# FACULTY OF APPLIED SCIENCES

## SYLLABUS

## FOR

## B.Sc. (Honours) CHEMISTRY

## (SEMESTER: I-VI)

(Under Choice based Credit System)

**Examinations: 2025 Onwards**

## Department of Chemistry

## I K GUJRAL PUNJAB TECHNICAL UNIVERSITY

## KAPURTHALA

Note:

**(i) Subject to change in the syllabi at any time. Please visit the University website time to time.**

# IK Gujral Punjab Technical University

## VISION

To be an institution of excellence in the domain of higher technical education that serves as the fountainhead for nurturing the future leaders of technology and techno- innovation responsible for the techno-economic, social, cultural and environmental prosperity of the people of the State of Punjab, the Nation and the World.

## MISSION

To provide seamless education through the pioneering use of technology, in partnership with industry and society with a view to promote research, discovery and entrepreneurship and

To prepare its students to be responsible citizens of the world and the leaders of technology and techno-innovation of the 21st Century by developing in them the desirable knowledge, skill and attitudes base for the world of work and by instilling in them a culture for seamlessness in all facets of life.

## OBJECTIVES

- To offer globally-relevant, industry-linked, research-focused, technology- enabled seamless education at the graduate, postgraduate and research levels in various areas of engineering & technology and applied sciences keeping in mind that the manpower so spawned is excellent in quality, is relevant to the global technological needs, is motivated to give its best and is committed to the growth of the Nation;
- To foster the creation of new and relevant technologies and to transfer them to industry for effective utilization;
- To participate in the planning and solving of engineering and managerial problems of relevance to global industry and to society at large by conducting basic and applied research in the areas of technologies. To develop and conduct continuing education programmes for practicing engineers and managers with a view to update their fundamental knowledge base and problem-solving capabilities in the various areas of core competence of the University;
- To develop strong collaborative and cooperative links with private and public sector industries and government user departments through various avenues such as undertaking

of consultancy projects, conducting of collaborative applied research projects, manpower development programmes in cutting-edge areas of technology, etc;

- To develop comprehensive linkages with premier academic and research institutions within the country and abroad for mutual benefit;
- To provide leadership in laboratory planning and in the development of instructional resource material in the conventional as well as in the audio- visual, the video and computer-based modes;
- To develop programmes for faculty growth and development both for its own faculty as well as for the faculty of other engineering and technology institutions;
- To anticipate the global technological needs and to plan and prepare to cater to them;
- To interact and participate with the community/society at large with a view to inculcate in them a feel for scientific and technological thought and endeavour; and
- To actively participate in the technological development of the State of Punjab through the undertaking of community development programmes including training and education programmes catering to the needs of the unorganized sector as well as that of the economically and socially weaker sections of society.

## ACADEMIC PHILOSOPHY

The philosophy of the education to be imparted at the University is to awaken the **"deepest potential"** of its students as holistic human beings by nurturing qualities of self-confidence, courage, integrity, maturity, versatility of mind as well as a capacity to face the challenges of tomorrow so as to enable them to serve humanity and its highest values in the best possible way.

# Department of Chemistry

## VISION

The Chemistry at IKGPTU campus will address the challenging and important questions in the physical and life sciences of current era using its multi-disciplinary vision, its culture of synergistic collaboration and translational science, and its excellence in the physical, medical and engineering sciences. Chemistry Department continues to explore the new fields and frontiers and, with them, fundamentally new and innovative ways to address the increasingly complex scientific, health, energy and environmental problems of our time.

## MISSION

- Inspiring and educating undergraduate students in chemistry and molecular-driven sciences in the core concepts of chemistry and the scientific methodology.
- To explore the new frontier area of organometallic catalysis in synthetic chemistry.
- Developing more-economic and greener strategies for chemical synthesis and production
- Understanding how molecules and materials behave, interact and transform at macroscopic, molecular, atomic and electronic levels, and exploring the contribution of geometric and electronic structure to function.
- Informing the public about the excitement of science, its impact on everyday life, and the crucial role it plays in human health, energy and environmental stewardship
- Building centralized, state-of-the-science facilities designed to promote collaborative synergies among faculty, staff and students and across disciplinary boundaries.
- Sharing the excitement of new chemical knowledge across IKGPTU and to other institutions, educators, and the global community through scientific communications and outreach.

# TITLE OF THE PROGRAM: B.Sc. (Honours) CHEMISTRY

**YEAR OF IMPLIMENTATION:** New Syllabus will be implemented from June 2019 onwards.

**DURATION:** The course shall be three years, with semester system (6 semesters, with two semesters in a year). The Choice based credit system will be applicable to all the semesters.

**ELGIBILITY FOR ADMISSION:** Candidates with 50% marks (5% relaxation for SC/ST) in aggregate in 10+2 in any science subject or any other examination recognized equivalent thereto.

**INTAKE CAPACITY:** 45 (Forty five)

**MEDIUM OF INSTRUCTION:** English.

**PROGRAM EDUCATIONAL OBJECTIVES:**
The Program Educational Objectives (PEOs) of the B.Sc. (Honours) Chemistry Program indicate expectations from our graduates a few years after graduation

| | |
|---|---|
| PEO1 | Apply scientific knowledge of chemical sciences and its allied sciences and maturity of experience to lead in the solution of complex problems in chemical Sciences |
| PEO2 | Become a technically qualified chemist to address complex problems and be able to apply learned skills in chemical world. |
| PEO3 | Maintain and enhance professional competence by acquiring new knowledge and refining skills |
| PEO4 | Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions. |
| PEO5 | Apply reasoning using scientific knowledge to assess health, safety, legal and cultural issues of society. |
| PEO6 | Fulfill the needs of society in solving technical problems using chemistry techniques, principles, tools and practices, in an ethical and responsible manner. |

**PROGRAM OUTCOMES:** At the end of the program, the student will be able to:

| | |
|---|---|
| PO1 | Describe and apply the basic principles of chemistry and to carry out practical techniques important in chemical analysis. |
| PO2 | Create and evaluate hypotheses, theories, methods and evidence within their proper contexts. Solve complex problems by critical understanding, analysis and synthesis |
| PO3 | Develop proficiency in the analysis of complex chemistry problems and the use of allied fields or other appropriate techniques to solve them. |

| | |
|---|---|
| PO4 | Be familiarised with the emerging areas of Chemistry and their applications in various spheres of Chemical sciences and to apprise the students of its relevance in future studies. |
| PO5 | Engage in lifelong learning and adapt to changing professional and societal needs. |
| PO6 | Communicate effectively scientific information both in written and oral formats. |

**PROGRAM SPECIFIC OUTCOMES**:

At the end of the program,

| | |
|---|---|
| PSO1 | Students will have an ability to identify, formulate, and solve complex chemical problems by applying principles of chemistry, science, and mathematics |
| PSO2 | The students will acquire in-depth knowledge to understand the role of chemistry in society and critically interpret the chemical literature. |
| PSO3 | Students will be skilled in problem solving, critical thinking and analytical reasoning as applied to problems related to chemical sciences. |
| PSO4 | Students will be able to address social, economic, and environmental issues. |
| PSO5 | Students will be able to learn and analyze the various principles using various scientific experiments. |
| PSO6 | Students will be able to explore new areas of research in both chemistry and allied fields of science and technology. |
| PSO7 | Students will have an ability to communicate effectively with a range of audiences in writing and orally. |

**SCHEME OF THE PROGRAM:**

| Semester-I | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Sr. No** | **Code** | **Theory Papers** | **Hours** | **L-T-P** | **Credits** | **Marks Distribution** | | **Marks** |
| | | | | | | Internal | External | |
| 1. | BHCL101-19 | Inorganic Chemistry-I | 45 | 3-1-0 | 4 | 40 | 60 | 100 |
| 2. | BHCL102-19 | Organic Chemistry-I | 45 | 3-1-0 | 4 | 40 | 60 | 100 |
| 3. | UC-BSHP-112-19<br><br>UGSEC2501 | Electricity and Magnetism<br>**Or**<br>Computer I<br>(Problem Solving Techniques) | 45 | 3-1-0 | 4 | 40 | 60 | 100 |
| 4. | UC-BSHM-104-19 | Calculus-I | 45 | 3-1-0 | 4 | 40 | 60 | 100 |
| 5. | BHHL105-19 | Communicative English-I | 30 | 2-0-0 | 2 | 20 | 30 | 50 |
| 6. | BHHL106A-19<br><br>BHHL106B-19 | Punjabi Compulsory-I<br>**Or**<br>Mudhli Punjabi-I | 30 | 2-0-0 | 2 | 20 | 30 | 50 |
| 7. | BHCP107-19 | Inorganic Chemistry Lab-I | 40 | 0-0-4 | 2 | 30 | 20 | 50 |
| 8. | BHCP108-19 | Organic Chemistry Lab-I | 40 | 0-0-4 | 2 | 30 | 20 | 50 |
| 9 | UC-BSHP-113-19<br>**Or**<br>UGSEC2502 | Physics Lab-I<br><br>**Or**<br>Computer Lab I<br>(Problem Solving Techniques Laboratory) | 40 | 0-0-4 | 2 | 30 | 20 | 50 |
| | | **Total** | | **16-4-12** | **26** | | | **650** |

* Student opting for computer paper in Semester-I under the Physics/Computer option shall continue with Computer up to Semester-III.

# Semester-II

| Sr. No | Code | Theory Papers | Hours | L-T-P | Credits | Marks Distribution | | Marks |
|---|---|---|---|---|---|---|---|---|
| | | | | | | Internal | External | |
| 1. | BHCL111-19 | Inorganic Chemistry-II | 45 | 3-1-0 | 4 | 40 | 60 | 100 |
| 2. | BHCL112-19 | Physical Chemistry-I | 45 | 3-1-0 | 4 | 40 | 60 | 100 |
| 3. | UC-BSHP-124-19<br><br>UGCA1909 | Waves and Vibrations<br>**Or**<br>Computer II<br>(Object Oriented Programming using C++) | 45 | 3-1-0 | 4 | 40 | 60 | 100 |
| 4. | UC-BSHM-204-19 | Vector Algebra & Vector Analysis | 45 | 3-1-0 | 4 | 40 | 60 | 100 |
| 5. | BHHL115-19 | Communicative English-II | 30 | 2-0-0 | 2 | 20 | 30 | 50 |
| 6. | BHHL116A-19<br><br>BHHL116B-19 | Punjabi Compulsory-II<br>**Or**<br>Mudhli Punjabi-II | 30 | 2-0-0 | 2 | 20 | 30 | 50 |
| 7. | BHCP117-19 | Inorganic Chemistry Lab-II | 40 | 0-0-4 | 2 | 30 | 20 | 50 |
| 8. | BHCP118-19 | Physical Chemistry Lab-I | 40 | 0-0-4 | 2 | 30 | 20 | 50 |
| 9 | UC-BSHP-125--19<br><br>UGCA 1910 | Physics Lab-II<br>**Or**<br>Computer Lab II<br>(Object Oriented Programming using C++ Laboratory) | 40 | 0-0-4 | 2 | 30 | 20 | 50 |
| | | **Total** | | **16-4-10** | **26** | | | **650** |

* Student opting for computer paper in Semester-I under the Physics/Computer option shall continue with Computer up to Semester-III.

# Semester-III

| Sr. No | Code | Theory Papers | Hours | L-T-P | Credits | Marks Distribution | | Marks |
|---|---|---|---|---|---|---|---|---|
| | | | | | | Internal | External | |
| 1. | BHCL201-25 | Organic Chemistry-II (Chemistry of Functional Groups-II) | 45 | 3-1-0 | 4 | 40 | 60 | 100 |
| 2. | BHCL202-25 | Physical Chemistry-II (Chemical Thermodynamics and Equilibrium) | 45 | 3-1-0 | 4 | 40 | 60 | 100 |
| 3. | BHCL203-19 | Spectroscopy | 45 | 3-1-0 | 4 | 40 | 60 | 100 |
| 4. | UC-BSHP-214-19<br><br>UGCA1914 | Physics-III (Elements of Modern Physics)<br>**Or**<br>Computer III (Programming in Python) | 45 | 3-1-0 | 4 | 40 | 60 | 100 |
| 5. | BHCL205-25 | Environmental Science | 30 | 2-0-0 | 2 | 20 | 30 | 50 |
| 6. | BHCP206-19 | Organic Chemistry Lab-II (Functional group Transformations and their Identifications) | 40 | 0-0-4 | 2 | 30 | 20 | 50 |
| 7. | BHCP207-25 | Physical Chemistry Lab-II (Chemical Thermodynamics and Equilibrium Lab) | 40 | 0-0-4 | 2 | 30 | 20 | 50 |
| 8. | UC-BSHP-215-19<br><br>UGCA1917 | Physics Lab-III<br>**Or**<br>Computer Lab III (Programming in Python Laboratory) | 40 | 0-0-4 | 2 | 30 | 20 | 50 |
| | | **Total** | | **14-4-12** | **24** | | | **600** |

* Student opting for computer paper in Semester-I under the Physics/Computer option shall continue with Computer up to Semester-III.

| Semester-IV | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Sr. No** | **Code** | **Theory Papers** | **Hours** | **L-T-P** | **Credits** | **Marks Distribution** | | **Marks** |
| | | | | | | Internal | External | |
| 1. | BHCL211-25 | Inorganic Chemistry-III (Crystal Field Theory and Transition Elements) | 45 | 3-1-0 | 4 | 40 | 60 | 100 |
| 2. | BHCL212-25 | Physical Chemistry-III (Chemical Kinetics, Solutions and Macromolecules) | 45 | 3-1-0 | 4 | 40 | 60 | 100 |
| 3. | BHCL2XX | Discipline Specific Elective –I* | 45 | 3-1-0 | 4 | 40 | 60 | 100 |
| 4. | UC-BSHM-408-19 | Maths-III | 45 | 3-1-0 | 4 | 40 | 60 | 100 |
| 5. | BHCL216-19 | Basic Analytical Chemistry | 30 | 2-0-0 | 2 | 20 | 30 | 50 |
| 6. | BHCP217-25 | Inorganic Chemistry Lab-III (Gravimetric Analysis and Inorganic Preparations) | 40 | 0-0-4 | 2 | 30 | 20 | 50 |
| 7. | BHCP218-25 | Physical Chemistry Lab-III (Chemical Kinetics, Solutions and Macromolecules Lab) | 40 | 0-0-4 | 2 | 30 | 20 | 50 |
| 8. | BHCP219-19 | Basic Analytical Chemistry Lab | 40 | 0-0-2 | 1 | 30 | 20 | 50 |
| | | **Total** | | **14-4-10** | **23** | | | **600** |

| **Discipline Specific Elective-I** | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Sr. No** | **Code** | **Theory Papers** | **Hours** | **L-T-P** | **Credits** | **Marks Distribution** | | **Marks** |
| | | | | | | Internal | External | |
| 1 | BHCL213-25 | Green Chemistry | 45 | 3-1-0 | 4 | 40 | 60 | 100 |
| 2 | BHCL214-19 | Polymer Chemistry | 45 | 3-1-0 | 4 | 40 | 60 | 100 |
| 3 | UGCA1921** | Software Engineering | 45 | 3-1-0 | 4 | 40 | 60 | 100 |
| 4 | UGCA1923** | Operating Systems | 45 | 3-1-0 | 4 | 40 | 60 | 100 |

*The student shall select one paper from the above-listed Discipline Specific Elective–I courses.
** Eligibility for opting these courses shall be based on having studied Computer I, II, and III in the previous semesters.

| Semester-V | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Sr. No** | **Code** | **Theory Papers** | **Hours** | **L-T-P** | **Credits** | **Marks Distribution** | | **Marks** |
| | | | | | | Internal | External | |
| 1. | BHCL301-25 | Inorganic Chemistry-IV (Organometallic Chemistry and Reaction Mechanism) | 45 | 3-1-0 | 4 | 40 | 60 | 100 |
| 2. | BHCL302-25 | Organic Chemistry-III (Heterocyclic Chemistry) | 45 | 3-1-0 | 4 | 40 | 60 | 100 |
| 3. | BHCL303-19 | Quantum Chemistry | 45 | 3-1-0 | 4 | 40 | 60 | 100 |
| 4. | BHCL3XX | Discipline Specific Elective-II* | 45 | 3-1-0 | 4 | 40 | 60 | 100 |
| 5. | BHCL306-25 | Ligand Field Theory | 45 | 3-1-0 | 4 | 40 | 60 | 100 |
| 6. | BHCP307-25 | Inorganic Chemistry Lab-IV (Volumetric Analysis Laboratory) | 40 | 0-0-4 | 2 | 30 | 20 | 50 |
| 7. | BHCP308-19 | Organic Chemistry Lab-III (Synthesis of organic compounds and their identifications) | 40 | 0-0-4 | 2 | 30 | 20 | 50 |
| | | **Total** | | **15-5-8** | **24** | | | **600** |

| **Discipline Specific Elective-II** | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Sr. No** | **Code** | **Theory Papers** | **Hours** | **L-T-P** | **Credits** | **Marks Distribution** | | **Marks** |
| | | | | | | Internal | External | |
| 1 | BHCL304-19 | Analytical Clinical Biochemistry | 45 | 3-1-0 | 4 | 40 | 60 | 100 |
| 2 | BHCL305-25 | Industrial Chemicals and Environment | 45 | 3-1-0 | 4 | 40 | 60 | 100 |
| 3 | UGCA1949** | Cyber Laws & IPR | 45 | 3-1-0 | 4 | 40 | 60 | 100 |
| 4 | UGCA1931** | Data Warehouse and Mining | 45 | 3-1-0 | 4 | 40 | 60 | 100 |

*The student shall select one paper from the above-listed Discipline Specific Elective–I courses.
** Eligibility for opting these courses shall be based on having studied Computer I, II, and III in the previous semesters.

| Semester-VI | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Sr. No** | **Code** | **Theory Papers** | **Hours** | **L-T-P** | **Credits** | **Marks Distribution** | | **Marks** |
| | | | | | | Internal | External | |
| 1. | BHCL311-19 | Organic Chemistry-IV (Natural Products and Biochemistry) | 45 | 3-1-0 | 4 | 40 | 60 | 100 |
| 2. | BHCL312-25 | Physical Chemistry-IV (Electrochemistry & Colloidal State) | 45 | 3-1-0 | 4 | 40 | 60 | 100 |
| 3. | BHCL3XX | Discipline Specific Elective-III | 45 | 3-1-0 | 4 | 40 | 60 | 100 |
| 4. | BHCL3XX | Discipline Specific Elective-IV | 45 | 3-1-0 | 4 | 40 | 60 | 100 |
| 5. | BHCP318-19 | Organic Chemistry Lab-IV (Biochemical and Nanotechnology Lab) | 40 | 0-0-4 | 2 | 30 | 20 | 50 |
| 6. | BHCP319-25 | Physical Chemistry Lab-IV (Electrochemistry & Colloidal State Lab) | 40 | 0-0-4 | 2 | 30 | 20 | 50 |
| 7. | BHCP320-25 | Project work* | | 0-0-4 | 2 | - | - | - |
| | | **Total** | | **12-4-8** | **24** | | | **500** |

*Evaluation shall be carried out by the Departmental Research Committee

| **Discipline Specific Elective-III & IV** | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Sr. No** | **Code** | **Theory Papers** | **Hours** | **L-T-P** | **Credits** | **Marks Distribution** | | **Marks** |
| | | | | | | Internal | External | |
| 1 | BHCL313-19 | Catalysis in Organometallic Compounds | 45 | 3-1-0 | 4 | 40 | 60 | 100 |
| 2 | BHCL314-19 | Analytical Methods in Chemistry | 45 | 3-1-0 | 4 | 40 | 60 | 100 |
| 3 | BHCL315-19 | Nanochemistry | 45 | 3-1-0 | 4 | 40 | 60 | 100 |
| 4 | BHCL316-19 | Molecular Modelling and Drug Design | 45 | 3-1-0 | 4 | 40 | 60 | 100 |
| 5 | UGCA1945 | Artificial Intelligence** | 45 | 3-1-0 | 4 | 40 | 60 | 100 |
| 6 | UGCA1948 | Information Security** | 45 | 3-1-0 | 4 | 40 | 60 | 100 |

** Eligibility for opting these courses shall be based on having studied Computer I, II, and III in the previous semesters.

**EXAMINATION AND EVALUATION**

| **THEORY** | | | | | |
|---|---|---|---|---|---|
| S.No. | | | Weightage in Marks | | Remarks |
| 1 | Internal Evaluation | Mid-Semester Examination | 30 | 10 | MSTs, Quizzes, assignments, attendance, etc. Constitute internal evaluation. Best of two mid-semester exams will be considered for evaluation |
| 2 | | Attendance | 5 | 5 | |
| 3 | | Assignments | 5 | 5 | |
| 4 | External Evaluation | End-Semester Examination | 60 | 30 | Conduct and checking of the answer sheets will be at the university level. |
| | **Total** | | **100** | **50** | |
| **PRACTICAL** | | | | | |
| 1 | Internal Evaluation | Daily evaluation of practical performance/ record/ viva voce | 15 | | |
| 2 | | Attendance | 5 | | |
| 3 | | Internal Practical Examination | 10 | | |
| 4 | External Evaluation | Final Practical Examination | 20 | | |
| | | **Total** | **50** | | |

**PATTERN OF END-SEMESTER EXAMINATION**

I. **Part A** will be One Compulsory question consisting of short answer type questions [Q No. 1(a-h)] covering whole syllabus. There will be no choice in this question. It will be of 16 marks comprising of **8 questions of 2 marks each**.

II. **Part B** will be comprising of eight questions [2-9]. Student will have to attempt any six questions from this part. It will be of 24 marks with **6 questions of 4 marks each**.

III. **Part C** will be comprising of two compulsory questions with internal choice in both these questions [10-11]. It will be of 20 marks with **2 questions of 10 marks each**.

**SYLLABUS OF THE PROGRAM**

The syllabus has been upgraded as per provision of the UGC module and demand of the academic environment. The contents of the syllabus have been duly arranged unit wise and included in such a manner so that due importance is given to requisite intellectual and laboratory skills. The application part of the respective contents has been appropriately emphasized.

