, working basic and using of elemental analysis device.

| Unit | Contents | Lecture/Tutorials |
|---|---|---|
| **1.** | **Introduction:** Interaction of electromagnetic radiation with molecules and various types of spectra; Born Oppenheimer Approximation. | **5** |
| **2.** | **Rotational, Vibrational and Raman spectroscopy**<br>Rotational spectroscopy: Selection rules, Intensities of spectral lines, determination of bond lengths of diatomic and linear triatomic molecules, isotopic substitution.<br>Vibrational spectroscopy: Classical equation of vibration, computation of force constant, amplitude of diatomic molecular vibration, Anharmonicity, Morse potential, dissociation energies, fundamental frequencies, overtones, hot bands, degree of freedom for polyatomic molecules, Normal modes of vibration, concept of group frequencies. | **16** |
| **3.** | **Vibration–rotation spectroscopy:** Diatomic vibrating rotator, P, Q, R branches. Raman spectroscopy: Qualitative treatment of rotational Raman effect; effect of nuclear spin, vibrational Raman spectra, Stokes and Anti –stokes lines; their intensity difference, rule of mutual exclusion. | **10** |
| **4** | **Electronic Spectroscopy**: Frank-Condon principle, electronic transitions, singlet and triplet states, fluorescence and phosphorescence, dissociation and predissociation. | **9** |
| **5.** | **Nuclear Magnetic Resonance (NMR) Spectroscopy and Electron Spin Resonance (ESR) Spectroscopy:** Principles of NMR spectroscopy, larmor precession, chemical shift and low resolution spectra, different scales (δ and T), spin–spin coupling and high resolution spectra, interpretation of PMR spectra of organic molecules.<br>Electron Spin Resonance (ESR) spectroscopy: Its principle, hyperfine structure, ESR of simple radicals | **10** |

**TEXTBOOKS/REFERENCE BOOKS:**

1. Physical chemistry by KL Kapoor, Macmillan India Ltd.
2. Fundamentals of Molecular Spectroscopy by CN Banwell and EM McCash, Tata McGraw Hill.

| POs<br>Cos | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 1 | 2 | 2 | 2 | 1 | - | 3 | 3 | 3 | 1 |
| CO2 | 1 | 3 | 3 | 2 | 1 | - | 3 | 3 | 3 | 1 |
| CO3 | 1 | 3 | 3 | 2 | 2 | - | 3 | 3 | 3 | 2 |
| CO4 | 1 | 3 | 3 | 3 | 2 | - | 3 | 3 | 3 | 2 |

# BCH-352: Project/Dissertation

(Semester VI)

L+T+P : **0+0+22**
Credits: : **11**
Contact hours : **52**

| **Description** |
|---|
| Students are required to work on the allotted topic and must make a presentation in front of advisory committee and B.Sc. Students. Students are expected to provide latest facts and updated information by consulting latest editions of textbooks, reference books, monographs, and peer-reviewed national & international research journals. |

| **S.No.** | **Course details** |
|---|---|
| 1. | Research work |
| 2. | Seminar |
| 3. | Evaluation by Research committee |
| 4. | Research work by taking 52 credit hours |