# SEMESTER-I

| I.K. GUJRAL PUNJAB TECHNICAL UNIVERSITY<br>DEPARTMENT OF CHEMISTY | | | | |
|---|---|---|---|---|
| **Course Name** | **B.Sc. (Honours) Chemistry** | | | |
| **Subject Code:** | **BHCL101-19** | | | |
| **Subject Title:** | **INORGANIC CHEMISTRY-I** | | | |
| **Contact Hours:** | **L:3** | **T:1** | **P:0** | **Credits:4** |
| **Examination Duration (hours)** | **3** | | | |
| **Objective(s):** | To teach the fundamental concepts of Inorganic Chemistry and their applications. | | | |

**Details of the Course (Atomic Structure and Chemical Bonding)**

| Unit | Contents | Contact Hours |
|---|---|---|
| I | **Atomic Structure:**<br>Bohr's theory, its limitations and atomic spectrum of hydrogen atom. Wave mechanics: de Broglie equation, Heisenberg's Uncertainty Principle and its significance, Schrödinger's wave equation, significance of ψ and $\psi^2$. Quantum numbers and their significance. Normalized and orthogonal wave functions. Sign of wave functions. Radial and angular wave functions for hydrogen atom. Radial and angular distribution curves. Shapes of s, p, d and f orbitals. Contour boundary and probability diagrams.<br>Pauli's Exclusion Principle, Hund's rule of maximum multiplicity, Aufbau's principle and its limitations, Variation of orbital energy with atomic number. | 10 |
| II | **Periodicity of Elements:**<br>s, p, d, f block elements, the long form of periodic table. Detailed discussion of the following properties of the elements, with reference to s & p-block.<br>(a) Effective nuclear charge, shielding or screening effect, Slater rules, variation of effective nuclear charge in periodic table.<br>(b) Atomic radii (van der Waals)<br>(c) Ionic and crystal radii.<br>(d) Covalent radii (octahedral and tetrahedral)<br>(e) Ionization enthalpy, Successive ionization enthalpies and factors affecting ionization energy. Applications of ionization enthalpy.<br>(f) Electron gain enthalpy, trends of electron gain enthalpy.<br>(g) Electronegativity, Pauling's/ Mulliken's/ Allred Rachow's/ and Mulliken-Jaffé's electronegativity scales. Variation of electronegativity with bond order, partial charge, hybridization, group electronegativity. Sanderson's electron density ratio. | 11 |
| III | **Chemical Bonding I:**<br>(a) Properties of ionic substances, Occurrence of ionic bonding, The radius ratio rules, Efficiency of packing, Hexagonal close packing, Cubic close packing, Structures of different crystal lattices, Sodium chloride, Cesium chloride, Wurtzite, Zinc blende, Fluorite, Rutile, Cristobalite, Nickel arsenide, Pervoskite, Rhenium oxide, Calcium carbide, The calcite | 12 |

| | | |
|---|---|---|
| | and aragonite structures.<br>(b) Lattice energy, Born-Haber cycle, The calculations of the lattice energy on the basis of Born- Lande equation, The predictive power of thermochemical calculations on ionic compounds, Covalent character in predominantly ionic compounds, Imperfections of crystals, Conductivity in ionic solids, Band theory, Intrinsic and photoexcited semiconductors, Transistors, High temperature superconductors. | |
| IV | **Chemical Bonding II:**<br>The Lewis theory, Valence bond theory - A mathematical approach, Resonance, Valence Shell Electron Pair Repulsion Model (VSEPR theory), Prediction of structures and variation of bond angles on the basis of VSEPR theory, Shortcomings of VSEPR theory, Concept of hybridization, Rules for obtaining hybrid orbitals, Extent of d-orbital participation in molecular bonding ($SO_2$, $PCl_5$, $SO_3$), Molecular orbital theory (LCAO method), Symmetry of molecular orbitals, Applications of MOT to homo- and hetero-nuclear diatomic molecules, Molecular orbital energy level diagrams ($Be_2$, $N_2$, $O_2$, $F_2$, LiH, NO, CO, HCl, $NO_2$, $BeH_2$, $NO_2^-$). | 12 |

**Reference Books**

| S.No. | Author(s) | Title of the Book | Publisher/Year |
|---|---|---|---|
| 1 | Lee, J.D. | Concise Inorganic Chemistry | ELBS, 1991. |
| 2 | Douglas, B.E. and Mc Daniel, D.H. | Concepts & Models of Inorganic Chemistry | Oxford, 1970 |
| 3 | Atkins, P.W. & Paula | J. Physical Chemistry | Oxford Press, 2006 |
| 4 | Day, M.C. and Selbin, J. | Theoretical Inorganic Chemistry | ACS Publications 1962 |

**Course Outcomes and Mapping**

At the end of the course, the student will be able to

**CO1.** Understand the fundamental concepts and postulates of various theories regarding the structure of atom

**CO2.** Learn the periodicity of the s & p block elements

**CO3.** Understand the various types of bonding present in the different inorganic compounds.

**CO4.** Learn about the various theories pertaining to the different types of bonding

| | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 | PSO7 |
|---|---|---|---|---|---|---|---|
| CO1 | 1 | 2 | 2 | 3 | 3 | 2 | 3 |
| CO2 | 2 | 1 | 2 | 3 | 2 | 3 | 3 |
| CO3 | 1 | 2 | 2 | 2 | 3 | 3 | 2 |
| CO4 | 0 | 2 | 1 | 3 | 2 | 2 | 2 |

| I.K. GUJRAL PUNJAB TECHNICAL UNIVERSITY<br>DEPARTMENT OF CHEMISTY | | | | |
|---|---|---|---|---|
| **Course Name** | **B.Sc. (Honours) Chemistry** | | | |
| **Subject Code:** | **BHCL102-19** | | | |
| **Subject Title:** | **ORGANIC CHEMISTRY-I** | | | |
| **Contact Hours:** | **L:3** | **T:1** | **P:0** | **Credits:4** |
| **Examination Duration (hours)** | **3** | | | |
| **Objective(s):** | 1. To teach the basic principles, reaction mechanisms and stereochemistry of organic compounds**.**<br>2. To impart knowledge regarding physical properties and chemical reactions of alkanes, alkenes, dienes, alkynes, arenes, alkyl and aryl halides etc**.**<br>3. To predict and account for the most commonly encountered reaction mechanisms **(**substitution, addition and elimination**)** in organic chemistry**.** | | | |

**Details of the Course**

| Unit | Contents | Contact Hours |
|---|---|---|
| I | **Structure and Bonding**<br>Hybridization, bond lengths, bond angles, bond energy, localized and delocalized chemical bond, van der Waals interactions, inclusion compounds, clatherates, charge transfer complexes, resonance, hyperconjugation, aromaticity, inductive and field effects, hydrogen bonding.<br>**Mechanism of Organic Reactions**<br>Curved arrow notation, drawing electron movements with arrows, half-headed and double-headed arrows, homolytic and heterolytic bond breaking, Types of reagents-electrophiles and nucleophiles, Types of organic reactions, Energy considerations, Reactive intermediates (carbocations, carbanions, free radicals, carbenes, arynes and nitrenes), Assigning formal charges on intermediates and other ionic species.<br>**Stereochemistry of Organic Compounds I**<br>Isomerism and its types, Optical isomerism-elements of symmetry, molecular chirality, enantiomers, stereogenic center, optical activity, properties of enantiomers, chiral and achiral molecules with two stereogeric centers, diastereomers, threo and erythro, diastereomers, meso compounds, resolution of enantiomers, inversion, retention and racemization. Relative and absolute configuration, sequence rules, D & L and R & S systems of nomenclature. | 12 |

| | | |
|---|---|---|
| II | **Stereochemistry of Organic Compounds II**<br>Geometric isomerism-determination of configuration of geometric isomers, E & Z system of nomenclature, geometric isomerism in oximes and alicyclic compounds, Conformational isomerism-conformational analysis of ethane and n-butane, conformational analysis of cyclohexane, axial and equatorial bonds, conformation of mono substituted cyclohexane derivative, Newman projection and Sawhorse formulae, Fischer and flying wedge formulae, Difference between configuration and conformation.<br>**Alkanes**<br>Introduction, IUPAC nomenclature, Isomerism and classification of carbon atoms of alkanes, Sources, methods of formation (with special reference to Wurtz reaction, Kolbe reaction, Corey-House reaction and decarboxylation of carboxylic acids), Physical properties and chemical reactions of alkanes, Mechanism of free radical halogenation of alkanes: orientation, reactivity and selectivity.<br>**Cycloalkanes**<br>Cycloalkanes-nomenclature, methods of formation, chemical reactions, Baeyer's strain theory and its limitations. Ring strain in small rings (cyclopropane and cyclobutane), theory of strainless rings. The case of cyclopropane ring; banana bonds | 13 |
| III | **Alkenes, Cycloalkenes, Dienes and Alkynes**<br>*Alkenes* Nomenclature, methods of synthesis (mechanisms of dehydration of alcohols and dehydrohalogenation of alkyl halides, regioselectivity in alcohol dehydration. Saytzeff rule, Hofmann elimination), physical properties and relative stabilities of alkenes. Chemical reactions of alkenes - mechanisms involved in hydrogenation, electrophilic and free radical additions, Markownikiff's rule, hydroboration-oxidation, oxymercuration-reduction. Epoxidation, ozonolysis, hydration, hydroxylation and oxidation with $KMnO_4$, Polymerization of alkenes. Substitution at the allylic and vinylic positions of alkenes. Industrial applications of ethylene and propene.<br>*Cycloalkenes* Methods of formation, conformation and Chemical reactions of cycloalkenes.<br>*Dienes* Nomenclature and classification of dienes: isolated, conjugated and cumulated dienes. Structure of allenes and butadiene, methods of formation, polymerization. Chemical reactions – 1, 2 and 1,4 addition, Diels-Alder reaction.<br>*Alkynes* Nomenclature, structure and bonding in alkynes. Methods of formation. Chemical reactions of alkynes, acidity of alkynes. Mechanism of electrophilic and nucleophilic addition reactions, hydroboration oxidation, metal-ammonia reductions, oxidation and polymerization. | 10 |
| IV | **Alkyl and Aryl Halides**<br>Nomenclature and classes of alkyl halides, methods of formation, chemical reactions**.** Mechanisms of nuclephilic substitution reactions of alkyl halides, SN2 and SN1 reactions with energy profile diagrams**.** | 10 |

| | | |
|---|---|---|
| | Polyhalogen compounds: chloroform, carbon tetrachloride.<br>Methods of formation of aryl halides, nuclear and side chain reactions. The addition elimination and the elimination-addition mechanisms of nucleophilic aromatic substitution reactions.<br>Relative reactivities of alkyl halides vs allyl, vinyl and aryl halides. Synthesis and uses of DDT and BHC.<br>**Arenes and Aromaticity**<br>Nomenclature of benzene derivatives. The aryl group. Aromatic nucleus and side chain.<br>Structure of benzene: Molecular formula and Kekule structure. Stability and carbon-carbonbond lengths of benzene, resonance structure, MO picture.<br>Aromaticity: The Huckel rule, aromatic ions, Aromatic electrophilic substitution -general pattern of mechanism, role of sigma and pi complexes. Machansim of nitration, halogenation, sulponation, mercuration and Friedel-Crafts reaction. Energy profie diagrams. Activating and deactivating substituents, orientation and ortho/para ratio. Side chain reactions of benzene derivations. Birch reduction. Methods of formation and chemical reactions of alkylbenzenes,<br>alkynylbenzenes and biphenyl. | |

**Reference Books**

| S.No. | Author(s) | Title of the Book | Publisher/Year |
|---|---|---|---|
| 1 | R. T. Morrison and P. S. Boyd | Organic Chemistry, 5th Edition | Allyn and Bacon Inc., Boston, 1992 |
| 2 | S. M. Mukerji, S. P. Singh and R. P. Kapoor | Organic Chemistry Vol. I/II | Wiley Eastern Ltd., New Delhi, 1985 |
| 3 | F. A. Carey | Organic Chemistry | McGraw-Hill, Inc, 2003 |
| 4 | G. Solomons | Fundamentals of Organic Chemistry | John Wiley, 2002 |
| 5 | Jerry March | Organic Reaction Mechanism | John Wiley Ed. 5, 2002 |
| 6 | L. G. Jr. Wade | Organic Chemistry | Prentice-Hall,1990 |
| 7 | T. L. Gilchrist and C.W. Rees | Carbenes, Nitrenes and Arynes | Thomas Nelson and Sons Ltd., London |

**Course Outcomes and Mapping**

At the end of the course, the student will be able to

**CO1.** Understand the fundamental concepts of organic chemistry i.e structure, bonding and various effects in organic compounds.

**CO2.** To learn the stereochemistry viz. optical isomerism, stereoisomerism and conformational isomerism of organic compounds.

**CO3.** To study the various known reactive intermediate in organic synthesis

**CO4.** To learn the fundamental and advanced concepts of reaction mechanisms along with the study of reaction mechanisms in various types of substitution addition and elimination reactions.

**CO5.** To predict the relationships between organic chemical structures and their reactivity.

| | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 | PSO7 |
|---|---|---|---|---|---|---|---|
| CO1 | 4 | 3 | 3 | - | 3 | 1 | 2 |
| CO2 | 3 | - | 3 | 1 | 3 | 2 | 1 |
| CO3 | 4 | 2 | 1 | - | 4 | 4 | - |
| CO4 | 4 | 4 | 4 | - | 4 | 3 | - |
| CO5 | 4 | 3 | 4 | - | 4 | - | - |

| I.K. GUJRAL PUNJAB TECHNICAL UNIVERSITY<br>DEPARTMENT OF CHEMISTY | | | | |
|---|---|---|---|---|
| **Course Name** | **B.Sc. (Honours) Chemistry** | | | |
| **Subject Code:** | **UC-BSHP-112-19** | | | |
| **Subject Title:** | **ELECTRICITY AND MAGNETISM** | | | |
| **Contact Hours:** | **L:3** | **T:1** | **P:0** | **Credits:4** |
| **Examination Duration (hours)** | **3** | | | |
| **Objective(s):** | The objective of the course is to expose the students to the formal structure of electricity and magnetism so that they can use these as per their requirement. | | | |

**Details of the Course**

| Unit | Contents | Contact Hours |
|---|---|---|
| I | **Review of Vector Analysis:** Vector algebra, scalar and vector product; Concept of Fields; scalar and vector field; gradient, divergence and curl and their physical significance; Conservative field, Line, surface and volume integral of a vector field, Gauss-divergence theorem and Stoke's theorem. | 10 |
| II | **Electrostatics:** Electrostatic field; electric flux; Gauss's law in differential and integral form; Applications of Gauss law-Electric filed due to point charge, infinite line of charge, uniformly charged spherical shell and solid sphere, plane charge sheet; Electric potential as line integral of electric field, potential due to point charge and electric dipole; calculation of electric field from potential; Poisson's equation and Laplace's equation(Cartesian coordinate); Capacitance; capacitance of a spherical conductor and cylindrical capacitor, Energy per unit volume in electrostatic field, Dielectric medium, dielectric polarization and its types, Displacement vector, Boundary conditions. | 13 |
| III | **Magnetostatics:** Magnetic flux; magnetic flux density; Faraday's law; magnetomotive force; Biot-Savart's law and its applications-straight conductor, circular coil, divergence and curl of magnetic field; Ampere's Circuital law in differential and integral form; Magnetic vector potential; ampere's force law; magnetic vector potential; Energy stored in a magnetic field, boundary conditions on magnetic fields. | 12 |
| IV | **Maxwell's Equations and Electromagnetic Waves:** Equation of | 11 |

| | | |
|---|---|---|
| | continuity for time varying fields; Inconsistency of ampere's law; concept of sinusoidal time variations (Phasor notation); Maxwell's equations in differential and integral form, physical significance; Maxwell equations in free space, static field and in Phasor notation; Difference between displacement current and conduction current; Wave equation in free space and in homogenous medium, Concept of Poynting vector; Poynting Theorem. | |

**Reference Books**


1. David Griffiths, Introduction to Electrodynamics, Pearson Education India Learning Private Limited; 4th Edition.
2. E.C. Jordan and K.G. Balmain, Electromagnetic waves and radiating systems, Prentice Hall.
3. Kraus John D, Electromagnetics, McGraw-Hill Publisher
4. W. Saslow, Electricity, magnetism and light, Academic Press
5. A Textbook of Electricity and Magnetism, S K Sharma, Shalini Sharma, S Dinesh & Co.
6. M. N. O. Sadiku, "Elements of Electromagnetics", Oxford University Publication, 2014.


**Course Outcomes and Mapping**

| At the end of the course, the student will be able to | |
|---|---|
| **CO1** | Understand and describe the different concepts of electromagnetism |
| **CO2** | To obtain the electric and magnetic fields for simple configurations under static conditions. |
| **CO3** | To analyse time varying electric and magnetic fields. |
| **CO4** | To understand Maxwell's equation in different forms and different media. |
| **CO5** | have a solid foundation in fundamentals required to solve problems and also to pursue higher studies. |

| | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 | PSO7 |
|---|---|---|---|---|---|---|---|
| CO1 | 3 | 1 | 2 | 2 | 2 | 1 | 2 |
| CO2 | 3 | 2 | 1 | - | 2 | 2 | 1 |
| CO3 | 3 | 2 | 3 | - | 2 | 1 | 2 |
| CO4 | 3 | 2 | 3 | 2 | - | 2 | 2 |
| CO5 | 2 | 2 | 3 | 2 | - | 2 | 2 |

| I.K. GUJRAL PUNJAB TECHNICAL UNIVERSITY<br>DEPARTMENT OF CHEMISTRY | | | | |
|---|---|---|---|---|
| **Course Name** | **B.Sc. (Honours) Chemistry** | | | |
| **Subject Code:** | **UC-BSHM-104-19** | | | |
| **Subject Title:** | **CALCULUS-I** | | | |
| **Contact Hours:** | **L:3** | **T:1** | **P:0** | **Credits:4** |
| **Examination Duration (hours)** | **3** | | | |
| **Objective(s):** | 1. The fundamental concepts of differential and integral calculus**.**<br>2. The geometrical meaning of functions, limits, continuity, derivatives, mean value theorems**.**<br>3. Applications of derivatives and integrals**.**<br>4. Limit, Continuity, partial derivatives and their applications in finding extreme values**.**<br>5. The utility of double and triple integrals in finding area and volume bounded by surfaces**.** | | | |

**Details of the Course**

| Unit | Contents |
|---|---|
| I | Functions of single variable, Simple examples of limit, continuity, differentiability, Derivative of elementary functions **(**t**-**ratios, logarithmic functions, exponential functions**)**, Higher order derivatives, Statement of Mean value theorems and simple applications, Applications of derivative**:** increasing decreasing functions, extreme values of functions**. (Ref. 1)** |
| II | Integration as an inverse process of differentiation, Finding integrals by partial fractions, by parts, Statement of fundamental theorem of calculus, Finding definite integrals by method of substitution, Applications of definite integral in finding length of an arc, area under simple curves, area enclosed between two curves**. (Ref. 1)** |
| III | Introduction of Limit, continuity of functions of two variables with simple examples, partial derivatives, Total derivatives, Homogeneous functions, Statement of Euler**'**s theorem, Simple examples of maxima**-**minima of functions of several variables, Lagrange**'**s method of multipliers**.** |
| IV | Double integrals, Change of order of integration, Jacobian, Double integral in polar coordinates, Triple integrals, Simple applications in finding area and volumes**.** |

**Reference Books**


1. Mathematics, A Text book for Class XII (Parts I & II), New Delhi: NCERT, 2003. **(**Unit I & II**)**
2. R.K. Jain and S.R.K. Iyengar, Advanced Engineering Mathematics, Narosa Pub., 4th Edition, 2015.
3. James Stewart, Calculus, 5th Edition, Brooks/Cole (Thomson), 2003.


**Course Outcomes and Mapping**

At the end of the course, the student will be

**CO1.** Understand the basic concepts of Differential and Integral Calculus.

**CO2.** Visualize all concepts geometrically.

**CO3.** Apply the knowledge of derivatives in finding extreme values of the function and definite integrals to find area under the curve.

**CO4.** Explain the concept of Limit, Continuity, partial derivatives of functions of severable variables and their applications.

**CO5.** Utilize the concept of multiple integrals in finding areas and volumes of different geometrical shapes.

| | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 | PSO7 |
|---|---|---|---|---|---|---|---|
| CO1 | 3 | - | 3 | 2 | 3 | 2 | - |
| CO2 | 3 | 1 | 3 | 2 | - | - | - |
| CO3 | 1 | 1 | 3 | 1 | 2 | 1 | - |
| CO4 | 3 | 3 | 3 | 1 | 2 | 1 | - |
| CO5 | 3 | 3 | 3 | 1 | 2 | 1 | - |

| I.K. GUJRAL PUNJAB TECHNICAL UNIVERSITY<br>DEPARTMENT OF CHEMISTRY SCIENCES | | | | |
|---|---|---|---|---|
| **Course Name** | **B.Sc. (Honours) Chemistry** | | | |
| **Subject Code:** | **BHHL105-19** | | | |
| **Subject Title:** | **COMMUNICATIVE ENGLISH-I** | | | |
| **Contact Hours:** | **L:2** | **T:0** | **P:0** | **Credits:2** |
| **Examination Duration (hours)** | **2** | | | |
| **Objective(s):** | 1. To help the students become proficient in LSRW-Listening, Speaking, Reading & Writing skills.<br>2. To help the students become the independent users of English language.<br>3. To develop in them vital communication skills, integral to their personal, social and professional interactions.<br>4. To teach them the appropriate language of professional communication. | | | |

**Details of the Course**

| Unit | Contents | Contact Hours |
|---|---|---|
| I | **(A)** ***The Poetic Palette*** **(Orient Black Swan, Second Edition, 2016)** The following poems from this anthology are prescribed:<br>1. Pippa's Song: Robert Browning<br>2. Apparently With No Surprise: Emily Dickinson<br>**3.** Fool and Flea: Jeet Thayil<br>**(B)** ***Prose Parables*** **(Orient Black Swan, 2013)**<br>The following stories from the above volume are prescribed:<br>a. The Kabuliwallah : Rabindranath Tagore<br>b. The Eyes Are Not Here: Ruskin Bond<br>c. Grief: Anton Chekov | 10 |
| II | **Vocabulary: Word Formation Processes;** Acquaintance with prefixes and suffixes from foreign languages in English to form derivatives; Synonyms, antonyms<br>**Grammar:** Subject-verb agreement; Noun-pronoun agreement; Misplaced modifiers; Articles; Determiners; Modals; Prepositions | 06 |
| III | **Reading and Understanding**<br>Close Reading; Comprehension | 04 |
| IV | **Mechanics of Writing & Speaking Skills**<br>Essay Writing (Descriptive/Narrative/Argumentative); Business letters; Précis Writing; Self Introductions; Group Discussion | 10 |

**Reference Books**

| S.No. | Author(s) | Title of the Book | Publisher/Year |
|---|---|---|---|
| 1 | John Eastwood | Oxford Practice Grammar | Oxford University Press, 2014 |
| 2 | Michael Swan | Practical English Usage. | OUP. 1995. |
| 3 | F.T. Wood | Remedial English Grammar | Macmillan.2007 |
| 4 | William Zinsser | On Writing Well | Harper Resource Book. 2001 |
| 5 | Sanjay Kumar and Pushp Lata | Communication Skills | Oxford University Press. 2011 |
| 6 | Liz Hamp-Lyons and Ben Heasly | Study Writing | Cambridge University Press. 2006. |

**Course Outcomes and Mapping**

At the end of the course,

**CO1.** Students will acquire basic proficiency in reading &listening, writing and speaking skills.

**CO2.** Students will be able to understand spoken and written English language, particularly the language of their chosen technical field.

**CO3.** They will be able to converse fluently and produce on their own clear and coherent texts.

**CO4.** Students will become proficient in professional communication such as interviews, group discussions, office environments, important reading skills as well as writing skills

| | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 | PSO7 |
|---|---|---|---|---|---|---|---|
| CO1 | 2 | 2 | 2 | 3 | 2 | 2 | 2 |
| CO2 | 3 | 3 | 2 | 3 | 2 | 3 | 3 |
| CO3 | 2 | 3 | 3 | 2 | 2 | 3 | 3 |
| CO4 | 2 | 2 | 3 | 3 | 3 | 2 | 3 |
| CO5 | 2 | 1 | 1 | 3 | 1 | 1 | 3 |

| I.K. GUJRAL PUNJAB TECHNICAL UNIVERSITY<br>DEPARTMENT OF CHEMICAL SCIENCES | | | | |
|---|---|---|---|---|
| **Course Name** | **B.Sc. (Honours) Chemistry** | | | |
| **Subject Code:** | **BHHL106A-19** | | | |
| **Subject Title:** | **PUNJABI COMPULSORY-I (ਪੰਜਾਬੀ ਲਾਜ਼ਮੀ-I)** | | | |
| **Contact Hours:** | **L:2** | **T:0** | **P:0** | **Credits:2** |
| **Examination Duration (hours)** | **2** | | | |
| **Objective(s):** | 1. To enhance the language ability of students.<br>2. To enhance the ability of Learning science and developing science literacy through local language teaching with science subjects. | | | |

**Details of the Course**

| Unit | Contents | Contact Hours |
|---|---|---|
| I | **ਕਵਿਤਾ ਭਾਗ:**<br>ਭਾਈ ਵੀਰ ਸਿੰਘ: ਸਮਾਂ, ਚਸ਼ਮਾ<br>ਪ੍ਰੋ. ਪੂਰਨ ਸਿੰਘ : ਪੰਜਾਬ ਨੂੰ ਕੂਕਾਂ ਮੈਂ, ਹੱਲ ਵਾਹੁਣ ਵਾਲੇ<br>ਪ੍ਰੋ.ਮੋਹਨ ਸਿੰਘ : ਮਾਂ, ਕੋਈ ਆਇਆ ਸਾਡੇ ਵਿਹੜੇ, ਪਿਆਰ ਪੰਧ<br>ਅੰਮ੍ਰਿਤਾ ਪ੍ਰੀਤਮ: ਆਖਾਂ ਵਾਰਿਸ ਸ਼ਾਹ ਨੂੰ, ਅੰਨਦਾਤਾ | 8 |
| II | **ਕਹਾਣੀ ਭਾਗ:**<br>ਸੰਤ ਸਿੰਘ ਸੇਖੋਂ : ਪੇਮੀ ਦੇ ਨਿਆਣੇ<br>ਸੁਜਾਨ ਸਿੰਘ : ਕੁਲਫੀ<br>ਕੁਲਵੰਤ ਸਿੰਘ ਵਿਰਕ : ਤੂੜੀ ਦੀ ਪੰਡ<br>ਗੁਰਦਿਆਲ ਸਿੰਘ : ਸਾਂਝ | 8 |
| III | ਭਾਸ਼ਾ ਦਾ ਟਕਸਾਲੀ ਰੂਪ, ਭਾਸ਼ਾ ਤੇ ਉਪ-ਭਾਸ਼ਾ ਵਿਚ ਅੰਤਰ, ਪੰਜਾਬੀ ਦੀਆਂ ਉਪ-ਭਾਸ਼ਾਵਾਂ,ਪੰਜਾਬੀ ਭਾਸ਼ਾ:ਨਿਕਾਸ ਤੇ ਵਿਕਾਸ।<br>ਭਾਸ਼ਾ ਤੇ ਲਿਪੀ, ਗੁਰਮੁਖੀ ਲਿਪੀ ਦੀਆਂ ਵਿਸ਼ੇਸ਼ਤਾਵਾਂ, ਗੁਰਮੁਖੀ ਲਿਪੀ: ਨਿਕਾਸ ਤੇ ਵਿਕਾਸ। | 8 |
| IV | ਸੰਖੇਪ ਰਚਨਾ (ਪ੍ਰੈਸੀ)<br>ਪੈਰ੍ਹਾ ਰਚਨਾ<br>ਸਰਲ ਅੰਗਰੇਜ਼ੀ ਪੈਰ੍ਹੇ ਦਾ ਪੰਜਾਬੀ ਅਨੁਵਾਦ | 6 |

**Reference Books**

| S.No. | Author(s) | Title of the Book | Publisher/Year |
|---|---|---|---|
| 1 | ਸੰਪ.ਡਾ.ਮਹਿਲ ਸਿੰਘ | ਸਾਹਿਤ ਦੇ ਰੰਗ | ਰਵੀ ਸਾਹਿਤ ਪਕਾਸ਼ਨ, ਅੰਮ੍ਰਿਤਸਰ,2016. |

**Course Outcomes and Mapping**

At the end of the course, the student will be able to

**CO1.** Translate and transfer/broadcast the western scientific knowledge in the local language.

**CO2.** Translate and transfer the indigenous/traditional scientific knowledge available in local knowledge into English and other global languages.

**CO3.** Understand the society through Punjabi language, literature and culture.

**CO4.** Learning science and in developing science literacy.

**CO5.** Improve the internal communication**.**

| | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 | PSO7 |
|---|---|---|---|---|---|---|---|
| CO1 | 1 | 2 | 1 | 1 | 2 | 2 | 2 |
| CO2 | 2 | 2 | 2 | 2 | 1 | 2 | 3 |
| CO3 | 2 | 1 | 2 | 3 | 1 | 1 | 3 |
| CO4 | 1 | 2 | 1 | 2 | 2 | 2 | 1 |
| CO5 | 2 | 1 | 1 | 2 | 2 | 2 | 3 |

| I.K. GUJRAL PUNJAB TECHNICAL UNIVERSITY<br>DEPARTMENT OF CHEMICAL SCIENCES | | | | |
|---|---|---|---|---|
| **Course Name** | **B.Sc. (Honours) Chemistry** | | | |
| **Subject Code:** | **BHHL106B-19** | | | |
| **Subject Title:** | **MUDHLI PUNJABI-I (ਮੁਢਲੀ ਪੰਜਾਬੀ )** | | | |
| **Contact Hours:** | **L:2** | **T:0** | **P:0** | **Credits:2** |
| **Examination Duration (hours)** | **2** | | | |
| **Objective(s):** | 1. To enhance the language ability of students.<br>2. To enhance the ability of Learning science and developing science literacy through local language teaching with science subjects. | | | |

**Details of the Course**

| Unit | Contents | Contact Hours |
|---|---|---|
| I | ਪੈਂਤੀ ਅੱਖਰੀ ( ਵਰਣਮਾਲਾ), ਅੱਖਰ ਕ੍ਰਮ<br>ਮਾਤਰਾਵਾਂ : ਮੁਢਲੀ ਜਾਣ-ਪਛਾਣ<br>ਲਗਾਖਰ :ਬਿੰਦੀ, ਟਿੱਪੀ, ਅੱਧਕ | 8 |
| II | ਪੰਜਾਬੀ ਸ਼ਬਦ ਬਣਤਰ: ਮੁਢਲੀ ਜਾਣ-ਪਛਾਣ<br>ਮੂਲ ਸ਼ਬਦ , ਅਗੇਤਰ, ਪਿਛੇਤਰ<br>ਸਮਾਨਾਰਥਕ ਸ਼ਬਦ, ਵਿਰੋਧਾਰਥਕ ਸ਼ਬਦ<br>ਸ਼ੁੱਧ- ਅਸ਼ੁੱਧ: ਦਿੱਤੇ ਪੈਰ੍ਹੇ ਵਿੱਚੋਂ ਅਸ਼ੁੱਧ ਸ਼ਬਦ ਨੂੰ ਸ਼ੁੱਧ ਕਰਨਾ | 8 |
| III | ਹਫਤੇ ਦੇ ਸੱਤ ਦਿਨਾਂ ਦੇ ਨਾਂ<br>ਬਾਰ੍ਹਾਂ ਮਹੀਨਿਆਂ ਦੇ ਨਾਂ<br>ਰੁੱਤਾਂ ਦੇ ਨਾਂ<br>ਇਕ ਸੌ ਤੱਕ ਗਿਣਤੀ ਸ਼ਬਦਾਂ ਵਿਚ | 6 |
| IV | ਸਧਾਰਣ ਸ਼ਬਦਾਂ ਦਾ ਅੰਗਰੇਜ਼ੀ ਤੋਂ ਪੰਜਾਬੀ ਅਨੁਵਾਦ<br>ਸਧਾਰਣ ਸ਼ਬਦਾਂ ਦਾ ਪੰਜਾਬੀ ਤੋਂ ਅੰਗਰੇਜ਼ੀ ਅਨੁਵਾਦ | 8 |

**Course Outcomes and Mapping**

At the end of the course, the student will be able to

**CO1.** Translate and transfer/broadcast the western scientific knowledge in the local language.

**CO2.** Translate and transfer the indigenous/traditional scientific knowledge available in local knowledge into English and other global languages.

**CO3.** Understand the society through Punjabi language, literature and culture.

**CO4.** Learning science and in developing science literacy.

| **CO5.** Improve the internal communication**.** | | | | | | | |
|---|---|---|---|---|---|---|---|
| | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 | PSO7 |
| CO1 | 1 | 2 | 1 | 1 | 2 | 2 | 2 |
| CO2 | 2 | 2 | 2 | 2 | 1 | 2 | 3 |
| CO3 | 2 | 1 | 2 | 3 | 1 | 1 | 3 |
| CO4 | 1 | 2 | 1 | 2 | 2 | 2 | 1 |
| CO5 | 2 | 1 | 1 | 2 | 2 | 2 | 3 |

| I.K. GUJRAL PUNJAB TECHNICAL UNIVERSITY<br>DEPARTMENT OF CHEMISTRY | | | | |
|---|---|---|---|---|
| **Course Name** | **B.Sc. (Honours) Chemistry** | | | |
| **Subject Code:** | **BHCP107-19** | | | |
| **Subject Title:** | **INORGANIC CHEMISTRY LAB-I** | | | |
| **Contact Hours:** | **L:0** | **T:0** | **P:4** | **Credits:2** |
| **Examination Duration (hours)** | **3** | | | |
| **Objective(s):** | The objective of this course is to provide practical knowledge and illustrative experiments about various types of inorganic titrations and preparation of simple inorganic compounds. | | | |

**Details of the Course**

| Unit | Contents |
|---|---|
| I | **Titrimetric Analysis**<br>(i) Calibration and use of apparatus<br>(ii) Preparation of solutions of different Molarity/Normality of titrants<br><br>**Acid-Base Titrations**<br>(i) Estimation of carbonate and hydroxide present together in mixture.<br>(ii) Estimation of carbonate and bicarbonate present together in a mixture.<br>(iii) Estimation of free alkali present in different soaps/detergents<br><br>**Oxidation-Reduction Titrimetry**<br>(i) Estimation of Fe (II) and oxalic acid using standardized $KMnO_4$ solution.<br>(ii) Estimation of oxalic acid and sodium oxalate in a given mixture.<br>(iii) Estimation of Fe(II) with $K_2Cr_2O_7$ using internal (diphenylamine, anthranilic acid) and external indicator.<br><br>**Iodo / Iodimetric Titrations**<br>(i) Estimation of Cu(II) and $K_2Cr_2O_7$ using sodium thiosulphate solution (Iodimetrically).<br>(ii) Estimation of (i) arsenite and (ii) antimony in tartar-emetic iodimetrically<br>(iii) Estimation of available chlorine in bleaching powder iodometrically.<br><br>**Inorganic preparations**<br>(i) Cuprous Chloride, $Cu_2Cl_2$<br>(ii) Preparation of Manganese (III) phosphate, $MnPO_4.H_2O$<br>(iii) Preparation of Aluminium potassium sulphate $KAl(SO_4)_2.12H_2O$ (Potash alum) or Chrome alum. |

**Reference Books**

| S.No. | Author(s) | Title of the Book | Publisher/Year |
|---|---|---|---|
| 1 | Vogel, A.I. | A Textbook of Quantitative Inorganic Analysis | ELBS |

**Course Outcomes and Mapping**

At the end of the course, the student will be able to

**CO1.** Understand to calibrate and run the instruments for analysis.

**CO2.** Learn to the quantitative analysis of various metal ions/cations and anions.

**CO3.** Understand the various principles of different techniques involved in the quantitative analysis.

**CO4.** Learn to prepare various inorganic compounds.

| | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 | PSO7 |
|---|---|---|---|---|---|---|---|
| CO1 | 1 | 2 | 2 | 3 | 3 | 2 | 2 |
| CO2 | 2 | 1 | 2 | 2 | 1 | 2 | 3 |
| CO3 | 1 | 2 | 2 | 2 | 2 | 3 | 2 |
| CO4 | 2 | 2 | 1 | 2 | 3 | 2 | 1 |
| CO5 | 1 | 1 | 2 | 2 | 1 | 1 | 3 |

| I.K. GUJRAL PUNJAB TECHNICAL UNIVERSITY<br>DEPARTMENT OF CHEMISTRY | | | | |
|---|---|---|---|---|
| **Course Name** | **B.Sc. (Honours) Chemistry** | | | |
| **Subject Code:** | **BHCP108-19** | | | |
| **Subject Title:** | **ORGANIC CHEMISTRY LAB-I** | | | |
| **Contact Hours:** | **L:0** | **T:0** | **P:4** | **Credits:2** |
| **Examination Duration (hours)** | **3** | | | |
| **Objective(s):** | The objective of this course is to provide practical knowledge and illustrative experiments regarding qualitative analysis, isolation, and purification of organic compounds. | | | |

**Details of the Course**

| Unit | Contents |
|---|---|
| I | **Determination of melting point**<br>Napthalene 80-82°, Benzoic acid 121.5-122°, Urea 132.5-133°, Succinic acid 184.5-185°, Cinnamic acid 132.5-133°, Salicylic acid 157.5-158°, Acetanilide 113.5-114°, m-Dinitrobenzene 90°, p-Dichlorobenzene 52°, Aspirin 135°<br><br>**Determination of boiling point**<br>Ethanol 78°, Cyclohexane 81.4°, Toluene 110.6°, Benzene 80° |
| II | **Distillation**<br>Simple distillation of ethanol-water mixture using water condenser<br>Distillation of nitrobenzene and aniline using air condenser<br>**Crystallization**<br>Concept of induction of crystallization<br>Phthalic acid from hot water **(**using fluted filter paper and stemless funnel**)**<br>Acetanilide from boiling water<br>Napthalene from ethanol<br>Benzoic acid from water |
| III | **Qualitative Analysis**<br>***Elemental analysis***<br>nitrogen, sulphur, chlorine, bromine, iodine<br>***Functional groups***<br>-phenols, carboxylic acids<br>-carbonyl compounds - ketones, aldehydes<br>-carbohydrates<br>-aromatic amines<br>-amides, ureas and anilides<br>-aromatic hydrocarbons and their halo- derivatives |

**Reference Books**

| S.No. | Author(s) | Title of the Book | Publisher |
|---|---|---|---|
| 1 | Brian S. Furniss, Antony J. Hannaford, Peter W.G. Smith and Austin R. Tatchell | Vogel's Textbook of Practical Organic Chemistry, 5th Edition | Longman, London |
| 2 | F.G. Mann and B. C. Saunders | Practical Organic Chemistry | Longman, New York |
| 3 | J.T. Sharp | Practical Organic Chemistry: A student handbook of techniques | Springer |
| 4 | Philippa B. Cranwell, Laurence M. Harwood and Cristopher J. Moody | Experimental Organic Chemistry, 3rd Edition | Wiley |

**Course Outcomes and Mapping**

At the end of the course, the students will be able

**CO1.** To check the purity of organic compounds by determining the melting or boiling points

**CO2.** To develop preparative skills for purification of organic compounds by crystallization method.

**CO3.** To determine the element or functional groups present in organic compound by organic qualitative analysis.

**CO4.** To present their work with practical skills and the awareness of health and safety procedures.

**CO5.** To apply related experiments for their research work

| | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 | PSO7 |
|---|---|---|---|---|---|---|---|
| CO1 | 2 | - | 2 | - | 3 | 1 | - |
| CO2 | 2 | - | 3 | - | 3 | 3 | - |
| CO3 | 3 | 3 | 4 | - | 3 | 3 | - |
| CO4 | 3 | 4 | 3 | 4 | 4 | 5 | 4 |
| CO5 | 2 | 3 | 4 | 2 | 4 | 4 | 4 |

| I.K. GUJRAL PUNJAB TECHNICAL UNIVERSITY<br>DEPARTMENT OF CHEMISTRY | | | | |
|---|---|---|---|---|
| **Course Name** | **B.Sc. (Honours) Chemistry** | | | |
| **Subject Code:** | **UC-BSHP-113-19** | | | |
| **Subject Title:** | **PHYSICS LAB -I** | | | |
| **Contact Hours:** | **L:0** | **T:0** | **P:4** | **Credits:2** |
| **Examination Duration (hours)** | **3** | | | |
| **Objective(s):** | The aim and objective of the lab course is to introduce the students to the formal structure of electromagnetism and phenomenon of wave optics so that they can use these as per their requirement. | | | |

**Details of the Course:**

**Note: Students are expected to perform about 8-10 experiments from the following list, selecting minimum of 6-7 from the Physical Lab and 2-3 from the Virtual lab.**

**List of experiments:**

1. Use a Multimeter for measuring (a) Resistances, (b) AC and DC Voltages, (c) DC Current, (d) Capacitances, and (e) Checking electrical fuses.
2. To study the laser beam characteristics like; wave length, aperture, spot size, etc. using diffraction grating.
3. To study the diffraction using laser beam and thus to determine the grating element.
4. To study wavelength and laser interference using Michelson's Interferometer.
5. To find the refractive index of a material/glass using spectrometer.
6. To find the refractive index of a liquid using spectrometer.
7. To determine the resolving power of a prism.
8. To study the magnetic field of a circular coil carrying current using a Steward and Gees Tangent Galvanometer.
9. Determine the radius of circular coil using the Circular coil.
10. To study B-H curve using CRO.
11. To find out polarizability of a dielectric substance.
12. To find out the horizontal component of earth's magnetic field (Bh).

**Reference Books**


1. A Text -book of Practical Physics, I. Prakash & Ramakrishna, 11th Edn, 2011, Kitab Mahal.
2. Engineering Practical Physics, S. Panigrahi & B. Mallick, 2015, Cengage Learning India Pvt. Ltd.
3. Practical Physics, G.L. Squires, 2015, 4th Edition, Cambridge University
4. Press.Practical Physics, C L Arora. S. Chand & Company Ltd.
5. http://www.vlab.co.in

**Course Outcomes and Mapping**

| **Course Outcomes:** At the end of the course, the student will be able to | |
|---|---|
| **CO1** | Able to verify the theoretical concepts/laws learnt in theory courses. |
| **CO2** | Trained in carrying out precise measurements and handling sensitive equipment. |
| **CO3** | Understand the methods used for estimating and dealing with experimental uncertainties and systematic "errors". |
| **CO4** | Learn to draw conclusions from data and develop skills in experimental design. |
| **CO5** | Document a technical report which communicates scientific information in a clear and concise manner. |

| | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 | PSO7 |
|---|---|---|---|---|---|---|---|
| CO1 | 3 | 3 | 2 | 2 | 2 | 1 | 2 |
| CO2 | 3 | 3 | 1 | - | 2 | 2 | 1 |
| CO3 | 3 | 3 | 2 | - | 2 | 1 | 2 |
| CO4 | 3 | 2 | 2 | 2 | - | 2 | 2 |
| CO5 | 2 | 2 | 2 | 2 | - | 2 | 2 |

## Computer I-Problem Solving Techniques

| UGSEC2501 | Problem Solving Techniques | 3L:1T:0P | 4 Credits |
|---|---|---|---|

**Course Objectives**

CO1: Express the logical flow used in Programming.
CO2: Design algorithms for solving various real life problems
CO3: Implement programs using C.
CO4: Choose the right data type and statements for programs.
CO5: Explain various concepts of C programming language.

**Prerequisite:** This is an introductory programming course and hence no prerequisites

**Course Content:**

### UNIT I: (CO-1, CO-2)

**Logic Development:** Data Representation, Flowcharts, Problem Analysis, Decision Trees/Tables, Pseudo code and algorithms. Fundamentals: Character set, Identifiers and Key Words, Data types, Constants, Variables, Expressions, Statements, Symbolic Constants. [CO1]

**Operations and Expressions:** Arithmetic operators, Unary operators, Relational Operators, Logical Operators, Assignment and Conditional Operators, Library functions. [CO2]

### UNIT II: (CO-2, CO-3, CO-4)

**Data Input and Output:** formatted & unformatted input output.
**Control Statements:** While, Do–while and For statements, Nested loops, If–else, Switch, Break – Continue statements.

### UNIT III: (CO-2, CO-3, CO-4)

**Functions**: Brief overview, defining, accessing functions, passing arguments to function, specifying argument data types, function prototypes, recursion. [CO4]
**Arrays**: Defining, processing arrays, passing arrays to a function, multi–dimensional arrays.

**Strings**: String declaration, string functions and string manipulation Program Structure Storage Class: Automatic, external and static variables. [CO3]

**UNIT IV: (CO-2, CO-3, CO-4, CO-5)**

**Structures & Unions:** Defining and processing a structure, user defined data types, structures and pointers, passing structures to functions, unions.

**Pointers:** Understanding Pointers, Accessing the Address of a Variable, Declaration and Initialization of Pointer Variables, Accessing a Variable through its Pointer, Pointers and Arrays

**File Handling:** File Operations, Processing a Data File [CO5]

**Text Books:**


1. Programming in ANSI C, E. Balagurusami, Fourth Edition, Tata McGraw Hill.
2. Programming in C, Third Edition, Stephen G Kochan, Pearson.
3. The C Programming Language, Kernighan & Richie, Second Edition, PHI Publication.


**Reference Books:**


1. Object Oriented Programming, Lafore R, Third Edition, Galgotia Publications
2. Let us C, Yashvant P Kanetkar, Seventh Edition, BPB Publications, New Delhi.
3. Programming in C, Byron S. Gottfried, Second Edition, McGraw Hills.
4. Problem Solving and Programming in C, R.S. Salaria, Second Edition
5. Programming in C, Atul Kahate.

## Computer Lab I-Problem Solving Techniques Laboratory

| UGSEC2502 | Problem Solving Techniques Laboratory | 0L:0T:4P | 2 Credits |
|---|---|---|---|

**Course Outcomes: After studying this course, students will be able to:**

CO1: Select the right statement for the program.
CO2: Experiment with different input values.
CO3: Test the output with boundary conditions.
CO4: Distinguish between various control statements and data types.
CO5: Implement programs for various problems.

**Instructions**: Instructor can increase/decrease the experiments as per the requirement.

**Assignments:**

1. WRITE A PROGRAM to display your name. Write another program to print message with inputted name.
2. WRITE A PROGRAM to add two numbers.
3. WRITE A PROGRAM to find the square of a given number.
4. WRITE A PROGRAM to calculate the average of three real numbers.
5. Write a program to Find ASCII Value of a Character
6. WRITE A PROGRAM to Find the Size of int, float, double and char
7. WRITE A PROGRAM to Compute Quotient and Remainder
8. WRITE A PROGRAM to accept the values of two variables.
9. WRITE A PROGRAM to find the simple interest, inputs are amount, period in years and rate of interest.
10. Basic salary of an employee is input through the keyboard. The DA is 25% of the basic salary while the HRA is 15% of the basic salary. Provident Fund is deducted at the rate of 10% of the gross salary(BS+DA+HRA). WRITE A PROGRAM to calculate the net salary
11. WRITE A PROGRAM to find area of a circle using PI as constant
12. WRITE A PROGRAM to find volume of a cube using side as input from user
13. WRITE A PROGRAM using various unformatted Input Functions
14. WRITE A PROGRAM to find area of rectangle and print the result using unformatted output Functions

15. WRITE A PROGRAM to find the larger of two numbers.
16. WRITE A PROGRAM to find greater of three numbers using Nested If.
17. WRITE A PROGRAM to find whether the given number is even or odd.
18. WRITE A PROGRAM to Generate Multiplication Table Using for loop
19. WRITE A PROGRAM to Generate Multiplication Table Using while loop
20. WRITE A PROGRAM to Make a Simple Calculator Using switch...case
21. WRITE A PROGRAM to find whether the given number is a prime number.
22. WRITE A PROGRAM using function to find the largest of three numbers
23. WRITE A PROGRAM using function to print first 20 numbers and its squares.
24. WRITE A PROGRAM to find the factorial of a given number.
25. WRITE A PROGRAM to print the sum of two matrices
26. WRITE A PROGRAM to Find the Length of a String
27. WRITE A PROGRAM to Copy String using strcpy()
28. WRITE A PROGRAM to compare a string
29. WRITE A PROGRAM to reverse a string
30. WRITE A PROGRAM to reverse a string
31. WRITE A PROGRAM to multiply two numbers using pointers.
32. WRITE A PROGRAM to display address of variable using pointers
33. WRITE A PROGRAM to show the memory occupied by Structure and Union
34. WRITE A PROGRAM to create Student I-Card using a Structure
35. WRITE A PROGRAM to read data from a file from a file
36. WRITE A PROGRAM to save Employee details in a file using File Handling

# SEMESTER-II

| I.K. GUJRAL PUNJAB TECHNICAL UNIVERSITY<br>DEPARTMENT OF CHEMICAL SCIENCES | | | | |
|---|---|---|---|---|
| **Course Name** | **B.Sc. (Honours) Chemistry** | | | |
| **Subject Code:** | **BHCL111-19** | | | |
| **Subject Title:** | **INORGANIC CHEMISTRY-II** | | | |
| **Contact Hours:** | **L:3** | **T:1** | **P:0** | **Credits:4** |
| **Examination Duration (hours)** | **3** | | | |
| **Objective(s):** | To teach the fundamental concepts of Inorganic Chemistry and their applications. | | | |

**Details of the Course**

| Unit | Contents | Contact Hours |
|---|---|---|
| I | **Chemistry of s & p block elements:**<br><br>**IA-VII A and Zero Groups:** General remarks about each group, trends in electronic configuration, structure of elements, atomic and ionic, Radii, ionization potential, electron affinity, electronegativity, oxidation states, Inert pair effect, Relative stability of different oxidation states, diagonal relationship and anomalous behaviour of first member of each group. Allotropy and catenation. Complex formation tendency of s and p block elements, Important classes of Compounds of s and p block elements.<br>**Alkali Metals:** Oxides, hydroxides, peroxides and super oxides, halides, halides, hydrides, solutions of metals in liquid ammonia, complexes crowns and cryptands and podands.<br>**Alkaline Earth Metals:** Solutions of the metals in liquid ammonia, hydroxides, oxides, sulfates, hydrides, halides, carbides, structures of calcium carbide, structures of basic beryllium acetate $Be_4O(CH_3COO)_6$, beryllium oxalate complexes $Be(Oxalate)_2$. Structure of chlorophyll `a'. | 11 |
| II | **Chemistry of s & p block elements:**<br><br>**Group III (Boron Group)**: Oxides, halides and hydrides of group III elements, boron sesquioxide and borates structure of borates, trihalides and lower halides of boron, preparation of boron hydrides reactions and structures of boranes.<br>**Group IV (Carbon Group):** Structure and allotropy of the elements, types and structure of carbides, oxides of carbon and silicon, types and structures of silicates, Organo-silicon compounds and the silicones, halides of IV group elements.<br>**Group V (Nitrogen Group):** Hydrides, properties and structure of ammonia, hydrazine, hydroxylamine, trihalides and Pentahalides of V groups elements, oxides of nitrogen, structure of $N_2O$, NO, $N_2O_3$, $N_2O_4$ and $N_2O_5$, oxo acids of nitrogen and phosphorous, phosphazenes and cyclophosphazenes. | 13 |

| | | |
|---|---|---|
| III | **Chemistry of s & p block elements:**<br><br>**Group VI (Oxygen Group):** Structure and allotropy of the elements. Oxides of sulfur (structure of $SO_2$ and $SO_3$) oxoacids of sulfur halides of sulfur, selenium and tellurium, compounds of Sulfur and nitrogen ($S_4N_4$).<br>**Group VII:** Oxides of halogens ($OF_2$, $O_2F_2$, $Cl_2O$, $ClO_2$, $Cl_2O_6$, $BrO_2$, $I_2O_5$) (structures), Preparation, reaction and structure interhalogen compounds. ($ClF_3$, $BrF_3$, $I_2$, $Cl_5$, $IF_5$, $IF_7$) Polyhalides, basic properties of halogens.<br>**Zero Group (Chemistry of noble gases):** Clatharate compounds, preparation, structure and bonding of noble gas compounds (XeF2, XeF4, XeF6, XeO3, XeO2F2, XeO4). | 11 |
| IV | **Coordination Chemsitry I:**<br>Werner's theory, nomenclature of coordination complexes, isomerism in coordination complexes, chelating agents, metal chelates and chelate effects, names and abbreviations of important ligands, polydenate ligands, polypyarzolyborates, macrocylic ligands, macrocylic effect, ketoenolates, troplonates, tripod ligands, conformation of chelate rings, stereochemistry of coordination numbers 2-12, factors determining kinetic and thermodynamic stability. | 10 |

**Reference Books**

| S.No. | Author(s) | Title of the Book | Publisher/Year |
|---|---|---|---|
| 1 | J.D. Lee | Concise Inorganic Chemistry, 4th Ed. | ELBS, 1991 |
| 2 | J.E. Huheey | Inorganic Chemistry | Harper & Row |
| 3 | F.A.Cotton and G. Wilinson | Advanced Inorganic Chemistry | Wiley, VCH, 1999 |
| 4 | N.N. Greenwood and A. Earnshaw | Chemistry of Elements | Butterworth Heinemann 1997 |
| 5 | G. L. Miessler & A. Tarr. Donald | Inorganic Chemistry 4th Ed., | Pearson, 2010 |
| 6 | B.E. Douglas, D.H. Mc Daniel, & J.J. Alexander | Concepts & Models of Inorganic Chemistry 3rd Ed. | John Wiley Sons, N.Y. 1994. |

**Course Outcomes and Mapping**

At the end of the course, the student will be able to

**CO1.** Understand the fundamental concepts and theories of s & p block elements

**CO2.** Learn about the different compounds of s & p block elements, their structure, synthesis and stability of the coordination complexes.

**CO3.** Understand the structure, formation and properties of various compounds of s & p block elements.

**CO4.** Learn about various ligands and their effect on the formation of coordination compounds.

**CO5.** Learn about the terms and theories of the coordination compounds**.**

| | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 | PSO7 |
|---|---|---|---|---|---|---|---|
| CO1 | 1 | 2 | 3 | 2 | 2 | 3 | 2 |
| CO2 | 2 | 1 | 2 | 3 | 3 | 2 | 2 |
| CO3 | 1 | 2 | 2 | 3 | 2 | 2 | 1 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| CO4 | 1 | 2 | 2 | 3 | 2 | 2 | 1 |
| CO5 | 0 | 1 | 2 | 2 | 1 | 2 | 1 |

| **I.K. GUJRAL PUNJAB TECHNICAL UNIVERSITY**<br>**DEPARTMENT OF CHEMICAL SCIENCES** | | | | |
|---|---|---|---|---|
| **Course Name** | **B.Sc. (Honours) Chemistry** | | | |
| **Subject Code:** | **BHCL112-19** | | | |
| **Subject Title:** | **PHYSICAL CHEMISTRY-I** | | | |
| **Contact Hours:** | **L:3** | **T:1** | **P:0** | **Credits:4** |
| **Examination Duration (hours)** | **3** | | | |
| **Objective(s):** | This course will equip students with the necessary chemical knowledge concerning the fundamentals in the basic areas of physical chemistry viz. different states of matter and ionic equilibrium. The problem solving skills of students are expected to be enhanced through due weightage given to numerical problems in each unit. | | | |

**Details of the Course**

| Unit | Contents | Contact Hours |
|---|---|---|
| I | **Gaseous state**<br>Kinetic molecular theory of gases: postulates and derivation of the kinetic gas equation; collision frequency; collision diameter; mean free path and viscosity of gases, including their temperature and pressure dependence, relation between mean free path and coefficient of viscosity, variation of viscosity with temperature and pressure.<br>Maxwell distribution and its use in evaluating molecular velocities (average, root mean square and most probable) and average kinetic energy, law of equipartition of energy.<br>Behaviour of real gases: Deviations from ideal gas behaviour, compressibility factor, *Z*, and its variation with pressure for different gases. Causes of deviation from ideal behavior. van der Waals equation of state, its derivation and application in explaining real gas behaviour, continuity of states, critical state, relation between critical constants and van der Waals constants, law of corresponding states, Numericals. | 12 |
| II | **Liquid state:**<br>Qualitative treatment of the structure of the liquid state; physical properties of liquids; vapour pressure, surface tension and coefficient of viscosity, and their determination. Effect of addition of various solutes on surface tension and viscosity. Explanation of cleansing action of detergents. Temperature variation of viscosity of liquids and comparison with that of gases. Qualitative discussion of structure of water. | 10 |
| III | **Solid State**<br>Nature of the solid state, law of constancy of interfacial angles, law of rational indices, Miller indices, elementary ideas of symmetry, symmetry elements and symmetry operations, qualitative idea of point and space groups, seven crystal systems and fourteen Bravais lattices; X-ray diffraction, Bragg's law, a simple account of rotating crystal method and powder pattern method. Analysis of powder diffraction patterns of NaCl, | 11 |

| | | |
|---|---|---|
| | CsCl and KCl. Defects in crystals. Glasses and liquid crystals. | |
| IV | **Ionic equilibria**<br>Strong, moderate and weak electrolytes, degree of ionization, factors affecting degree of ionization, ionization constant and ionic product of water. Ionization of weak acids and bases, pH scale, common ion effect; dissociation constants of mono-, di-and triprotic acids.<br>Salt hydrolysis-calculation of hydrolysis constant, degree of hydrolysis and pH for different salts. Buffer solutions; derivation of Henderson equation and its applications; buffer capacity, buffer range, buffer action and applications of buffers in analytical chemistry and biochemical processes in the human body.<br>Solubility and solubility product of sparingly soluble salts – applications of solubility product principle. Qualitative treatment of acid – base titration curves (calculation of pH at various stages). Theory of acid–base indicators; selection of indicators and their limitations. | 12 |

**Reference Books**

| S.No. | Author(s) | Title of the Book | Publisher/Year |
|---|---|---|---|
| 1 | P.W. Atkins & J. de Paula | Atkin's Physical Chemistry | Oxford University Press (2006) |
| 2 | S.H. Maron & C.F. Prutton | Principles of Physical Chemistry, 1st edition | Oxford and IBH (1958) |
| 3 | G.W. Castellan | Physical Chemistry, 4th edition | Narosa (2004) |
| 4 | D. W. Ball | Physical Chemistry | Thomson Press, India (2007) |

**Course Outcomes and Mapping**

At the end of the course, the student will be able to

**CO1.** Understand the basic principles and theories pertaining to various states of matter

**CO2.** Solve various problems related to real gases and pH concept**.**

**CO3.** Define the various types of crystal systems and defects in solids**.**

**CO4.** Familiarise with the concept of acids and bases and differentiate between them

**CO5.** Rationalise bulk properties and processes governing gaseous, liquid and solid states**.**

| | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 | PSO7 |
|---|---|---|---|---|---|---|---|
| CO1 | 3 | 1 | 1 | - | 2 | 1 | 1 |
| CO2 | 3 | 2 | 3 | - | 1 | - | 1 |
| CO3 | 2 | 2 | 1 | - | 2 | 1 | 1 |
| CO4 | 3 | 2 | 2 | - | 2 | 1 | 1 |
| CO5 | 3 | 2 | 2 | - | 1 | - | 1 |

| **I.K. GUJRAL PUNJAB TECHNICAL UNIVERSITY<br>DEPARTMENT OF CHEMICAL SCIENCES** | | | | |
|---|---|---|---|---|
| **Course Name** | **B.Sc. (Honours) Chemistry** | | | |
| **Subject Code:** | **UC-BSHP-124-19** | | | |
| **Subject Title:** | **WAVES AND VIBRATIONS** | | | |
| **Contact Hours:** | **L:3** | **T:1** | **P:0** | **Credits:4** |
| **Examination Duration (hours)** | **3** | | | |
| **Objective(s):** | The objective of the course is to develop basic understanding of Interference, Diffraction and Polarization among students. The Students also learn about the LASER and its applications. Students will be equipped with knowledge to measure wavelength, refractive index and other related parameters, which will act as a strong background if he/she chooses to pursue sciences as a career. | | | |

**Details of the Course**

| Unit | Contents | Contact Hours |
|---|---|---|
| I | **Interference:** Electromagnetic nature of light, Definition and properties of wave front, Huygens Principle, Temporal and Spatial Coherence, Division of amplitude and wavefront, Young's double slit experiment, Lloyd's single mirror and Fresnel's Biprism, Interference in Thin Films, Newton's Rings and Michelson Interferometer. | 11 |
| II | **Diffraction and Polarization:** Huygens Principle, Huygens-Fresnel Diffraction theory, Fraunhofer diffraction: Single slit. Circular aperture, Rayleigh criterion of resolution, Resolving Power of a telescope, Double slit, Multiple slits, Diffraction grating; Polarization, Plane polarized light, Representation of Unpolarized and Polarized light, Polarization by Reflection, Brewster's law, Malus Law, Polarization by Selective absorption by Crystals, Polarization by Scattering, Polarization by Double Refraction. | 11 |
| III | **Simple Harmonic Motion:** Simple harmonic motion, Energy of a SHO, Simple, Compound and Torsional pendulum, Electrical Oscillations, damped oscillations, damped harmonic oscillator – heavy, critical, and light damping, Damping coefficients, energy decay in a damped harmonic oscillator, quality factor, forced mechanical oscillators, resonance. | 12 |
| IV | **Laser and Application:** Lasers, Spontaneous emission, Stimulated absorption, Stimulated emission, Einstein coefficients, Conditions for Laser actions, Population inversion, Different types of Laser, Pumping mechanism: Optical Pumping, Electric Discharge and Electrical pumping, Resonators, Two, Three, and Four level laser systems, Ruby laser, He-Ne gas Laser, Semiconductor laser, CO2 laser, applications of laser: Holography, Principle of Holography. | 11 |

**Reference Books**


1. Optics: A.K. Ghatak (Tata-McGraw Hill), 1992.
2. Fundamentals of Optics: F.A. Jenkins and H.E. White (McGraw Hill), 1981.
3. A Text Book of Optics: Subrahmaniyam N. & et al.(S. Chand Publishing) (2006).
4. O. Svelto, "Principles of Lasers", Springer Science & Business Media, 2010.


**Course Outcomes and Mapping**

| At the end of the course, the student will be | | | | | | | |
|---|---|---|---|---|---|---|---|
| **CO1** | Able to understand the theoretical concepts learned in the theory course. | | | | | | |
| **CO2** | Trained in carrying out precise measurements and handling equipment. | | | | | | |
| **CO3** | Learn to draw conclusions from data and develop skills in experimental design**.** | | | | | | |
| **CO4** | Able to understand the principles of error analysis and develop skills in experimental design**.** | | | | | | |
| **CO5** | Able to document a technical report which communicates scientific information in a clear and concise manner. | | | | | | |
| | **PSO1** | **PSO2** | **PSO3** | **PSO4** | **PSO5** | **PSO6** | **PSO7** |
| CO1 | 3 | 3 | 2 | 2 | 2 | 1 | 2 |
| CO2 | 3 | 3 | 1 | - | 2 | 2 | 1 |
| CO3 | 3 | 3 | 2 | - | 2 | 1 | 2 |
| CO4 | 3 | 2 | 2 | 2 | - | 2 | 2 |
| CO5 | 2 | 2 | 2 | 2 | - | 2 | 2 |

| **I.K. GUJRAL PUNJAB TECHNICAL UNIVERSITY**<br>**DEPARTMENT OF CHEMICAL SCIENCES** | | | | |
|---|---|---|---|---|
| **Course Name** | **B.Sc. (Honours) Chemistry** | | | |
| **Subject Code:** | **UC-BSHM- 204-19** | | | |
| **Subject Title:** | **VECTOR ALGEBRA & VECTOR ANALYSIS** | | | |
| **Contact Hours:** | **L:3** | **T:1** | **P:0** | **Credits:4** |
| **Examination Duration (hours)** | **3** | | | |
| **Objective(s):** | The objectives of this course are to make the students understand the following**:**<br>1. The fundamental concepts of Scalars and Vector algebra**.**<br>2. The geometrical meaning of projections and orthogonality**.**<br>3. Applications of gradient, divergence and curl**.**<br>4. Geometric meaning of scalar and vector valued functions, gradient of scalar point function**.**<br>5. The utility of Gauss, Green and Stokes Theorem**.** | | | |

**Details of the Course**

| Unit | Contents |
|---|---|
| I | Definitions of Scalars, vectors, position vector, unit vector, types of vectors, Addition of vectors, direction ratios, direction cosines, multiplication by a scalar, dot product, cross product of vectors, projection of vectors on a line. |
| II | Vector joining two points, section formula, angle between two vectors, Cauchy-Schwartz inequality, Solenoidal vectors, orthogonality, Area of triangle, area of parallelogram, Scalar and vector product of three vectors. |
| III | Scalar valued point functions, vector valued point functions, Derivative along a curve, directional derivatives, Differentiation and partial differentiation of a vector function. Derivative of sum, dot product and cross product of two vectors, Gradient, divergence and curl Gradient of a scalar point function. Geometrical interpretation of gradient of a scalar point function (grad φ). |
| IV | Divergence and curl of a vector point function, Character of divergence and curl of a vector point function, relation between Cartesian and cylindrical or spherical coordinates, Statements of Theorems of Gauss, Green and Stokes **(**without proof**).** |

**Reference Books**


1. Mathematics, A Text book for Class XII (Parts I & II), New Delhi: NCERT, 2003. (Unit I & II)
2. G.B. Thomas and R.L. Finney, Calculus, 9th Ed., Pearson Education, Delhi, 2005.
3. H. Anton, I. Bivens and S. Davis, Calculus, John Wiley and Sons (Asia) P. Ltd. 2002.
4. P.C. Matthew's, Vector Calculus, Springer Verlag London Limited, 1998.


**Course Outcomes and Mapping**

| At the end of the course, the students will be able to | |
|---|---|
| **CO1** | Understand the basic concepts of Scalars and Vector algebra. |
| **CO2** | Visualize all concepts geometrically. |
| **CO3** | Apply the knowledge of dot product and cross product in finding projections, area and orthogonality. |
| **CO4** | Utilize the concept of scalar and vector valued functions, gradient of scalar point function, divergence and curl of vector point functions, their geometrical interpretation. |
| **CO5** | Acquire the knowledge of the concept of relation between cartesian, cylindrical and spherical polar coordinates, Gauss, Green and Stokes Theorem. |

| | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 | PSO7 |
|---|---|---|---|---|---|---|---|
| CO1 | 3 | - | 3 | 2 | 3 | 2 | - |
| CO2 | 3 | 1 | 3 | 2 | - | - | - |
| CO3 | 1 | 1 | 3 | 1 | 2 | 1 | - |
| CO4 | 3 | 3 | 3 | 1 | 2 | 1 | - |
| CO5 | 3 | 3 | 3 | 1 | 2 | 1 | - |

| **I.K. GUJRAL PUNJAB TECHNICAL UNIVERSITY**<br>**DEPARTMENT OF CHEMICAL SCIENCES** | | | | |
|---|---|---|---|---|
| **Course Name** | **B.Sc. (Honours) Chemistry** | | | |
| **Subject Code:** | **BHHL115-19** | | | |
| **Subject Title:** | **COMMUNICATIVE ENGLISH-II** | | | |
| **Contact Hours:** | **L:2** | **T:0** | **P:0** | **Credits:2** |
| **Examination Duration (hours)** | **2** | | | |
| **Objective(s):** | 1. To help the students become proficient in LSRW-Listening, Speaking, Reading & Writing skills<br>2. To develop in them vital communication skills, integral to their personal, social and professional interactions<br>3. To teach them the appropriate language of professional communication.<br>4. To help the students become the independent users of English language. | | | |

**Details of the Course**

| Unit | Contents | Contact Hours |
|---|---|---|
| I | **(Literature)**<br>**(A) *The Poetic Palette* (Orient BlackSwan, Second Edition, 2016)**<br>The following poems from this anthology are prescribed:<br>4. The Soul's Prayer: Sarojini Naidu<br>5. I Sit and Look Out: Walt Whitman<br>6. Women's Rights: Annie Louise Walker<br><br>**(B) *Prose Parables* (Orient Black Swan, 2013)**<br>The following stories from the above volume are prescribed:<br>a. The Doctor's Word: R.K. Narayan<br>b. The Doll's House: Katherine Mansfield<br>c. Dusk: H.H. Munroe (Saki) | 10 |
| II | **Vocabulary:**<br>Standard abbreviations; One word substitution; Word Pairs (Homophones/Homonyms)<br>**Grammar:** Sentence Structures; Use of phrases and clauses in sentences; Transformation of Sentences; Importance of proper punctuation | 06 |
| III | **Reading and Understanding:**<br>Summary Paraphrasing; Analysis and Interpretation; Translation (from Hindi/Punjabi to English and vice-versa)<br>Close Reading; Comprehension; | 04 |

| | | |
|---|---|---|
| IV | **Mechanics of Writing & Speaking Skills:**<br>Report writing; Career Documents- Job applications, Resume/CV writing, Common Everyday Situations: Conversations & Dialogues, Formal Presentations | 10 |

**Reference Books**

| S.No. | Author(s) | Title of the Book | Publisher/Year |
|---|---|---|---|
| 1 | John Eastwood | Oxford Practice Grammar | Oxford University Press,2014 |
| 2 | Michael Swan. | Practical English Usage. | OUP. 1995. |
| 3 | F.T. Wood | Remedial English Grammar | Macmillan.2007 |
| 4 | William Zinsser | On Writing Well | Harper Resource Book. 2001 |
| 5 | Sanjay Kumar and Pushp Lata. | Communication Skills | Oxford University Press. 2011 |
| 6 | Liz Hamp-Lyons and Ben Heasly | Study Writing | Cambridge University Press. 2006. |

**Course Outcomes and Mapping**

At the end of the course,

**CO1.** Students will acquire basic proficiency in LSRW skills- listening, speaking, reading, and writing.

**CO2.** To develop their vocabulary so that they can understand spoken and written English language, particularly the language of their chosen technical field

**CO3.** To introduce students to the skills and strategies of reading and writing by identifying organizational patterns, spotting classification systems and understanding associations between ideas through study of literary texts.

**CO4.** They will be able to converse fluently and produce on their own clear and coherent texts.

**CO5.** To improve the employability of students and make them proficient in professional communication through understanding of career documents; job interviews; group discussions; internal communication in office environments etc.

| | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 | PSO7 |
|---|---|---|---|---|---|---|---|
| CO1 | 2 | 2 | 2 | 3 | 2 | 2 | 2 |
| CO2 | 3 | 2 | 2 | 3 | 2 | 3 | 3 |
| CO3 | 2 | 3 | 3 | 2 | 2 | 3 | 3 |
| CO4 | 2 | 2 | 3 | 3 | 3 | 2 | 3 |
| CO5 | 2 | 1 | 1 | 3 | 1 | 1 | 3 |

| I.K. GUJRAL PUNJAB TECHNICAL UNIVERSITY<br>DEPARTMENT OF CHEMICAL SCIENCES | | | | |
|---|---|---|---|---|
| **Course Name** | **B.Sc. (Honours) Chemistry** | | | |
| **Subject Code:** | **BHHL116A-19** | | | |
| **Subject Title:** | **PUNJABI COMPULSORY-II (ਪੰਜਾਬੀ ਲਾਜ਼ਮੀ-II)** | | | |
| **Contact Hours:** | **L:2** | **T:0** | **P:0** | **Credits:2** |
| **Examination Duration (hours)** | **2** | | | |
| **Objective(s):** | 1. To enhance the language ability of students.<br>2. To enhance the ability of Learning science and developing science literacy through local language teaching with science subjects. | | | |

**Details of the Course**

| Unit | Contents | Contact Hours |
|---|---|---|
| I | ਡਾ.ਹਰਿਭਜਨ ਸਿੰਘ: ਅਪ੍ਰਮਾਣਿਕ, ਤੇਰੇ ਹਜ਼ੂਰ ਮੇਰੀ ਹਾਜ਼ਰੀ ਦੀ ਦਾਸਤਾਨ<br>ਸ਼ਿਵ ਕੁਮਾਰ ਬਟਾਲਵੀ: ਕੰਡਿਆਲੀ ਥੋਰ੍ਹ, ਧਰਮੀ ਬਾਬਲ ਪਾਪ ਕਮਾਇਆ, ਰੁੱਖ<br>ਪਾਸ਼: ਇਨਕਾਰ,ਸਭ ਤੋਂ ਖਤਰਨਾਕ,ਦਹਿਕਦੇ ਅੰਗਿਆਰਾਂ 'ਤੇ<br>ਸੁਰਜੀਤ ਪਾਤਰ: ਹੁਣ ਘਰਾਂ ਨੂੰ ਪਰਤਣਾ, ਕੁਝ ਕਿਹਾ ਤਾਂ..., ਪੁਲ | 8 |
| II | **ਕਹਾਣੀ ਭਾਗ:**<br>ਸੰਤੋਖ ਸਿੰਘ ਧੀਰ: ਕੋਈ ਇਕ ਸਵਾਰ<br>ਪ੍ਰੇਮ ਪ੍ਰਕਾਸ਼: ਲੱਛਮੀ<br>ਮੋਹਨ ਭੰਡਾਰੀ : ਘੋਟਣਾ<br>ਵਰਿਆਮ ਸਿੰਘ ਸੰਧੂ : ਆਪਣਾ ਆਪਣਾ ਹਿੱਸਾ | 8 |
| III | ਪੰਜਾਬੀ ਭਾਸ਼ਾ ਦੀਆਂ ਵਿਸ਼ੇਸ਼ਤਾਵਾਂ<br>ਪੰਜਾਬੀ ਭਾਸ਼ਾ ਉਪਰ ਪਏ ਪ੍ਰਭਾਵ | 6 |
| IV | ਰਿਪੋਰਟਿੰਗ, ਸਮਾਚਾਰ ਲਿਖਣ ਦੀ ਵਿਧੀ ਤੇ ਤੱਤ<br>ਪੰਜਾਬੀ ਪੈਰ੍ਹੇ ਦਾ ਸਰਲ ਅੰਗਰੇਜ਼ੀ ਅਨੁਵਾਦ<br>ਦਫਤਰੀ ਚਿੱਠੀ ਪੱਤਰ | 8 |

**Reference Books**

| S.No. | Author(s) | Title of the Book | Publisher/Year |
|---|---|---|---|
| 1 | ਸੰਪ.ਡਾ.ਮਹਿਲ ਸਿੰਘ | ਸਾਹਿਤ ਦੇ ਰੰਗ | ਰਵੀ ਸਾਹਿਤ ਪ੍ਰਕਾਸ਼ਨ, ਅੰਮ੍ਰਿਤਸਰ,2016. |

**Course Outcomes and Mapping**

At the end of the course, the student will be able to

**CO1.** Translate and transfer/broadcast the western scientific knowledge in the local language.

**CO2.** Translate and transfer the indigenous/traditional scientific knowledge available in local knowledge into English and other global languages.

**CO3.** Understand the society through Punjabi language, literature and culture.

**CO4.** Learning science and in developing science literacy.

**CO5.** Improve the internal communication**.**

| | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 | PSO7 |
|---|---|---|---|---|---|---|---|
| CO1 | 1 | 2 | 1 | 1 | 2 | 2 | 2 |
| CO2 | 2 | 2 | 2 | 2 | 1 | 2 | 3 |
| CO3 | 2 | 1 | 2 | 3 | 1 | 1 | 3 |
| CO4 | 1 | 2 | 1 | 2 | 2 | 2 | 1 |
| CO5 | 2 | 1 | 1 | 2 | 2 | 2 | 3 |

| **I.K. GUJRAL PUNJAB TECHNICAL UNIVERSITY**<br>**DEPARTMENT OF CHEMICAL SCIENCES** | | | | |
|---|---|---|---|---|
| **Course Name** | **B.Sc. (Honours) Chemistry** | | | |
| **Subject Code:** | **BHHL116B-19** | | | |
| **Subject Title:** | **MUDHLI PUNJABI-II (ਮੁਢਲੀ ਪੰਜਾਬੀ-II )** | | | |
| **Contact Hours:** | **L:2** | **T:0** | **P:0** | **Credits:2** |
| **Examination Duration (hours)** | **2** | | | |
| **Objective(s):** | 1. To enhance the language ability of students.<br>2. To enhance the ability of Learning science and developing science literacy through local language teaching with science subjects. | | | |

**Details of the Course**

| Unit | Contents | Contact Hours |
|---|---|---|
| I | ਸ਼ਬਦ ਸ਼੍ਰੇਣੀਆਂ : ਪਛਾਣ ਤੇ ਵਰਤੋਂ-<br>ਨਾਂਵ<br>ਪੜਨਾਂਵ<br>ਵਿਸ਼ੇਸ਼ਣ<br>ਕਿਰਿਆ<br>ਕਿਰਿਆ ਵਿਸ਼ੇਸ਼ਣ | 8 |
| II | ਰੋਜ਼ਾਨਾ ਵਰਤੋਂ ਦੀ ਪੰਜਾਬੀ ਸ਼ਬਦਾਵਲੀ:<br>ਬਾਜ਼ਾਰ, ਵਪਾਰ, ਰਿਸ਼ਤੇ-ਨਾਤੇ ਤੇ ਕਿੱਤਿਆਂ ਸਬੰਧੀ। | 6 |
| III | ਪੰਜਾਬੀ ਵਾਕ ਬਣਤਰ :<br>ਸਧਾਰਣ ਵਾਕ<br>ਸੰਯੁਕਤ ਵਾਕ<br>ਮਿਸ਼ਰਤ ਵਾਕ | 8 |
| IV | ਸਧਾਰਣ ਵਾਕਾਂ ਦਾ ਅੰਗਰੇਜ਼ੀ ਤੋਂ ਪੰਜਾਬੀ ਅਨੁਵਾਦ<br>ਸਧਾਰਣ ਵਾਕਾਂ ਦਾ ਪੰਜਾਬੀ ਤੋਂ ਅੰਗਰੇਜ਼ੀ ਅਨੁਵਾਦ | 8 |

**Course Outcomes and Mapping**

At the end of the course, the student will be able to

- **CO1.** Translate and transfer/broadcast the western scientific knowledge in the local language.
- **CO2.** Translate and transfer the indigenous/traditional scientific knowledge available in local knowledge into English and other global languages.
- **CO3.** Understand the society through Punjabi language, literature and culture.
- **CO4.** Learning science and in developing science literacy.
- **CO5.** Improve the internal communication**.**

| | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 | PSO7 |
|---|---|---|---|---|---|---|---|
| CO1 | 1 | 2 | 1 | 1 | 2 | 2 | 2 |
| CO2 | 2 | 2 | 2 | 2 | 1 | 2 | 3 |
| CO3 | 2 | 1 | 2 | 3 | 1 | 1 | 3 |
| CO4 | 1 | 2 | 1 | 2 | 2 | 2 | 1 |
| CO5 | 2 | 1 | 1 | 2 | 2 | 2 | 3 |

| **I.K. GUJRAL PUNJAB TECHNICAL UNIVERSITY**<br>**DEPARTMENT OF CHEMICAL SCIENCES** | | | | |
|---|---|---|---|---|
| **Course Name** | **B.Sc. (Honours) Chemistry** | | | |
| **Subject Code:** | **BHCP117-19** | | | |
| **Subject Title:** | **INORGANIC CHEMISTRY LAB-II** | | | |
| **Contact Hours:** | **L:0** | **T:0** | **P:4** | **Credits:2** |
| **Examination Duration (hours)** | **3** | | | |
| **Objective(s):** | The objective of this course is to provide practical knowledge regarding salt analysis. | | | |

**Details of the Course**

| Unit | Contents |
|---|---|
| I | Identification of cations and anions in a mixture which may contain combinations of acid ions.<br>These must contain interferring acid anions and one, the insoluble.<br><br>**(a) Special Tests for Mixture of Anions**<br><br>(i) Carbonate in the presence of sulphate.<br>(ii) Nitrate in the presence of nitrite<br>(iii) Nitrate in the presence of bromide and iodide.<br>(iv) Nitrate in the presence of chlorate.<br>(v) Chloride in the presence of bromide and iodide.<br>(vi) Chloride in the presence of bromide.<br>(vii) Chloride in the presence of iodide.<br>(viii) Bromide and iodide in the presence of each other and of chloride.<br>(ix) Iodate and iodide in the presence of each other.<br>(x) Phosphate, arsenate and arsenite in the presence of each other.<br>(xi) Sulphide, sulphite, thiosulphate and sulphate in the presence of each other.<br>(xii) Borate in the presence of copper and barium salts.<br>(xiii) Oxalate in the presence of fluoride.<br>(xiv) Oxalate, tartrate, acetate, citrate in the presence of each other.<br><br>**(b) Separation and Identification of Cations in Mixtures**<br><br>(i) Separation of cations in groups.<br>(ii) Separation and identification of Group I, Group II (Group IIA and IIB), Group III, Group IV, Group V and Group VI cations.<br><br>**(c) Identification of Cations Including Less Familiar Elements by Spot Tests Assisted by Group Analysis (3 cations).** |

**Reference Books**

| S.No. | Author(s) | Title of the Book | Publisher/Year |
|---|---|---|---|
| 1 | Vogel, A.I. | Vogel's book on Inorganic Qualitative Analysis | ELBS |

**Course Outcomes and Mapping**

At the end of the course, the student will be able to

**CO1.** Understand the concept of qualitative analysis.

**CO2.** Learn to identify present cations and anions through qualitative analysis of various metal ions/cations and anions.

**CO3.** Understand the various techniques/principles involved in the qualitative analysis of mixtures in presence or absence of interfering ions.

**CO4.** Learn to separate and identify less familiar ions through qualitative analysis.

| | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 | PSO7 |
|---|---|---|---|---|---|---|---|
| CO1 | 1 | 2 | 2 | 3 | 2 | 2 | 1 |
| CO2 | 2 | 2 | 1 | 1 | 0 | 2 | 2 |
| CO3 | 1 | 2 | 0 | 2 | 2 | 2 | 3 |
| CO4 | 2 | 3 | 2 | 2 | 2 | 3 | 2 |

| **I.K. GUJRAL PUNJAB TECHNICAL UNIVERSITY**<br>**DEPARTMENT OF CHEMICAL SCIENCES** | | | | |
|---|---|---|---|---|
| **Course Name** | **B.Sc.(Honours) Chemistry** | | | |
| **Subject Code:** | **BHCP118-19** | | | |
| **Subject Title:** | **PHYSICAL CHEMISTRY LAB-I** | | | |
| **Contact Hours:** | **L:0** | **T:0** | **P:4** | **Credits:2** |
| **Examination Duration (hours)** | **3** | | | |
| **Objective(s):** | To provide students practical knowledge and skills about various topics taught in theory class of physical chemistry, which in turn will enhance their problem solving and analytical skills. | | | |

**Details of the Course**

| Unit | Contents |
|---|---|
| I | **Surface tension measurements.**<br>a) Determine the surface tension by (i) drop number (ii) drop weight method.<br>b) Study the variation of surface tension of detergent solutions with concentration. |
| II | **Viscosity measurement using Ostwald's viscometer.**<br>**a)** Determination of viscosity of aqueous solutions of (i) polymer (ii) ethanol and (iii) sugar at room temperature.<br>**b)** Study the variation of viscosity of sucrose solution with the concentration of solute. |
| III | Indexing of a given powder diffraction pattern of a cubic crystalline system**.** |
| IV | **pH metry**<br>a) Study the effect on pH of addition of HCl/NaOH to solutions of acetic acid, sodium acetate and their mixtures.<br>b) Preparation of buffer solutions of different pH;<br>(i) Sodium acetate-acetic acid<br>(ii) Ammonium chloride-ammonium hydroxide<br>c) pH metric titration of (i) strong acid vs. strong base, (ii) weak acid vs. strong base.<br>d) Determination of dissociation constant of a weak acid. |

**Reference Books**

| S.No. | Author(s) | Title of the Book | Publisher |
|---|---|---|---|
| 1 | J.B**.** Yadav | Practical Physical Chemistry | Krishna |
| 2 | Findlay | Practical Physical Chemistry | Longman, New York |

**Course Outcomes and Mapping**

At the end of the course, the students will be able to

**CO1.** Understand the basic procedures for carrying out a physical chemistry practical like preparation and standardisation of solutions, handling the equipments and measuring with precision.

**CO2.** Correlate the theoretical and practical aspects and know about the limits of the experimental error.

**CO3.** Determine the various physical parameters for the various problems under study.

**CO4.** Verify various laws studied in the theory part.

| | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 | PSO7 |
|---|---|---|---|---|---|---|---|
| CO1 | 1 | 1 | 3 | - | 3 | 2 | 1 |
| CO2 | 2 | 2 | 3 | - | 3 | 2 | 2 |
| CO3 | 2 | 3 | 3 | - | 2 | 1 | 1 |
| CO4 | 2 | 3 | 3 | - | 3 | 2 | 1 |

| **I.K. GUJRAL PUNJAB TECHNICAL UNIVERSITY<br>DEPARTMENT OF CHEMICAL SCIENCES** | | | | |
|---|---|---|---|---|
| **Course Name** | **B.Sc. (Honours) Chemistry** | | | |
| **Subject Code:** | **UC-BSHP-125-19** | | | |
| **Subject Title:** | **PHYSICS LAB -II** | | | |
| **Contact Hours:** | **L:4** | **T:0** | **P:0** | **Credits:4** |
| **Examination Duration (hours)** | **3** | | | |
| **Objective(s):** | The aim and objective of the Physics Lab course is to introduce the students of B. Sc. (Hons.) to the formal structure of wave and vibrations and mechanics so that they can use these as per their requirement. | | | |

**Details of the Course:**

**Note: Students are expected to perform about 8-10 experiments from the following list, selecting minimum of 6-7 from the Physical Lab and 2-3 from the Virtual lab.**

**List of experiments:**

1. Measurement of volume using travelling microscope. Use of Plumb line and Spirit level.
2. To determine the frequency of an electrically maintained tuning fork in a) Transverse mode of vibration b) Longitudinal mode of vibration.
3. To find out the frequency of AC mains using sonometer.
4. To study the characteristic of Ge-Si junction diode.
5. To analyze the suitability of a given Zener diode as a power regulator.
6. To determine the horizontal and vertical distance between two points using a Sextant.
7. To determine the height of an inaccessible object using a Sextant.
8. To study the Motion of a Spring and calculate (a) Spring Constant (b) Value of g and (c) Modulus of rigidity.
9. To determine the time period of a simple pendulum for different length and acceleration due to gravity.
10. To study the variation of time period with distance between centre of suspension and centre of gravity for a compound 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.
11. To find the moment of inertia of an irregular body about an axis through its C.G with the torsional pendulum.
12. To determine the angular acceleration α, torque τ, and Moment of Inertia of flywheel.

**Reference Books**

1. Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, 1971, Asia Publishing House.
2. Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers.
3. A Text Book of Practical Physics, I. Prakash & Ramakrishna, 11th Edn, 2011, Kitab

Mahal.
4. Engineering Practical Physics, S. Panigrahi & B. Mallick, 2015, Cengage Learning India Pvt. Ltd.
5. Practical Physics, G.L. Squires, 2015, 4th Edition, Cambridge University Press.
6. Practical Physics, C L Arora, S. Chand & Company Ltd.
7. http://www.vlab.co.in

**Course Outcomes and Mapping**

| At the end of the course, the student will be | | | | | | | |
|---|---|---|---|---|---|---|---|
| **CO1** | Able to understand the theoretical concepts learned in the theory course. | | | | | | |
| **CO2** | Trained in carrying out precise measurements and handling equipment. | | | | | | |
| **CO3** | Learn to draw conclusions from data and develop skills in experimental design**.** | | | | | | |
| **CO4** | Able to understand the principles of error analysis and develop skills in experimental design**.** | | | | | | |
| **CO5** | Able to document a technical report which communicates scientific information in a clear and concise manner. | | | | | | |
| | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 | PSO7 |
| CO1 | 2 | 2 | 3 | 3 | 2 | 3 | 3 |
| CO2 | 2 | 2 | 3 | 2 | 2 | 3 | - |
| CO3 | 2 | - | 3 | 2 | 2 | 3 | 1 |
| CO4 | 2 | 2 | 3 | 1 | 1 | 2 | 2 |
| CO5 | 2 | 2 | 2 | 1 | 2 | 2 | - |

**Computer II- Object Oriented Programming using C++**

| UGCA1909 | Object Oriented Programming using C++ | 3L:1T:0P | 4 Credits |
|---|---|---|---|

**Course Outcomes:**

| CO# | Course outcomes |
|---|---|
| CO1 | Outline the role of programming for solving real world problems. |
| CO2 | Explain Object oriented approach for finding Solutions to various problems with the help of C++ language. |
| CO3 | Implement computer based solutions to various real-world problems using C++ |
| CO4 | Select the right Object Oriented Concept for optimal solution. |
| CO5 | Review different solutions for a common problem. |

| Detailed Contents | Contact hours |
|---|---|
| **Unit-I**<br><br>**Principles of object oriented programming**<br>Introduction to OOP and its basic features, Basic components of a C++, Program and program structure, Compiling and Executing C++ Program. Difference between Procedure Oriented Language(C) and Object Oriented Language [CO1] | 12 |
| **Unit-II** | 10 |
| **Classes & Objects and Concept of Constructors**<br>Defining classes, Defining member functions, Declaration of objects to class, Access to member variables from objects, Different forms of member functions, Access specifiers (Private, public, protected), Array of objects. Introduction to constructors, Parameterized constructors, Copy Constructor, Multiple constructors in class, Dynamic initialization of objects, Destructors.[CO2] | |

| | |
|---|---|
| **Unit-III**<br><br>**Inheritance and Operator overloading**<br>Introduction to Inheritance, Types of inheritance: - Single inheritance, Multiple inheritance, Multilevel inheritance, Hierarchical inheritance, Hybrid inheritance, Defining operator overloading, Overloading of Unary and Binary operators, Rules for overloading operators [CO3] | 12 |
| **Unit-IV**<br><br>**Polymorphism and File Handling**<br>Early Binding, Late Binding, Virtual Functions, pure virtual functions, Abstract Classes. [CO5]<br>Opening and Closing File, Reading and Writing a file. | 10 |

**Text Books:**


1. Object Oriented Programming with C++, E. Balagurusami, Fourth Edition, Tata Mc-Graw Hill.
2. Object Oriented Programming in Turbo C++, Robert Lafore, Fourth Edition Galgotia Publications.
3. The C++ Programming Language, Bjarna Stroustrup, Third Edition, Addison-Wesley Publishing Company.
4. Object Oriented Programming Using C++, Salaria, R. S, Fourth Edition, Khanna Book Publishing.

| UGCA1910 | Object Oriented Programming using C++ Laboratory | 0L:0T:4P | 2 Credits |
|---|---|---|---|

**Course Outcomes:**

| CO# | Course outcomes |
|---|---|
| CO1 | Design the classes. |
| CO2 | Illustrate the concept of memory representation for objects |
| CO3 | Implement programs using OOP concepts for various problems. |
| CO4 | Implement file handling in C++ |
| CO5 | Select the right data types to represent class properties. |

**Instructions: Develop all program in C++**

**Assignments:**

| | |
|---|---|
| 1. | Write a program to enter mark of 6 different subjects and find out the total mark (Using cin and cout statement) |
| 2. | Write a function using reference variables as arguments to swap the values of pair of integers. |
| 3. | Write a function to find largest of three numbers. |
| 4. | Write a program to find the factorial of a number. |
| 5. | Define a class to represent a bank account which includes the following members as Data members:<br>a) Name of the depositor b) Account Number c) Withdrawal amount d) Balance amount in the account<br>Member Functions:<br>a) To assign initial values b)To deposit an amount c) To withdraw an amount after checking the balance d) To display name and balance. |

| | |
|---|---|
| 6. | Write the above program for handling n number of account holders using array of objects. |
| 7. | Write a C++ program to compute area of right angle triangle, equilateral triangle, isosceles triangle using function overloading concept. |
| 8. | Consider a publishing company that markets both book and audio cassette version to its works. Create a class Publication that stores the title (a string) and price (type float) of a publication. Derive the following two classes from the above Publication class: Book which adds a page count (int) and Tape which adds a playing time in minutes(float). Each class should have get_data() function to get its data from the user at the keyboard. Write the main() function to test the Book and Tape classes by creating instances of them asking the user to fill in data with get_data() and then displaying it using put_data(). |
| 9. | Consider an example of declaring the examination result. Design three classes student, exam and result. The student has data members such as rollno, name. Create the lass exam by inheriting the student class. The exam class adds data members representing the marks scored in 5 subjects. Derive the result from exam-class and it has own data members like total, avg. |
| 10. | Write a program for overloading of Unary ++ operator. |
| 11. | Write a program for overloading of Binary + operator. |
| 12. | Write a program of Virtual Functions. |
| 13. | Write a program of Abstract Classes. |
| 14. | Write a program to read and write from file. |

**Reference Books:**


1. Object Oriented Programming with C++, E. Balagurusami, Fourth Edition, Tata Mc-Graw Hill.
2. Object Oriented Programming in Turbo C++, Robert Lafore, Fourth Edition Galgotia Publications.
3. The C++ Programming Language, Bjarna Stroustrup, Third Edition, Addison-Wesley Publishing Company.
4. Object Oriented Programming Using C++, Salaria, R. S, Fourth Edition, Khanna Book Publishing.

# SEMESTER-III

| I.K. GUJRAL PUNJAB TECHNICAL UNIVERSITY<br>DEPARTMENT OF CHEMISTRY | | | | |
|---|---|---|---|---|
| **Course Name** | **B.Sc. (Honours) Chemistry** | | | |
| **Subject Code:** | **BHCL201-25** | | | |
| **Subject Title:** | **ORGANIC CHEMISTRY-II (Chemistry Of Functional Groups-II)** | | | |
| **Contact Hours:** | **L:3** | **T:1** | **P:0** | **Credits:4** |
| **Examination Duration (hours)** | **3** | | | |
| **Objective(s):** | 4. To predict and account for the most commonly encountered reaction mechanisms **(**substitution, addition and elimination**)** in organic chemistry**.**<br>5. To impart knowledge regarding physical properties and chemical reactions of oxygen, nitrogen and sulphur containing functional groups**.**<br>6. To study the classifications and properties of biomolecules like carbohydrates, amino acids, proteins, peptides and nucleic acids**.** | | | |

**Details of the Course**

| Unit | Contents | Contact Hours |
|---|---|---|
| I | **Alcohols**<br>Classification, Monohydric alcohol - methods of formation by reduction of aldehydes, ketones, carboxylic acids and esters. Hydrogen bonding, Acidic nature. Reactions of alcohols. Dihydric alcohols - nomenclature, methods of formation, chemical reactions of vicinal glycols, oxidative cleavage [$Pb(OAc)_4$ and $HIO_4$] and pinacol-pinacolone rearrangement. Trihydirc alcohols - nomenclature and methods of formation, chemical reactions of glycerol.<br>**Phenols**<br>Structure and bonding. Physical properties, Acidity of phenols and substituent effects, Comparative acidic strengths of alcohols and phenols, Resonance stabilization of phenoxide ion. Preparation and reactions of phenols - electrophilic aromatic substitution, acylation and carboxylation, Kolb-Schmitt reaction. Preparation of aryl ethers, Cleavage of aryl ethers by hydrogen halides, Claisen rearrangement of allyl aryl ethers, Oxidation of phenols. Gatterman synthesis, Hauben-Hoesch reaction, Laderer-Manasse reaction and Reimen-Tiemann reaction.<br>**Ethers and Epoxides**<br>Structure and bonding in ethers and epoxides**.** Physical properties of ethers, Preparation of ethers**.** The Williamson ether synthesis, Acid catalyzed cleavage of ethers**.** Preparation of epoxides, Conversion of vicinal halohydrins to epoxides, Reactions of epoxides**:** Nucleophilic ring opening, acid**-**catalyzed ring opening**.** | 10 |

| | | |
|---|---|---|
| II | **Aldehydes and Ketones**<br>Structure of the carbonyl groups. Physical properties, Sources of aldehydes and/or ketones from alkenes, alkynes, carboxylic acids, acid chlorides, nitriles and alcohols.<br>Reaction of aldehydes with Grignard reagent to produce ketones. Hydroformylation, Synthesis of aldehydes and ketones using 1,3-dithianes. Reactions of aldehydes and ketones: Clemmensen, Wolff-Kishner, $LiAlH_4$, and $NaBH_4$ reductions. Addition of Grignard reagents and organolithium reagents to aldehydes and ketones. Principles of nucleophilic addition: hydration of aldehydes and ketones, cyanohydrin formation, acetal formation. Benzoin, aldol, Perkin and Knoevenagel condensations. Use of acetals as protecting groups. Reactions of aldehydes and ketones with ammonia, primary amines and secondary amines. Enamines and Wittig reaction, Stereoselective addition to carbonyl groups. Oxidation of aldehydes. Mannich reaction. BaeyerVilliger oxidation of ketones, Cannizzaro reaction. Meerwein-Ponndorf-Verley reaction, Halogenation of enolizable ketone. An introduction to α,β-unsaturated aldehydes and ketones.<br>**Sulphur containing compounds**<br>Preparation and reactions of thiols, thioethers and sulphonic acids.<br>**Amines**<br>Amine nomenclature, Structure and bonding, physical properties. Basicity of amines. Structural features effecting basicity of amines. tetraalkylammonium salts as Phase Transfer Catalysts. Preparation of primary, secondary and tertiary amines: Nucleophilic substitution by azide ion on alkyl halides, nitration of arenes, nucleophilic ring opening of epoxides by ammonia, nucleophilic addition of amines to aldehydes and ketones, nucleophilic substitution by ammonia on α-halo acids. Nucleophilic acyl substitution. Preparation of amines by alkylation of ammonia, The Gabriel synthesis of primary alkylamines, preparation of amines by reduction of azides, epoxides, nitriles, nitro and amides. Reductive amination, Reaction of amines with alkyl halides, The Hofmann elimination. Electrophilic aromatic substitution in arylamines, nitrosation of alkylamines and arylamines. Synthetic transformations of aryl diazonium salts, azo coupling. | 12 |
| III | **Carboxylic Acids**<br>Structure and bonding, physical properties, acidity of carboxylic acids, effects of substituents on acid strength . Dicarboxylic acids. Methods of formation and effect of heat and dehydrating agents. Preparation of carboxylic acids: carboxylation of Grignard reagents, oxidation of alkylbenzenes, oxidation of primary alcohols, aldehydes. Preparation and hydrolysis of nitriles. Reactions of carboxylic acids. Hell-Volhard-Zelinsky reaction. Synthesis of acid chlorides, esters and amides. Reduction of carboxylic acids. Mechanism of decarboxylation. Intramolecular ester formation. Hydroxy acids: malic, tartaric and citric acids. Methods of formation and chemical reactions of unstaturated monocarboxylic acids. | 12 |

| | | |
|---|---|---|
| | **Carboxylic Acid Derivatives**<br>Structure of acid chlorides, esters, amides, acid anhydrides and nitriles. Relative stability of acyl derivatives. Physical properties, interconversion of acid derivatives by nucleophilic acyl substitution in acyl chlorides and acid anhydrides. Sources and physical properties of esters. Acid as well as base catalyzed ester hydrolysis. Reactions of esters with ammonia, amines, Grignard reagents and lithium aluminium hydride. Amides: hydrolysis of amides. Lactams. Preparation of nitriles, hydrolysis, addition of Grignard reagents to nitriles. | |
| IV | **Carbohydrates**<br>Classification of carbohydrates, Fischer projections and D-, L- notations of glyceraldehyde, aldotetroses, aldopentoses and aldohexoses. Cyclic forms of carbohydrates: Furanoses and Pentoses. Mutarotation and mechanism. Introduction to ketoses, deoxy sugars, amino sugars and branched chain carbohydrates. Glycosides: The Fischer glycosidation, mechanism. examples of disaccharides and polysaccharides. Reactions of carbohydrates: Reduction of monosaccharides, oxidation of monosaccharides. Determination of ring size of monosaccharides. Cyanohydrin formation and chain extension. Kiliani-Fischer synthesis. Epimerization, isomerizaion and retrocleavage: Interconversion of glucose into mannose, fructose. Acylation and alkylation of carbohydrate hydroxyl group. Mechanism of osazone formation, An introduction to disaccharides (maltose, sucrose and lactose) and polysaccharides (starch and cellulose) without involving structure determination.<br>**Amino Acids, Peptides, Proteins and Nucleic Acids**<br>Classification, structure and stereochemistry of amino acids. Acid-base behaviour, isoelectric point and electrophoresis. Preparation and reactions of α-amino acids. Structure and nomenclature of peptides and proteins. Classification of proteins. Peptide structure determination, end group analysis, selective hydrolysis of peptides. Classical peptide synthesis, the Edman degradation. The strategy of peptide synthesis: amino and carboxyl group protection, peptide bond formation. Solid-phase peptide synthesis: The Merrifield method. Secondary structures of peptides and proteins. Introduction to tertiary and quaternary structures of proteins. Protein denaturation/renaturation. Nucleosides and nucleotides. secondary structure of DNA: The double helix. Tertiary structure of DNA: supercoils. Nucleic acids: Introduction. Constitutents of nucleic acids. Ribonucleosides and ribonucleotides. The double helical structure of DNA. | 11 |

**Text and Reference Books**

| S.No. | Author(s) | Title of the Book | Publisher/Year |
|---|---|---|---|
| 1 | F.A. Carey | Organic Chemistry, 8th edition | McGraw Hill, Inc. |
| 2 | Morrison and Boyd | Organic Chemistry | Prentice Hall |

| | | | |
|---|---|---|---|
| 3 | G. Solomons | Fundamentals of Organic Chemistry | John Wiley, 2002 |
| 4 | S.M. Mukherji, S.P. Singh and R.P. Kapoor | Organic Chemistry Vol. I, II & III | Wiley Eastern Ltd (New Age International). |
| 5 | Jerry March | Organic Reaction Mechanism | John Wiley Ed. 5, 2002 |
| 6 | L. G. Jr. Wade | Organic Chemistry | Prentice-Hall,1990 |
| 7 | Stritwieser, Heathcock and Kosover | Introduction to organic chemistry | Macmilan |

**Course Outcomes and Mapping**

At the end of the course, the student will be able to

**CO1.** Learn the range of organic compounds containing various types of functional groups like oxygen, nitrogen and sulphur.

**CO2.** gain in-depth understanding of carbohydrates, amino acids, proteins and nucleotides and their roles in biological system.

**CO3.** To study the various known reactive intermediate in organic synthesis

**CO4.** To learn the fundamental and advanced concepts of reaction mechanisms along with the study of reaction mechanisms in various types of substitution addition and elimination reactions.

**CO5.** To predict the relationships between organic chemical structures and their reactivity.

| | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 | PSO7 |
|---|---|---|---|---|---|---|---|
| CO1 | 4 | 4 | 3 | - | 3 | 4 | 2 |
| CO2 | 4 | 2 | 3 | 1 | 2 | 2 | - |
| CO3 | 4 | 2 | 1 | - | 4 | 4 | - |
| CO4 | 4 | 4 | 4 | - | 4 | 3 | - |
| CO5 | 4 | 3 | 4 | - | 4 | - | - |

| I.K. GUJRAL PUNJAB TECHNICAL UNIVERSITY<br>DEPARTMENT OF CHEMICAL SCIENCES | | | | |
|---|---|---|---|---|
| **Course Name** | **B.Sc. (Honours) Chemistry** | | | |
| **Subject Code:** | **BHCL202-25** | | | |
| **Subject Title:** | **PHYSICAL CHEMISTRY-II (Chemical Thermodynamics & Equilibrium)** | | | |
| **Contact Hours:** | **L:3** | **T:1** | **P:0** | **Credits:4** |
| **Examination Duration (hours)** | **3** | | | |
| **Objective(s):** | This course will equip students with the necessary knowledge concerning the fundamentals in thermodynamics of chemical processes and equilibria in chemical systems. The problem solving skills of students are expected to be enhanced through due weightage given to numerical problems in each unit. | | | |

**Details of the Course**

| Unit | Contents | Contact Hours |
|---|---|---|
| I | **Chemical Thermodynamics:**<br>Intensive and extensive variables; state and path functions; isolated, closed and open systems; zeroth law of thermodynamics.<br>*First law:* Concept of heat, *q*, work, *w*, internal energy, *U*, and statement of first law; enthalpy, *H*, relation between heat capacities, calculations of *q*, *w*, *U* and *H* for reversible, irreversible and free expansion of gases (ideal and van der Waals) under isothermal and adiabatic conditions.<br>*Thermochemistry:* Heats of reactions: standard states; enthalpy of formation of molecules and ions and enthalpy of combustion and its applications; calculation of bond energy from thermochemical data, effect of temperature (Kirchhoff's equations) and pressure on enthalpy of reactions. | 12 |
| II | **Chemical Thermodynamics:**<br>*Second Law:* Concept of entropy; thermodynamic scale of temperature, statement of the second law of thermodynamics; molecular and statistical interpretation of entropy. Calculation of entropy change for reversible and irreversible processes.<br>*Third Law:* Statement of third law, concept of residual entropy.<br>*Free Energy Functions:* Gibbs and Helmholtz energy; variation of S, G, A with T, V, P; Free energy change and spontaneity. Relation between Joule-Thomson coefficient and other thermodynamic parameters; inversion temperature; Gibbs-Helmholtz equation. | 10 |
| III | **Chemical Equilibrium:**<br>Law of Mass Action, Law of Chemical Equilibrium, Thermodynamic derivation of law of chemical equilibrium, Van't Hoff Reaction isotherm, Equilibrium constants, their types and derivation of relations between the various equilibrium constants $K_p$, $K_c$ and $K_x$, De donder's treatment of Chemical Equilibria, degree of advancement of a chemical reaction and reaction potential, Temperature dependence of the equilibrium constant - | 11 |

| | | |
|---|---|---|
| | van't Hoff equation and related numericals, Pressure dependence of Equilibrium constants. Equilibrium constants of reactions involving real gases, Le Chatelier's principle, Linear Free Energy Relationships- Hammet Equation and Hammet Plot. | |
| IV | **Phase Equilibria:**<br>Concept of phases, components and degrees of freedom, derivation of Gibbs Phase Rule, Clausius-Clapeyron equation and its applications to solid-liquid, liquid-vapour and solid-vapour equilibria. One-Component Systems; Water System, Carbondioxide system, Sulphur system. Two Component Systems; Simple Eutectic Systems (Lead-Silver system) Concept of Cooling Curves, Systems in which two components form a stable compound (Formation of compounds with Congruent and Incongruent melting points). | 12 |

**Text Books**

| S.No. | Author(s) | Title of the Book | Publisher/Year |
|---|---|---|---|
| 1 | Puri, Sharma and Pathania | Principles of Physical Chemistry | Vishal Publishing Company |
| 2 | K L Kapoor | A Textbook of Physical Chemistry, Volume 2 | Mc Graw Hill Education |
| 3 | Gurtu and Gurtu | Advanced Physical Chemistry | Pragati Prakashan |

**Reference Books**

| S.No. | Author(s) | Title of the Book | Publisher/Year |
|---|---|---|---|
| 1 | P.W. Atkins & J. de Paula | Atkin's Physical Chemistry | Oxford University Press (2006) |
| 2 | S.H. Maron & C.F. Prutton | Principles of Physical Chemistry, 1st edition | Oxford and IBH (1958) |
| 3 | G.W. Castellan | Physical Chemistry, 4th edition | Narosa (2004) |
| 4 | D. A. McQuarrie, & J. D. Simon | Molecular Thermodynamics | Viva Books Pvt. Ltd.: New Delhi (2004) |
| 5 | M. J. Assael, A. R. H. Goodwin, M. Stamatoudis, W. A. Wakeham, & S. Will | Commonly Asked Questions in Thermodynamics | CRC Press: NY (2011) |

## Course Outcomes and Mapping

At the end of the course, the student will be able to

**CO1.** Understand the basic principles and theories pertaining to thermodynamics and equilibrium of chemical reactions.

**CO2.** Solve various problems related to thermodynamics of different chemical processes

**CO3.** Define the various laws of thermodynamics.

**CO4.** Analyse and draw phase diagrams for single and two-component systems

**CO5.** Understand thermodynamics of processes at equilibrium.

| | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 | PSO7 |
|---|---|---|---|---|---|---|---|
| CO1 | 3 | 1 | 1 | - | 2 | 1 | 1 |
| CO2 | 3 | 2 | 3 | - | 1 | - | 1 |
| CO3 | 2 | 2 | 1 | - | 2 | 1 | 1 |
| CO4 | 3 | 2 | 2 | - | 2 | 1 | 1 |
| CO5 | 3 | 2 | 2 | - | 1 | - | 1 |

| I.K. GUJRAL PUNJAB TECHNICAL UNIVERSITY<br>DEPARTMENT OF CHEMISTRY | | | | |
|---|---|---|---|---|
| **Course Name** | **B.Sc. (Honours) Chemistry** | | | |
| **Subject Code:** | **BHCL203-19** | | | |
| **Subject Title:** | **SPECTROSCOPY** | | | |
| **Contact Hours:** | **L:3** | **T:1** | **P:0** | **Credits:4** |
| **Examination Duration (hours)** | **3** | | | |
| **Objective(s):** | To teach the fundamental concepts of Spectroscopy and their applications. | | | |

**Details of the Course**

| Unit | Contents | Contact Hours |
|---|---|---|
| I | Introduction, interaction of electromagnetic radiation with molecules; various types of spectroscopy; absorption and emission spectroscopy; Born-Oppenheimer approximation.<br><br>Vibrational and IR spectroscopy: Classical equation of vibration, computation of force constant, amplitude of diatomic molecular vibrations, anharmonicity, Morse potential, dissociation energies, fundamental frequencies, overtones, hot bands, degrees of freedom for polyatomic molecules, modes of vibration, Fundamental and non-fundamental molecular vibrations; concept of group frequencies. Vibration-rotation spectroscopy: diatomic vibrating rotator, P, Q, R branches. | 12 |
| II | 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.<br><br>Rotation spectroscopy: Selection rules, intensities of spectral lines, determination of bond lengths of diatomic and linear triatomic molecules, isotopic substitution.<br><br>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. | 11 |
| III | Electronic spectroscopy and UV spectroscopy: Franck-Condon principle, electronic transitions, singlet and triplet states, fluorescence and phosphorescence, dissociation and predissociation, | 10 |

| | | |
|---|---|---|
| | calculation of electronic transitions of polyenes using free electron model.<br>$\lambda_{max}$, Chromophores and Auxochromes, Bathochromic and Hypsochromic shifts, Intensity of absorption; Application of Woodward Rules for calculation of $\lambda_{max}$ 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. | |
| IV | Nuclear Magnetic Resonance (NMR) spectroscopy: General principle of NMR spectroscopy and Proton Magnetic Resonance Spectroscopy, Larmor precession, chemical shift and factors influencing it; Spin – Spin coupling and coupling constant, different scales, low resolution spectra, high resolution spectra, anisotropic effects in alkene, alkyne, aldehydes and aromatics, Interpetation of NMR spectra of simple compounds.<br><br>Applications of IR, UV and NMR for identification of simple organic molecules. | 12 |

**Text Books**

| S.No. | Author(s) | Title of the Book | Publisher/Year |
|---|---|---|---|
| 1 | Pavia, Lampman, Kriz, Vyvyan | Spectroscopy | Cengage Learning |
| **Reference Books** | | | |
| 1 | Banwell, C. N. & McCash, E. M. | Fundamentals of Molecular Spectroscopy 4th Ed. | Tata McGraw-Hill: New Delhi (2006). |
| 2 | Kakkar, R. | Atomic & Molecular Spectroscopy | Cambridge University Press (2015) |
| 3 | Kemp, W. | *Organic Spectroscopy* | Palgrave |

**Course Outcomes and Mapping**

At the end of the course, the student will be able to

**CO1.** Understand the fundamental principles and theories of various spectroscopic techniques
**CO2.** Learn the interaction of various electromagnetic radiations with matter Learn about the behaviour of different types of compounds towards different electromagnetic radiations
**CO3.** Understand the applications of interaction of light in their characterization Learn about the role of different techniques in the characterization of different compounds
**CO4.**
**CO5.**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 | PSO7 |
| CO1 | 1 | 2 | 2 | 3 | 3 | 2 | 3 |
| CO2 | 3 | 1 | 3 | 3 | 1 | 2 | 1 |
| CO3 | 2 | 3 | 2 | 2 | 2 | 3 | 1 |
| CO4 | 2 | 2 | 1 | 2 | 3 | 1 | 2 |
| CO5 | 1 | 2 | 3 | 2 | 2 | 1 | 2 |

| I.K. GUJRAL PUNJAB TECHNICAL UNIVERSITY<br>DEPARTMENT OF CHEMISTRY | | | | |
|---|---|---|---|---|
| **Course Name** | **B.Sc. (Honours) Chemistry** | | | |
| **Subject Code:** | **UC-BSHP-214-19** | | | |
| **Subject Title:** | **PHYSICS-III (ELEMENTS OF MODERN PHYSICS)** | | | |
| **Contact Hours:** | **L:3** | **T:1** | **P:0** | **Credits:4** |
| **Examination Duration (hours)** | **3** | | | |
| **Objective(s):** | The objective of the course is to develop basic understanding concepts of modern physics, namely to special relativity and to the quantum nature of light and energy, emphasizing whenever possible, how classical concepts have shown up to be inadequate in explaining experiments, which will act as a strong background if he/she chooses to pursue science as a career. | | | |

**Details of the Course**

| Unit | Content | Hours |
|---|---|---|
| **I** | **Dual Nature of Waves and Particles:** Black body radiation, Planck's quantum, Planck's constant and light as a collection of photons; Photo Electric effect and Compton scattering. De Broglie wavelength and matter waves; Davisson-Germer experiment, Problems with Rutherford model-instability of atoms and observation of discrete atomic spectra; Bohr's quantization rule and atomic stability; Wave-particle duality, Heisenberg uncertainty principle- impossibility of a particle following a trajectory; Estimating minimum energy of a confined particle using uncertainty principle; Energy-time uncertainty principle. | **10** |
| **II** | **Quantum Mechanics:** Two slit interference experiment with photons, atoms & particles; linear superposition principle as a consequence; Matter waves and wave amplitude; Schrodinger equation for non-relativistic particles; Momentum and Energy operators; stationary states; physical interpretation of wavefunction, probabilities and normalization; Probability and probability current densities in one dimension. One dimensional infinitely rigid box- energy eigenvalues and eigenfunctions, normalization; Quantum dot as an example. | **10** |
| **III** | **Atomic structure:** The nuclear atom, Electron orbits, Atomic spectra, The Bohr Model, Energy level and spectra, Correspondence principle, Nuclear motion, Atomic excitation, Many electron atoms, Exclusion Principle, electron spin, spin orbit coupling, X-ray spectra. Zeeman effect, Stern-Garlach experiment. | **10** |
| **IV** | **Special Theory of Relativity:** Michelson-Morley Experiment and its outcome. Postulates of Special Theory of Relativity. Lorentz Transformations. Simultaneity and order of events. Lorentz contraction. Time dilation. Relativistic transformation of velocity, frequency and wave number. Relativistic addition of velocities. Variation of mass with velocity. Massless Particles. Mass-energy Equivalence. Relativistic Doppler effect. Relativistic Kinematics. Transformation of Energy and Momentum. Energy- Momentum Four Vector. | **10** |

**Text and Recommended Books:**


1. Concepts of Modern Physics, Arthur Beiser, 2009, McGraw-Hill
2. Modern Physics, J.R. Taylor, C.D. Zafiratos, M.A. Dubson,2009, PHI Learning
3. Six Ideas that Shaped Physics: Particle Behave like Waves, Thomas A. Moore, 2003, McGraw Hill
4. Quantum Physics, Berkeley Physics, Vol.4. E.H. Wichman, 2008, Tata McGraw-Hill Co.
5. Modern Physics, R.A. Serway, C.J. Moses, and C.A.Moyer, 2005, Cengage Learning


**Course Outcomes and Mapping**

| At the end of the course, the student will be able to | | | | | | | |
|---|---|---|---|---|---|---|---|
| **CO1** | gained a deep understanding on the motivations that have led in the past century to the relativistic and quantum revolution in physics | | | | | | |
| **CO2** | demonstrate ability to apply wave-particle duality and uncertainty principle to solve physics problems. | | | | | | |
| **CO3** | demonstrate ability to solve quantum mechanical eigenvalue equations for various operators and obtain expectation values of the corresponding observables. | | | | | | |
| **CO4** | demonstrate ability to solve 1-D quantum problems including the quantum particle in a box, a well, the simple harmonic oscillator, and the transmission and reflection of waves. | | | | | | |
| **CO5** | solve problems involving the quantization of mass, charge, light, and energy including Avogadro's number, black-body radiation, photoelectric effect, and other related issues. | | | | | | |
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 |
| **CO1** | 2 | 1 | 2 | 1 | - | 1 | 2 |
| **CO2** | 2 | 2 | 1 | 2 | 1 | 1 | 1 |
| **CO3** | 3 | 2 | 2 | 2 | 1 | 1 | 2 |
| **CO4** | 2 | 2 | 2 | 2 | 1 | 1 | 2 |
| **CO5** | 2 | 2 | 2 | 2 | 1 | 1 | 2 |

| I.K. GUJRAL PUNJAB TECHNICAL UNIVERSITY<br>DEPARTMENT OF CHEMISTRY | | | | |
|---|---|---|---|---|
| **Course Name** | **B.Sc. (Honours) Chemistry** | | | |
| **Subject Code:** | **BHCL205-25** | | | |
| **Subject Title:** | **ENVIRONMENTAL SCIENCE** | | | |
| **Contact Hours:** | **L:2** | **T:0** | **P:0** | **Credits:2** |
| **Examination Duration (hours)** | **3** | | | |
| **Objective(s):** | This course will equip students with the necessary knowledge and make them aware about the environmental issues . | | | |

**Details of the Course**

| Unit | Contents | Contact Hours |
|---|---|---|
| I | **Introduction to Environmental Studies**<br>Multidisciplinary nature of Environmental Studies**:** Scope & Importance, Need for Public Awareness<br>**Ecosystems**<br>Concept of an Ecosystem: Structure & functions of an ecosystem (Producers, Consumers & Decomposers) Energy Flow in anecosystem: Food Chain, Food web and Ecological Pyramids, Characteristic features, structure & functions of following Ecosystems: Grassland Ecosystem, Desert Ecosystem, Forest Ecosystem, Aquatic Ecosystem (Ponds, Lakes, River & Ocean) | 7 |
| II | **Natural Resources**<br>Forest Resources Their uses, functions, values and threats ***(***Overexploitation, Deforestation, Timber extraction, Agriculture Pressure***)***, Forest Conservation Act<br>Water Resources***:*** Their uses ***(***Agriculture, Domestic & Industrial***)***, functions & values, Overexploitation and Pollution of Ground & Surface water resources (Case study of Punjab***)***, Conflict over water (International and inter-state), Water Conservation, Rainwater Harvesting<br>Land Resources***:*** Land as a resource; Land degradation, soil erosion and desertification<br>Energy Resources***:*** Renewable & non**-**renewable energy resources, use of alternate energy resources ***(***Solar, Wind, Biomass, Thermal***)***, Urban problems related to Energy | 8 |
| III | **Biodiversity & its conservation**<br>Levels of Biodiversity**:** Species, Genetic & Ecosystem<br>India as a mega biodiversity nation, Biodiversity hot spots and biogeographic regions of India<br>Examples of Endangered & Endemic species of India, Red data book,<br>Biodiversity conservation,-In-situ an Ex-situ, Linkage of biodiversity with other Env Problems i.e ,Climate Change, Desertification, Soil Erosion. | 7 |

| | | |
|---|---|---|
| IV | **Environmental Pollution & Social Issues**<br>Types, Causes, Effects & Control of Air, Water, Soil & Noise Pollution, Nuclear hazards and accidents & Health risks, Global Climate Change**:** Global warming, Ozone depletion, Acid rain, Melting of Glaciers & Ice caps, Rising sea levels**.**<br>Environmental disasters**:** Earthquakes, Floods, Cyclones, Landslides<br>**Field Work**<br>Visit to a National Park, Biosphere Reserve, Wildlife Sanctuary Documentation & preparation of a Biodiversity (flora & fauna) register of campus/river/forest<br>Visit to a local polluted site : Urban/Rural/Industrial/Agricultural Identification & Photography of resident or migratory birds, insects (butterflies)<br>Public hearing on environmental issues in a village | 8 |

**Text Books**


**1.** Bharucha, E. (2004), Text Book for Environmental Studies. University Grants Commission, New Delhi.


**Reference Books**


1. Odum, E.P. (1971). Fundamentals of Ecology. W.B. Saunders Co. USA, 574p
2. Rao, M N. and Datta, A.K. (1987). Waste Water treatment. Oxford & IBH Publ. Co. Pvt.Ltd. 345p.
3. Sharma B.K., 2001. Environmental Chemistry. Geol Publ. House, Meerut
4. Agarwal, K.C. 2001 Environmental Biology, Nidi Publ. Ltd. Bikaner.
5. Cunningham, W.P. Cooper, T.H. Gorhani, E & Hepworth, M.T. 2001, Environmental Encyclopedia, Jaico Publ. House, Mumabai, 1196p.
6. Heywood, V.H & Waston, R.T. 1995. Global Biodiversity Assessment. Cambridge Univ. Press 1140p.
7. Mckinney, M.L. & School, R.M. 1996. Environmental Science systems & Solutions, Web enhanced edition. 639p.
8. Miller G, Tyler and Scott, Spoolman, (2011). Essentials of Ecology, Brooks/Cole Learning, USA.
9. Rai, G.D. (2010). Conventional and Non-conventional Energy sources, Khanna Publishers.
10. Anne, E. Magurran and Brian J. (2010). Biological Diversity Frontiers in Measurement andAssessment. McGill (Eds.), Oxford University Press (2010).
11. Navjot S Sodhi and Paul R, (2010). Conservation Biology for All. Ehrlich (Eds.), Oxford University Press.
12. Pandey B.N. (2012). Biodiversity Issues Threats and Conservation. Narendra Publishing.
13. Manahan S., (2017). Environmental Chemistry, CRC Press (2017).


**Course Outcomes and Mapping**

At the end of the course, the student will be able to

**CO1.** Understand environmental problems at local and national level through

literature and general awareness.

**CO2.** Gain practical knowledge by visiting wildlife areas, environmental institutes and various personalities who have done practical work on various environmental Issues.

**CO3.** Apply interdisciplinary approach to understand key environmental issues and critically analyze them to explore the possibilities to mitigate these problems.

**CO4.** Reflect critically about their roles and identities as citizens, consumers and environmental actors in a complex, interconnected world**.**

**CO5.** Become aware of the local, regional and global environmental problems**.**

| | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 | PSO7 |
|---|---|---|---|---|---|---|---|
| CO1 | 3 | 2 | 3 | 2 | 3 | 2 | 2 |
| CO2 | 2 | 3 | 3 | 3 | 2 | 3 | 3 |
| CO3 | 3 | 3 | 3 | 2 | 2 | 2 | 3 |
| CO4 | 3 | 3 | 3 | 2 | 2 | 2 | 3 |
| CO5 | 3 | 1 | 2 | 3 | 2 | 2 | 3 |

| I.K. GUJRAL PUNJAB TECHNICAL UNIVERSITY<br>DEPARTMENT OF CHEMISTRY | | | | |
|---|---|---|---|---|
| **Course Name** | **B.Sc. (Honours) Chemistry** | | | |
| **Subject Code:** | **BHCP206-19** | | | |
| **Subject Title:** | **ORGANIC CHEMISTRY LAB-II: (Functional Group Transformations and their Identifications)** | | | |
| **Contact Hours:** | **L:0** | **T:0** | **P:4** | **Credits:2** |
| **Examination Duration (hours)** | **3** | | | |
| **Objective(s):** | The objective of this course is to provide practical knowledge and illustrative experiments regarding synthesis, separation and purification of organic compounds. | | | |

**Details of the Course**

| Unit | Contents |
|---|---|
| I | Functional group detection using spectroscopy techniques<br>Application of IR and UV spectroscopy in functional groups characterization of various compounds containing different functional groups (20 compounds). |
| II | One step synthesis<br>1. Acetylation of the following compounds using conventional method or using green approach<br>(a) amines (aniline, o-, p-toluidines)<br>(b) phenols (β-naphthol, 2-amino phenol, salicylic acid)<br>2. Benzolyation of the following compounds<br>(a) amines (aniline, o-, p- toluidines)<br>(b) phenols (β-naphthol, resorcinol) by Schotten-Baumann reaction.<br>3. Oxidation of ethanol/ isopropanol (Iodoform reaction).<br>4. Bromination of any one of the following:<br>(a) Acetanilide by conventional methods<br>(b) Acetanilide using green approach (Bromate-bromide method)<br>5. Nitration of any one of the following:<br>(a) Acetanilide/nitrobenzene by conventional method<br>(b) Salicylic acid by green approach (using ceric ammonium nitrate).<br>The above derivatives should be prepared using 0.5-1.0 g of the organic |

| | |
|---|---|
| | compound. The solid samples must be collected and may be used for recrystallization, melting point and TLC. |
| III | Chromatography<br>a. Separation of a mixture of two amino acids by ascending and horizontal paper chromatography<br>b. Separation of a mixture of two sugars by ascending paper chromatography<br>c. Separation of a mixture of *o*-and *p*-nitrophenol or *o*-and *p*-aminophenol by thin layer chromatography (TLC) |

**Reference Books**

| S.No. | Author(s) | Title of the Book | Publisher |
|---|---|---|---|
| 1 | Furniss, B.S., Hannaford, A.J., Smith, P.W.G. & Tatchell, A.R. | Practical Organic Chemistry, 5th Ed. | Pearson (2012) |
| 2 | F.G. Mann and B. C. Saunders | Practical Organic Chemistry | Longman, New York |
| 3 | Ahluwalia, V.K. & Aggarwal, R. | Comprehensive Practical Organic Chemistry: Preparation and Quantitative Analysis, | University Press (2000) |
| 4 | Ahluwalia, V.K. & Dhingra, S. | Comprehensive Practical Organic Chemistry: Qualitative Analysis | University Press (2000) |

**Course Outcomes and Mapping**

At the end of the course, the students will be able

**CO1.** To synthesise organic compounds by conventional and greener approach.

**CO2.** To develop preparative skills for purification of organic compounds by crystallization method.

**CO3.** To separate the organic compound by thin layer chromatography technique.

**CO4.** To present their work with practical skills and the awareness of health and safety procedures.

**CO5.** To apply related experiments for their research work

| | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 | PSO7 |
|---|---|---|---|---|---|---|---|
| CO1 | 3 | 1 | 2 | - | 3 | 2 | - |
| CO2 | 2 | - | 3 | - | 3 | 3 | - |
| CO3 | 3 | 3 | 4 | - | 3 | 3 | - |
| CO4 | 3 | 4 | 3 | 4 | 4 | 5 | 4 |
| CO5 | 2 | 3 | 4 | 2 | 4 | 4 | 4 |

| I.K. GUJRAL PUNJAB TECHNICAL UNIVERSITY<br>DEPARTMENT OF CHEMISTRY | | | | |
|---|---|---|---|---|
| **Course Name** | **B.Sc. (Honours) Chemistry** | | | |
| **Subject Code:** | **BHCP207-25** | | | |
| **Subject Title:** | **PHYSICAL CHEMISTRY LAB-II (Chemical Thermodynamics and Equilibrium Lab)** | | | |
| **Contact Hours:** | **L:0** | **T:0** | **P:4** | **Credits:2** |
| **Examination Duration (hours)** | **4** | | | |
| **Objective(s):** | To provide students practical knowledge and skills about various topics taught in theory class of physical chemistry, which in turn will enhance their problem solving and analytical skills. | | | |

**Details of the Course**

| **Contents** |
|---|
| 1. Determination of heat capacity of a calorimeter for different volumes using change of enthalpy data of a known system (method of back calculation of heat capacity of calorimeter from known enthalpy of solution or enthalpy of neutralization).<br>2. Determination of heat capacity of the calorimeter and enthalpy of neutralization of hydrochloric acid with sodium hydroxide.<br>3. Calculation of the enthalpy of ionization of ethanoic acid.<br>4. Determination of heat capacity of the calorimeter and integral enthalpy (endothermic and exothermic) solution of salts.<br>5. Determination of basicity/proticity of a polyprotic acid by the thermochemical method in terms of the changes of temperatures observed in the graph of temperature versus time for different additions of a base. Also calculate the enthalpy of neutralization of the first step.<br>6. Determination of enthalpy of hydration of copper sulphate.<br>7. Study of the solubility of benzoic acid in water and determination of $\Delta H$.<br>8. Determination of equilibrium constant of the reaction; $KI + I_2 \leftrightarrow KI_3$ by the distribution method.<br>9. Determination of formula of complex formed between the cupric ion and ammonia by distribution method.<br>*Any other experiment related to thermochemistry carried out in the class.* |

**Reference Books**

| S.No. | Author(s) | Title of the Book | Publisher |
|---|---|---|---|
| 1 | J.B. Yadav | Practical Physical Chemistry | Krishna |
| 2 | B. D. Khosla, V. C. Garg, & A. Gulati, | Senior Practical Physical Chemistry | R. Chand & Co. New Delhi (2011) |

| | | | |
|---|---|---|---|
| 3 | V. D. Athawale, & P. Mathur, | Experimental Physical Chemistry | New Age International: New Delhi (2001) |

**Course Outcomes and Mapping**

At the end of the course, the students will be able to

**CO1.** Understand the basic procedures for carrying out a physical chemistry practical like preparation and standardisation of solutions, handling the equipments and measuring with precision.

**CO2.** Correlate the theoretical and practical aspects and know about the limits of the experimental error.

**CO3.** Determine the various physical parameters for the various problems under study.

**CO4.** Verify various laws studied in the theory part.

| | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 | PSO7 |
|---|---|---|---|---|---|---|---|
| CO1 | 1 | 3 | 3 | 3 | 3 | 3 | 3 |
| CO2 | 2 | 2 | 3 | 3 | 3 | 2 | 2 |
| CO3 | 2 | 3 | 3 | 2 | 2 | 3 | 3 |
| CO4 | 2 | 3 | 3 | 1 | 2 | 2 | 3 |

| I.K. GUJRAL PUNJAB TECHNICAL UNIVERSITY<br>DEPARTMENT OF CHEMISTRY | | | | |
|---|---|---|---|---|
| **Course Name** | **B.Sc. (Honours) Chemistry** | | | |
| **Subject Code:** | **UC-BSHP-215-19** | | | |
| **Subject Title:** | **PHYSICS LAB-III (Elements of Modern Physics Lab)** | | | |
| **Contact Hours:** | **L:0** | **T:0** | **P:4** | **Credits:2** |
| **Examination Duration (hours)** | **3** | | | |
| **Objective(s):** | The aim and objective of the Physics Lab course is to introduce the students of B. Sc. (Hons.) Physics to the formal structure of wave and vibrations and mechanics so that they can use these as per their requirement. | | | |

**Details of the Course**

| **Contents** |
|---|
| **Students are expected to perform about 8-10 experiments from the following list, selecting minimum of 6-7 from the Physical Lab and 2-3 from the Virtual lab**<br>1. To determine value of Boltzmann constant using V-I characteristic of PN diode.<br>2. To show the tunneling effect in tunnel diode using I-V characteristics.<br>3. To determine work function of material of filament of directly heated vacuum diode<br>4. To determine value of Planck's constant using LEDs of at least 4 different colors.<br>5. Measurement of Planck's constant using black body radiation and photo-detector.<br>6. To determine work function of material of filament of directly heated vacuum diode.<br>7. To determine the ionization potential of mercury.<br>8. To determine the wavelength of H-alpha emission line of Hydrogen atom.<br>9. To determine the absorption lines in the rotational spectrum of Iodine vapour.<br>10. To study the diffraction patterns of single and double slits using laser source and measure its intensity variation using Photosensor and compare with incoherent source – Na light.<br>11. Photo-electric effect: photo current versus intensity and wavelength of light; maximum energy of photo-electrons versus frequency of light<br>12. To determine the value of e/m by magnetic focusing.<br>13. To experimentally demonstrate the concept of quantization of energy levels according to Bohr's model of atom using Franck-Hertz Apparatus.<br>14. To determine the wavelength of laser source using diffraction of single slit.<br>15. To determine the wavelength of laser source using diffraction of double slits.<br>16. Study of Electron spin resonance- determine magnetic field as a function of the resonance frequency. |

**Text and Reference Books:**

1. Experimental Physics - M.A. Hippargi.
2. Experimental Physics – Gadad & Hiregoudar.

3. Practical Physics - C. L. Arora.
4. Advanced Practical Physics – Worsnop and Flint.

5. Practical Physics – Gupta & Kumar Vol I, Vol II
6. http://vlab.amrita.edu/?sub=1&brch=195

**Course Outcomes and Mapping**

| At the end of the course, the student will be | |
|---|---|
| **CO1** | Able to understand the theoretical concepts learned in the theory course. |
| **CO2** | Trained in carrying out precise measurements and handling equipment. |
| **CO3** | Learn to draw conclusions from data and develop skills in experimental design**.** |
| **CO4** | Able to understand the principles of error analysis and develop skills in experimental design**.** |
| **CO5** | Able to document a technical report which communicates scientific information in a clear and concise manner. |

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 |
|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 3 | 2 | 2 | 2 | 1 | 2 |
| **CO2** | 3 | 3 | 3 | 3 | 2 | 2 | 1 |
| **CO3** | 3 | 3 | 2 | - | 2 | 1 | 2 |
| **CO4** | 3 | 2 | 2 | 2 | - | 2 | 2 |
| **CO5** | 2 | 2 | 2 | 2 | - | 2 | 2 |

| I.K. GUJRAL PUNJAB TECHNICAL UNIVERSITY<br>DEPARTMENT OF CHEMISTRY | | | | |
|---|---|---|---|---|
| **Course Name** | **B.Sc. (Honours) Chemistry** | | | |
| **Subject Code:** | **UGCA1914** | | | |
| **Subject Title:** | **Programming in Python** | | | |
| **Contact Hours:** | **L:3** | **T:1** | **P:0** | **Credits:4** |
| **Examination Duration (hours)** | **3** | | | |
| **Objective(s):** | - | | | |

**Course Outcomes:** Students will be able to:

| CO# | Course Outcomes |
|---|---|
| CO1 | Explain environment, data types, operators used in Python. |
| CO2 | Compare Python with other programming languages. |
| CO3 | Outline the use of control structures and numerous native data types with their methods. |
| CO4 | Design user defined functions, modules, files, and packages and exception handling methods. |
| CO5 | Write solutions for Object Oriented Programming Concepts. |

| Detailed Contents | Contact hours |
|---|---|
| **Unit-I**<br><br>**Introduction to Python Programming Language:** Programming Language, History and Origin of Python Language, Features of Python, Limitations, Major Applications of Python, Getting, Installing Python, Setting up Path and Environment Variables, Running Python, First Python Program, Python Interactive Help Feature, Python differences from other languages. [CO1] [CO2]<br><br>**Python Data Types & Input/Output:** Keywords, Identifiers, Python Statement, Indentation, Documentation, Variables, Multiple Assignment, Understanding Data Type, Data Type Conversion, Python Input and Output Functions, Import command. [CO1]<br><br>**Operators and Expressions:** Operators in Python, Expressions, Precedence, Associativity of Operators, Non Associative Operators. [CO1] | 12 |

| | |
|---|---|
| **Unit-II**<br><br>**Control Structures:** Decision making statements, Python loops, Python control statements.<br><br>**Python Native Data Types:** Numbers, Lists, Tuples, Sets, Dictionary, Functions & Methods of Dictionary, Strings (in detail with their methods and operations).[CO3] | 10 |
| **Unit-III**<br><br>**Python Functions:** Functions, Advantages of Functions, Built-in Functions, User defined functions, Anonymous functions, Pass by value Vs. Pass by Reference, Recursion, Scope and Lifetime of Variables. [CO3]<br><br>**Python Modules:** Module definition, Need of modules, Creating a module, Importing module, Path Searching of a Module, Module Reloading, Standard Modules, Python Packages. [CO3] | 12 |
| **Unit-IV**<br><br>**Exception Handling:** Exceptions, Built-in exceptions, Exception handling, User defined exceptions in Python. | 10 |
| **File Management in Python:** Operations on files (opening, modes, attributes, encoding, closing), read() & write() methods, tell() & seek() methods, renaming & deleting files in Python, directories in Python. [CO4]<br><br>**Classes and Objects:** The concept of OOPS in Python, Designing classes, Creating objects, Accessing attributes, Editing class attributes, Built-in class attributes, Garbage collection, Destroying objects. [CO5] | |

**Text Books:**


1. Programming in Python, Pooja Sharma, BPB Publications, 2017.
2. Core Python Programming, R. Nageswara Rao, 2nd Edition, Dreamtech.


**Reference Books:**


1. Python, The complete Reference, Martin C. Brown, Mc Graw Hill Education.
2. Python in a Nutshell, A. Martelli, A. Ravenscroft, S. Holden, OREILLY.

| I.K. GUJRAL PUNJAB TECHNICAL UNIVERSITY<br>DEPARTMENT OF CHEMISTRY | | | | |
|---|---|---|---|---|
| **Course Name** | **B.Sc. (Honours) Chemistry** | | | |
| **Subject Code:** | **UGCA1917** | | | |
| **Subject Title:** | **Programming in Python Laboratory** | | | |
| **Contact Hours:** | **L:0** | **T:0** | **P:4** | **Credits:2** |
| **Examination Duration (hours)** | **3** | | | |
| **Objective(s):** | - | | | |

**Course Outcomes**: Students will be able to :

| CO# | Course outcomes |
|---|---|
| CO1 | Outline various programming constructs like data types and control structures of Python. |
| CO2 | Implement different data structures. |
| CO3 | Implement modules and functions. |
| CO4 | Illustrate concept of object oriented programming. |
| CO5 | Implement file handling. |

**List of assignments:**

| | |
|---|---|
| 1. | Compute sum, subtraction, multiplication, division and exponent of given variables input by the user. |
| 2. | Compute area of following shapes: circle, rectangle, triangle, square, trapezoid and parallelogram. |
| 3. | Compute volume of following 3D shapes: cube, cylinder, cone and sphere. |
| 4. | Compute and print roots of quadratic equation $ax^2+bx+c=0$, where the values of a, b, and c are input by the user. |
| 5. | Print numbers up to N which are not divisible by 3, 6, 9,, e.g., 1, 2, 4, 5, 7,…. |
| 6. | Write a program to determine whether a triangle is isosceles or not? |
| 7. | Print multiplication table of a number input by the user. |
| 8. | Compute sum of natural numbers from one to n number. |
| 9. | Print Fibonacci series up to n numbers e.g. 0 1 1 2 3 5 8 13…..n |
| 10. | Compute factorial of a given number. |
| 11. | Count occurrence of a digit 5 in a given integer number input by the user. |
| 12. | Print Geometric and Harmonic means of a series input by the user. |

| | |
|---|---|
| 13. | Evaluate the following expressions:<br>a. $x-x^2/2!+x^3/3!-x^4/4!+\ldots x^n/n!$<br>b. $x-x^3/3!+x^5/5!-x^7/7!+\ldots x^n/n!$ |
| 14. | Print all possible combinations of 4, 5, and 6. |
| 15. | Determine prime numbers within a specific range. |
| 16. | Count number of persons of age above 60 and below 90. |
| 17. | Compute transpose of a matrix. |
| 18. | Perform following operations on two matrices.<br>1) Addition 2) Subtraction 3) Multiplication |
| 19. | Count occurrence of vowels. |
| 20. | Count total number of vowels in a word. |
| 21. | Determine whether a string is palindrome or not. |
| 22. | Perform following operations on a list of numbers:<br>1) Insert an element 2) delete an element 3) sort the list 4) delete entire list |
| 23. | Display word after Sorting in alphabetical order. |
| 24. | Perform sequential search on a list of given numbers. |
| 25. | Perform sequential search on ordered list of given numbers. |
| 26. | Maintain practical note book as per their serial numbers in library using Python dictionary. |
| 27. | Perform following operations on dictionary<br>1) Insert 2) delete 3) change |
| 28. | Check whether a number is in a given range using functions. |
| 29. | Write a Python function that accepts a string and calculates number of upper case letters and lower case letters available in that string. |

| | |
|---|---|
| 30. | To find the Max of three numbers using functions. |
| 31. | Multiply all the numbers in a list using functions. |
| 32. | Solve the Fibonacci sequence using recursion. |
| 33. | Get the factorial of a non-negative integer using recursion. |
| 34. | Write a program to create a module of factorial in Python. |
| 35. | Design a Python class named *Rectangle,* constructed by a length & width, also design a method which will compute the area of a rectangle. |
| 36. | Design a Python class named *Circle* constructed by a radius and two methods which will compute the area and the perimeter of a circle. |
| 37. | Design a Python class to reverse a string 'word by word'. |
| 38. | Write a Python program to read an entire *text file*. |
| 39. | Design a Python program to read first n lines of a *text file.* |
| 40. | Construct a Python program to write and append text to a file and display the text. |

**Text Books:**


1. Programming in Python, Pooja Sharma, BPB Publications, 2017.
2. Core Python Programming, R. Nageswara Rao, 2nd Ediiton, Dreamtech.


**Reference Books:**


1. Python, The complete Reference, Martin C. Brown, Mc Graw Hill Education.
2. Python in a Nutshell, A. Martelli, A. Ravenscroft, S. Holden, OREILLY.

# SEMESTER-IV

| I.K. GUJRAL PUNJAB TECHNICAL UNIVERSITY<br>DEPARTMENT OF CHEMISTRY | | | | |
|---|---|---|---|---|
| **Course Name** | **B.Sc. (Honours) Chemistry** | | | |
| **Subject Code:** | **BHCL211-25** | | | |
| **Subject Title:** | **INORGANIC CHEMISTRY-III (Crystal Field Theory and Transition Elements)** | | | |
| **Contact Hours:** | **L:3** | **T:1** | **P:0** | **Credits:4** |
| **Examination Duration (hours)** | **3** | | | |
| **Objective(s):** | To teach the fundamental concepts of Inorganic Chemistry and their applications. | | | |

**Details of the Course**

| Unit | Contents | Contact Hours |
|---|---|---|
| I | **Coordination Chemistry I:**<br>Valence bond theory: postulates, applications and shortcomings, the electroneutrality principle and back bonding. Crystal field theory: crystal field effects in tetrahedral, square planar, octahedral, tetragonal cases, measurement of 10 Dq, CFSE, CFSE in weak and strong fields, pairing energies, factors affecting the magnitude of 10 Dq ($\Delta_o$, $\Delta_t$). The thermodynamic effects of the crystal field splitting (Hydration, Ligation and Lattice Energies), the structural consequences of CFSE (Ionic Radii and Jahn-Teller effect), the nephalauxetic effect, the spectrochemical series, and limitations of the crystal field theory. | 10 |
| II | **Coordination Chemistry II:**<br>The ligand field theory, The molecular orbital treatment of octahedral, tetrahedral and square planar complexes (qualitative picture only), Comparison of the VBT, CFT and MOT picture of bonding in case of transition metal complexes.<br>**Transition Elements-I:**<br>***d*-block elements:** General characteristics, electronic configuration, oxidation states, Stability of various oxidation states and e.m.f. (Latimer diagrams), atomic radii, ionic radii, metallic character, ionization energy, standard electrode potential, colour, magnetic properties, tendency to form complexes. Comparisons of properties (ionic radii, oxidation state, coordination number and M-M bonding) of 2nd and third 3rd transition metal series with 1st row transition metal series. | 11 |

| | | |
|---|---|---|
| III | **Transition Elements-II:**<br><br>***d*-block elements:** Chemistry of Ti, V, Cr Mn, Fe and Co in various oxidation states (excluding their metallurgy).<br>***f*-block elements: Lanthanoids**: Electronic configurations, oxidation states, ionic radii, lanthanide contraction, colour, spectral and magnetic properties, lanthanum compounds. **Actinoids:** electronic configurations, oxidation states, ionic radii, actinide contraction, colour, spectral and magnetic properties. Comparison of lanthanoids and actinoids. | 12 |
| IV | **Bioinorganic Chemistry:**<br>Non-photosynthetic processes, Essential and trace elements on biological processes, Toxicity of metal ions (Hg, Pb, Cd and As), Biological role of alkali and alkaline earth metal ions with special reference of sodium-potassium pump, Porphyrins and metalloporphyrins,<br>Iron and its application in bio-systems, Iron storage and transport, ferritin, transferrin, Hemoglobin and myoglobin: structure and function of hemoglobin, Physiology of myoglobin and hemoglobin, Nature of heme-dioxygen binding in hemoglobin and myoglobin, Cooperativity in hemoglobin, Model systems, Bohr's Effect, Poisoning effects of CO and other ligands. | 12 |

**Text Books**

| S.No. | Author(s) | Title of the Book | Publisher/Year |
|---|---|---|---|
| 1 | Lee, J.D. | Concise Inorganic Chemistry | ELBS, 1991. |
| 2 | J.E. Huheey | Inorganic Chemistry | Harper & Row |
| 3 | Puri, B.R., Sharma, L.R. and Kalia, K.C. | Principles of Inorganic Chemistry | 2016 |

**Reference Books**

| S.No. | Author(s) | Title of the Book | Publisher/Year |
|---|---|---|---|
| 1 | Purcell, K.F & Kotz, J.C. | Inorganic Chemistry | W.B. Saunders Co, 1977. |
| 2 | Douglas, B.E. and Mc Daniel, D.H. | Concepts & Models of Inorganic Chemistry | Oxford, 1970 |
| 3 | Lippard, S.J. & Berg, J.M. | Principles of Bioinorganic Chemistry | Panima Publishing Company 1994 |
| 4 | Lippard, S.J. & Berg, J.M. | Principles of Bioinorganic Chemistry | Panima Publishing Company 1994 |
| 5 | Basolo, F, and Pearson, R.C. | Mechanisms of Inorganic Chemistry | John Wiley & Sons, NY, 1967 |
| 6 | Greenwood, N.N. & Earnshaw A. | Chemistry of the Elements | Butterworth-Heinemann,1997 |

**Course Outcomes and Mapping**

At the end of the course, the student will be able to

**CO1.** Understand the fundamental concepts of various theories of coordination compounds

**CO2.** Learn the periodicity of the transition elements

**CO3.** Understand the chemistry involved in the different transition elements.

**CO4.** Learn about the role of metal ions in the biological systems.

**CO5.** Understand the effect of trace metals on the biological systems

| | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 | PSO7 |
|---|---|---|---|---|---|---|---|
| CO1 | 3 | 2 | 2 | 3 | 3 | 2 | 1 |
| CO2 | 2 | 3 | 2 | 3 | 1 | 3 | 2 |
| CO3 | 2 | 2 | 3 | 2 | 2 | 2 | 3 |
| CO4 | 1 | 2 | 2 | 2 | 2 | 1 | 2 |
| CO5 | 2 | 1 | 2 | 2 | 1 | 3 | 2 |

| I.K. GUJRAL PUNJAB TECHNICAL UNIVERSITY<br>DEPARTMENT OF CHEMISTRY | | | | |
|---|---|---|---|---|
| **Course Name** | **B.Sc. (Honours) Chemistry** | | | |
| **Subject Code:** | **BHCL212-25** | | | |
| **Subject Title:** | **PHYSICAL CHEMISTRY-III (Chemical Kinetics, Solutions and Macromolecules)** | | | |
| **Contact Hours:** | **L:3** | **T:1** | **P:0** | **Credits:4** |
| **Examination Duration (hours)** | **3** | | | |
| **Objective(s):** | This course will equip students with the necessary knowledge concerning the fundamentals in physical chemistry concerning chemical kinetics, catalysis, adsorption, macromolecules and solutions. The problem solving skills of students are expected to be enhanced through due weightage given to numerical problems in each unit. | | | |

**Details of the Course**

| Unit | Contents | Contact Hours |
|---|---|---|
| I | **Chemical Kinetics**<br>Order and molecularity of a reaction, rate law and rate constant of a reaction, Integrated form of rate expressions up to second order reactions, Half- life Time of a reaction, Methods for determining the order of a reaction, Mechanisms of complex reactions; Equilibrium and steady state approximation, Kinetics of complex reactions (integrated rate expressions up to first order only): (i) Opposing reactions (ii) consecutive reactions and (iii) chain reactions.<br>Temperature dependence of reaction rates; Arrhenius equation; activation energy, Numericals. Collision theory of reaction rates, Activated complex theory, Lindemann theory of unimolecular reactions. | 12 |
| II | **Catalysis and Adsorption:**<br>General Characteristics of Catalytic Reactions, Acid- Base Catalysis, Enzyme catalysis; Michaelis-Menten mechanism, The Lineweaver-Burk and Eadie-Hofstee method for determination of Vmax, Heterogeneous Catalysis; Kinetics of surface catalyzed unimolecular and bimolecular reactions.<br>Adsorption: Physical adsorption, chemisorption and Factors effecting adsorption, The Freundlich Adsorption Isotherm, Langmuir Theory of Adsorption, and BET theory of Multilayer adsorption (preliminary idea only), Types of Adsorption Isotherms, Gibb's Adsorption isotherm. | 12 |
| III | **Macromolecules:**<br>Degree of polymerization, Types of polymers, Molar masses of polymers, Determination of molar masses of macromolecules by viscometry, Osmometry, Ultracentrifugation, and Light Scattering. | 8 |

| | | |
|---|---|---|
| | Kinetics of Addition and Condensation Polymerization, Electrically conducting polymers and their applications. | |
| IV | **Solutions and Colligative Properties:**<br>Solutions of Liquids in liquids, Concentration Units and related numericals, Raoult's law, Vapour pressure of Ideal Solutions and related numericals. Ideal and Non ideal Solutions; Chemical Potential and Gibb's Duhem Margules equation.<br>Colligative properties of Dilute Solutions; Thermodynamic derivation using chemical potential to derive relations between the four colligative properties [(i) relative lowering of vapour pressure, (ii) elevation of boiling point, (iii) Depression of freezing point, (iv) osmotic pressure] and amount of solute. Some effects of Osmosis and Semi-Permeability, Reverse Osmosis. Applications in calculating molar masses of normal, dissociated and associated solutes in solution. Related Numericals. | 12 |

**Text Books**

| S.No. | Author(s) | Title of the Book | Publisher/Year |
|---|---|---|---|
| 1 | Puri, Sharma and Pathania | Principles of Physical Chemistry | Vishal Publishing Company |
| 2 | K L Kapoor | A Textbook of Physical Chemistry, Volume 1& 3 | Mc Graw Hill Education |
| 3 | Gurtu and Gurtu | Advanced Physical Chemistry | Pragati Prakashan |

**Reference Books**

| S.No. | Author(s) | Title of the Book | Publisher/Year |
|---|---|---|---|
| 1 | P.W. Atkins & J. de Paula | Atkin's Physical Chemistry | Oxford University Press (2006) |
| 2 | S.H. Maron & C.F. Prutton | Principles of Physical Chemistry, 1st edition | Oxford and IBH (1958) |
| 3 | G.W. Castellan | Physical Chemistry, 4th edition | Narosa (2004) |
| 4 | I .N. Levine | Physical Chemistry 6th Ed., | Tata Mc Graw Hill (2010) |
| 5 | T. Engel & P. Reid | Physical Chemistry 3rd Ed. | Prentice-Hall (2012) |

**Course Outcomes and Mapping**

At the end of the course, the student will be able to

**CO1.** Describe various terms associated with chemical kinetics, catalysis and

adsorption.

**CO2.** Analyse the various ways to define concentration of solutions and relate them to colligative properties.

**CO3.** Define the various concepts associated with macromolecules.

**CO4.** Familiarize with the phenomenon of adsorption and its related theories.

**CO5.** Understand the factors affecting the kinetics of chemical processes.

| | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 | PSO7 |
|---|---|---|---|---|---|---|---|
| CO1 | 3 | 1 | 1 | - | 2 | 1 | 1 |
| CO2 | 3 | 2 | 3 | - | 1 | - | 1 |
| CO3 | 2 | 2 | 1 | - | 2 | 1 | 1 |
| CO4 | 3 | 2 | 2 | - | 2 | 1 | 1 |
| CO5 | 3 | 2 | 2 | - | 1 | - | 1 |

| I.K. GUJRAL PUNJAB TECHNICAL UNIVERSITY<br>DEPARTMENT OF CHEMISTRY | | | | |
|---|---|---|---|---|
| **Course Name** | **B.Sc. (Honours) Chemistry** | | | |
| **Subject Code:** | **BHCL213-25** | | | |
| **Subject Title:** | **GREEN CHEMISTRY** | | | |
| **Contact Hours:** | **L:3** | **T:1** | **P:0** | **Credits:4** |
| **Examination Duration (hours)** | **3** | | | |
| **Objective(s):** | The objectives of this course are to:<br>• Introduce the principles and concepts of green chemistry and sustainability.<br>• Develop understanding of environmentally benign and alternative chemical processes.<br>• Introduce green metrics and sustainability assessment tools.<br>Highlight industrial, environmental, and societal applications of green chemistry. | | | |

**Details of the Course**

| Unit | Contents | Contact Hours |
|---|---|---|
| I | **Fundamentals of Green and Sustainable Chemistry:** *Introduction to Green Chemistry:* Definition, need and scope of green chemistry; sustainability and sustainable development; relationship of green chemistry with environment and industry. Twelve Principles of Green Chemistry with suitable examples.<br><br>*Green Metrics:* Atom economy, E-factor, process mass intensity (PMI), carbon efficiency and waste minimization.<br><br>Introduction to life-cycle assessment and circular economy concepts.<br><br>*Green Solvents and Reaction Media:* Water as solvent, solvent-free reactions, supercritical fluids, ionic liquids and deep eutectic solvents (DES).<br><br>*Catalysis in Green Chemistry:* Homogeneous, heterogeneous and biocatalysis; advantages of catalytic processes over stoichiometric processes. | 12 |

| | | |
|---|---|---|
| II | **Green Synthetic Strategies and Industrial Applications:**<br>*Designing Safer Chemicals and Processes:* Prevention of waste, safer reagents, minimization of toxic by-products, energy-efficient synthesis, renewable feedstocks, avoidance of unnecessary derivatization.<br>*Alternative Feedstocks:* Biomass-derived chemicals, biofuels and renewable raw materials.<br><br>*Selected Green Industrial Processes and Case Studies:* Green synthesis of ibuprofen, Green synthesis of paracetamol and adipic acid, Replacement of hazardous chlorinated compounds and greener alternatives, Green polymer synthesis and biodegradable polymers. | 12 |
| III | **Alternative Green Technologies in Chemical Synthesis:** *Microwave Chemistry:* Principles, advantages and applications in organic synthesis.<br><br>*Sonochemistry:* Principles and applications of ultrasound-assisted reactions.<br><br>*Mechanochemistry:* Solvent-free grinding reactions and ball milling techniques.<br><br>*Flow Chemistry:* Introduction to continuous flow processes and advantages in green synthesis.<br><br>*Photochemical and Electrochemical Methods*: Introduction to visible-light photocatalysis and electrochemical synthesis as sustainable alternatives. | 10 |
| IV | **Green Chemistry in Sustainable Development and Emerging Trends:**<br>*Green Chemistry in Industry:* Applications in pharmaceuticals, polymers, dyes, agrochemicals and energy sectors. Green Nanotechnology and Sustainable Materials.<br>*Carbon Capture, Utilization and Hydrogen Economy:* Basic concepts and applications. Waste Valorization and Circular Chemistry.<br>*Emerging Areas:* Artificial intelligence in green chemistry, computational solvent design and sustainable manufacturing.<br><br>Role of green chemistry in environmental protection, climate change mitigation and sustainable development goals (SDGs). | 11 |

**Text Book**

| S.No. | Author(s) | Title of the Book | Publisher/Year |
|---|---|---|---|
| 1 | V.K. Ahluwalia & M.R. Kidwai | New Trends in Green Chemistry | Anamalaya Publishers (2005) |
| 2 | Mike Lancaster | Green Chemistry: Environmentally Benign Approaches | Oxford University Press |
| **Reference Books** | | | |
| 1 | P.T. Anastas & J.K. Warner | Oxford Green Chemistry-Theory and Practical | University Press (1998) |

| | | | |
|---|---|---|---|
| 2 | A.S. Matlack | Introduction to Green Chemistry | Marcel Dekker (2001) |
| 3 | M.C. Cann & M.E. Connely | Real-World cases in Green Chemistry | American Chemical Society, Washington (2000) |
| 4 | M.A. Ryan & M. Tinnesand | Introduction to Green Chemistry | American Chemical Society, Washington (2002) |
| 5 | A. Lapkin & D. Constable | Green Chemistry Metrics | Wiley |

**Course Outcomes and Mapping**

At the end of the course, the student will be able to

CO1 Explain the principles and significance of green chemistry and sustainabl development.

CO2 Evaluate chemical reactions and processes using green chemistry metrics.

CO3 Understand alternative green technologies such as microwave, ultrasound, flow an photochemical methods.

CO4 Compare conventional and green synthetic methodologies from environmental an industrial perspectives.

CO5 Recognize the role of green chemistry in sustainable industrial development an environmental protection.

| | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 | PSO7 |
|---|---|---|---|---|---|---|---|
| CO1 | 2 | 2 | 3 | 2 | 2 | 1 | 2 |
| CO2 | 2 | 3 | 2 | 1 | 3 | 2 | 1 |
| CO3 | 1 | 2 | 3 | 1 | 2 | 2 | 1 |
| CO4 | 1 | 2 | 1 | 3 | 2 | 2 | 0 |
| CO5 | 2 | 3 | 2 | 2 | 1 | 2 | 2 |

| I.K. GUJRAL PUNJAB TECHNICAL UNIVERSITY<br>DEPARTMENT OF CHEMISTRY | | | | |
|---|---|---|---|---|
| **Course Name** | **B.Sc. (Honours) Chemistry** | | | |
| **Subject Code:** | **BHCL214-19** | | | |
| **Subject Title:** | **POLYMER CHEMISTRY** | | | |
| **Contact Hours:** | **L:3** | **T:1** | **P:0** | **Credits:4** |
| **Examination Duration (hours)** | **3** | | | |
| **Objective(s):** | This course will equip students with the knowledge concerning the fundamentals in the basic areas of Polymer Chemistry. | | | |

**Details of the Course**

| Unit | Contents | Contact Hours |
|---|---|---|
| I | **Introduction and history of polymeric materials:** Different schemes of classification of polymers, Polymer nomenclature, Molecular forces and chemical bonding in polymers, Texture of Polymers. **Functionality and its importance:** Criteria for synthetic polymer formation, classification of polymerization processes, Relationships between functionality, extent of reaction and degree of polymerization. Bifunctional systems, Poly-functional systems. | 10 |
| II | **Kinetics of Polymerization:** Mechanism and kinetics of step growth, radical chain growth, ionic chain **(**both cationic and anionic**)** and coordination polymerizations, Mechanism and kinetics of copolymerization, polymerization techniques**.** **Crystallization and crystallinity:** Determination of crystalline melting point and degree of crystallinity, Morphology of crystalline polymers, Factors affecting crystalline melting point**.** **Nature and structure of polymers-**Structure Property relationships**.** | 12 |
| III | **Determination of molecular weight of polymers (**$M_n$, $M_w$, etc**)** by end group analysis, viscometry, light scattering and osmotic pressure methods**.** Molecular weight distribution and its significance**.** Polydispersity index**.** **Glass transition temperature (**$T_g$**) and determination of** $T_g$ Free volume theory, WLF equation, Factors affecting glass transition temperature **(**$T_g$**).** **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**.** | 11 |
| IV | **Properties of Polymers (Physical, thermal, Flow & Mechanical** | 12 |

| | | |
|---|---|---|
| | **Properties).**<br>Brief introduction to preparation, structure, properties and application of the following polymers**:** polyolefins, polystyrene and styrene copolymers, poly**(**vinyl chloride**)** and related polymers, poly**(**vinyl acetate**)** and related polymers, acrylic polymers, fluoro polymers, polyamides and related polymers**.** Phenol formaldehyde resins **(**Bakelite, Novalac**)**, polyurethanes, silicone polymers, polydienes, Polycarbonates, Conducting Polymers, **[**polyacetylene, polyaniline, poly**(**p**-**phenylene sulphide polypyrrole, polythiophene**)].** | |

**Reference Books**

| S.No. | Author(s) | Title of the Book | Publisher/Year |
|---|---|---|---|
| 1 | G. Odian | Principles of Polymerization | John Wiley |
| 2 | F.W. Billmeyer | Text Book of Polymer Science | John Wiley |
| 3 | P. Ghosh | Polymer Science & Technology | Tata Mcgraw-Hill |
| 4 | R.W. Lenz: | Organic Chemistry of Synthetic High Polymers | - |

**Course Outcomes and Mapping**

At the end of the course, the student will be able to

**CO1.** Study the nomenclature, classifications and bonding in polymers

**CO2.** Learn the criteria for the synthesis of polymers and mechanism involved in polymerization

**CO3.** Understand the morphology, kinetics and their structure property relationship

**CO4.** Learn the various techniques used for determining the molecular weight of polymeric compounds

**CO5.** Study the physical, thermal, Flow and Mechanical Properties of Polymers

| | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 | PSO7 |
|---|---|---|---|---|---|---|---|
| CO1 | 4 | 4 | 3 | - | 3 | 4 | 2 |
| CO2 | 4 | 2 | 3 | 1 | 2 | 2 | - |
| CO3 | 4 | 2 | 1 | - | 4 | 4 | - |
| CO4 | 4 | 4 | 4 | - | 4 | 3 | - |
| CO5 | 4 | 3 | 4 | - | 4 | - | - |

| I.K. GUJRAL PUNJAB TECHNICAL UNIVERSITY<br>DEPARTMENT OF CHEMISTRY | | | | |
|---|---|---|---|---|
| **Course Name** | **B.Sc. (Honours) Chemistry** | | | |
| **Subject Code:** | **UC-BSHM-408-19** | | | |
| **Subject Title:** | **MATRICES & ORDINARY DIFFERENTIAL EQUATIONS** | | | |
| **Contact Hours:** | **L:3** | **T:1** | **P:0** | **Credits:4** |
| **Examination Duration (hours)** | **3** | | | |
| **Objective(s):** | The objective of the course on **Matrices & Ordinary Differential Equations** is to equip the B.Sc. (Hons) students with the theoretical aspects of matrices. Their applications in system of equations and real-life engineering problems. Furthermore, students will be introduced to Ordinary Differential Equations. | | | |

**Details of the Course**

| Unit | Contents | Contact Hours |
|---|---|---|
| I | **Matrices**: Introduction to matrix, Different kinds of matrices, Addition, Multiplication, Symmetric and Skew symmetric matrix, Transpose of matrix, trace of a matrix**.**<br>Determinants**:** Determinant of matrix, Properties of determinant, Singular and non-singular matrices, Adjoint and inverse of a matrix, Rank of a matrix. | 12 |
| II | **System of Equations:** Introduction to system of linear equations, Condition of Consistency of system of linear equations, Homogenous and Non-homogenous system of equations, Echelon form. Solving Linear system of Equations: Matrix inversion method, Gauss-Jordon method and Gauss Elimination method. | 12 |
| III | **ODE**: Introduction of differential coefficient, Ordinary differential equation, Order and degree of differential equation, Formation of differential equation, Difference between linear and non-linear differential equations**.** | 10 |
| IV | **Solving Ordinary Differential Equations:** Solution of Separable differential equations, linear differential equations of the first order, Exact differential equations, Solution of homogeneous differential equations, Bernoulli's equation and Riccati equation, The chemical application of these first order differential equations. | 11 |

**Reference Books**


1. Mathematics 10+2, NCERT, New Delhi.
2. Kreyszig, E., Advanced Engineering Mathematics, 9th Edition. Wiley Publications, 2005.
3. O'Neil, P.V., Advanced Engineering Mathematics 7th Edition. Cengage Learning

Custom Publishing, 2011.
4. Jain, R.K. and Iyengar, S.K., Advanced Engineering Mathematics 5th Edition. New Delhi: Narosa Publication, 2011.

**Course Outcomes and Mapping**

At the end of the course, the student will be able to

**CO1.** Learn the basic concepts of Matrices.

**CO2.** Understand about operations on matrices, such as, addition, subtraction and multiplication. And, the concept of determinants.

**CO3.** Use matrices in solving system of equations using Gauss Elimination method, Gauss-Jordon method, Matrix inversion method etc.

**CO4.** Be acquainted with knowledge of ordinary differential equations and Linear differential equations.

**CO5.** Apply the learnt techniques in solving various problems related to differential equations.

| | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 | PSO7 |
|---|---|---|---|---|---|---|---|
| CO1 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| CO2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| CO3 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| CO4 | 2 | 2 | 2 | 2 | 1 | 2 | 2 |
| CO5 | 2 | 2 | 2 | 2 | 1 | 1 | 1 |

| I.K. GUJRAL PUNJAB TECHNICAL UNIVERSITY<br>DEPARTMENT OF CHEMISTRY | | | | |
|---|---|---|---|---|
| **Course Name** | **B.Sc. (Honours) Chemistry** | | | |
| **Subject Code:** | **BHCL216-19** | | | |
| **Subject Title:** | **BASIC ANALYTICAL CHEMISTRY** | | | |
| **Contact Hours:** | **L:2** | **T:0** | **P:0** | **Credits:2** |
| **Examination Duration (hours)** | **3** | | | |
| **Objective(s):** | This is skill enhancement course to equip students with the necessary knowledge about basic techniques applied in analytical chemistry. | | | |

**Details of the Course**

| Unit | Contents | Contact Hours |
|---|---|---|
| I | **Introduction:** Introduction to Analytical Chemistry and its interdisciplinary nature. Concept of sampling. Importance of accuracy, precision and sources of error in analytical measurements. Presentation of experimental data and results, from the point of view of significant figures. | 6 |
| II | **Analysis of soil:** Composition of soil, humus and clay, Concept of pH and pH measurement, Complexometric titrations, Chelation, Chelating agents, use of indicators<br>**Analysis of water:** Definition of pure water, sources responsible for contaminating water, water sampling methods, water purification methods. | 10 |
| III | **Chromatography:** Definition, general introduction on principles of chromatography, paper chromatography, TLC etc. **Ion-exchange:** Column, ion-exchange chromatography etc. | 7 |
| IV | **Analysis of food products:** Nutritional value of foods, idea about food processing and food preservations and adulteration.<br>**Analysis of cosmetics:** Major and minor constituents and their function | 7 |

**Reference Books**


1. Willard, H. H. *Instrumental Methods of Analysis*, CBS Publishers.
2. Skoog & Lerry. *Instrumental Methods of Analysis*, Saunders College Publications, New York.
3. Skoog, D.A.; West, D.M. & Holler, F.J. *Fundamentals of Analytical Chemistry 6th Ed.,* Saunders College Publishing, Fort Worth (1992).
4. Harris, D. C. *Quantitative Chemical Analysis*, W. H. Freeman.
5. Dean, J. A. *Analytical Chemistry Notebook*, McGraw Hill.
6. Day, R. A. & Underwood, A. L. *Quantitative Analysis*, Prentice Hall of India.
7. Freifelder, D. Physical Biochemistry *2nd Ed.,* W.H. Freeman and Co., N.Y. USA (1982).
8. Cooper, T.G. *The Tools of Biochemistry,* John Wiley and Sons, N.Y. USA. 16 (1977).
9. Vogel, A. I. *Vogel's Qualitative Inorganic Analysis 7th Ed.,* Prentice Hall.

10. Vogel, A. I. Vogel's *Quantitative Chemical Analysis 6th Ed.,* Prentice Hall.
11. Robinson, J.W. *Undergraduate Instrumental Analysis 5th Ed.,* Marcel Dekker, Inc., New York.

**Course Outcomes and Mapping**

At the end of the course, the student will be able to

**CO1.** Understand the basics of analytical chemistry.
**CO2.** Know about soil and water, their sampling, analysis & purification methods.
**CO3.** Familarise with the principles and techniques of chromatography.
**CO4.** Aware of the nutritional value of various food items and concept of food processing and adulteration.
**CO5.** Understand the functions of various constituents present in cosmetics.

| | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 | PSO7 |
|---|---|---|---|---|---|---|---|
| CO1 | 3 | 2 | 1 | - | 3 | - | - |
| CO2 | 3 | 2 | 1 | 2 | 2 | 2 | 1 |
| CO3 | 3 | 2 | 1 | 1 | 2 | 2 | 1 |
| CO4 | 3 | 3 | 1 | 2 | - | 2 | 1 |
| CO5 | 3 | 3 | 1 | 2 | - | 2 | - |

| I.K. GUJRAL PUNJAB TECHNICAL UNIVERSITY<br>DEPARTMENT OF CHEMISTRY | | | | |
|---|---|---|---|---|
| **Course Name** | **B.Sc. (Honours) Chemistry** | | | |
| **Subject Code:** | **BHCP217-25 (Gravimetric Analysis and Inorganic Preparations)** | | | |
| **Subject Title:** | **INORGANIC CHEMISTRY LAB-III** | | | |
| **Contact Hours:** | **L:0** | **T:0** | **P:6** | **Credits:3** |
| **Examination Duration (hours)** | **3** | | | |
| **Objective(s):** | 1. To develop practical skills in quantitative inorganic analysis through gravimetric estimation techniques and accurate handling of laboratory apparatus.<br>2. To provide hands-on experience in the synthesis, purification, and characterization of important inorganic compounds and coordination complexes. | | | |

**Details of the Course**

| Unit | Contents |
|---|---|
| | **Gravimetric Analysis: (any five)**<br>1. Estimation of nickel(II) using dimethylglyoxime (DMG).<br>2. Estimation of copper(I) as copper(I) thiocyanate (CuSCN).<br>3. Estimation of chromium(III) as lead chromate ($PbCrO_4$).<br>4. Gravimetric determination of silver(I) as silver chloride (AgCl).<br>5. Estimation of aluminium(III) by precipitation with oxine (8-hydroxyquinoline).<br>6. Gravimetric determination of barium(II) as barium chromate ($BaCrO_4$).<br>7. Gravimetric determination of sulfate ion as barium sulfate ($BaSO_4$).<br>8. Gravimetric determination of calcium as calcium oxalate monohydrate ($CaC_2O_4 \cdot H_2O$).<br>**Inorganic Preparations: (any five)**<br>1. Preparation of copper(I) chloride ($Cu_2Cl_2$ or CuCl).<br>2. Preparation of potassium aluminium sulfate dodecahydrate, $KAl(SO_4)_2 \cdot 12H_2O$ (Potash Alum).<br>3. Preparation of tetraamminecopper(II) sulfate monohydrate, $[Cu(NH_3)_4]SO_4 \cdot H_2O$.<br>4. Preparation of potassium tris(oxalato)ferrate(III), $K_3[Fe(C_2O_4)_3]$.<br>5. Preparation of bis(acetylacetonato)copper(II), $Cu(C_5H_7O_2)_2$.<br>6. Preparation of bis(dimethylglyoximato)nickel(II), $Ni(DMG)_2$ or $Ni[C_4H_7N_2O_2]_2$.<br>7. Preparation of iron(III) hexacyanoferrate(II), $Fe_4[Fe(CN)_6]_3$ (Prussian Blue). |

**Text and Reference Books**

| S.No. | Author(s) | Title of the Book | Publisher/Year |
|---|---|---|---|
| 1 | Vogel, A.I. | Vogel's book on Quantitative Analysis | ELBS, 1986 |
| 2 | Marr, G. and Rockett, B.W. | Practical Inorganic Chemistry | 1972 |

**Course Outcomes and Mapping**

At the end of the course, the student will be able to

**CO1.** Understand the concept of quantitative analysis.

**CO2.** Understand the various techniques/principles involved in the quantitative analysis for present metal ions.

**CO3.** Learn to synthesize various inorganic compounds

**CO4.** Develop laboratory skills related to observation, calculation, data interpretation, and safe chemical handling.

**CO5.** Supplement and reinforce chemical principles taught in the theory units.

| | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 | PSO7 |
|---|---|---|---|---|---|---|---|
| CO1 | 3 | 2 | 1 | 2 | 2 | 1 | 2 |
| CO2 | 1 | 2 | 2 | 2 | 1 | 0 | 1 |
| CO3 | 2 | 1 | 1 | 2 | 2 | 1 | 2 |
| CO4 | 2 | 3 | 3 | 2 | 2 | 2 | 1 |
| CO5 | 1 | 2 | 2 | 2 | 3 | 1 | 2 |

| I.K. GUJRAL PUNJAB TECHNICAL UNIVERSITY<br>DEPARTMENT OF CHEMISTRY | | | | |
|---|---|---|---|---|
| **Course Name** | **B.Sc. (Honours) Chemistry** | | | |
| **Subject Code:** | **BHCP218-25** | | | |
| **Subject Title:** | **PHYSICAL CHEMISTRY LAB-III (Chemical Kinetics, Solutions and Macromolecules Lab)** | | | |
| **Contact Hours:** | **L:0** | **T:0** | **P:4** | **Credits:2** |
| **Examination Duration (hours)** | **4** | | | |
| **Objective(s):** | To provide students practical knowledge and skills about various topics taught in theory class of physical chemistry, which in turn will enhance their problem solving and analytical skills. | | | |

**Details of the Course**

| Unit | Contents |
|---|---|
| | 1. Determination of rate constant of hydrolysis of methyl acetate catalyzed by acid and also the energy of activation.<br>2. Compare the relative strengths of the acids by studying kinetics of hydrolysis of methyl acetate.<br>3. Study the hydrolysis of methyl acetate catalyzed by HCl and equimolar urea hydrochloride, and hence the degree of hydrolysis of the salt.<br>4. Investigate the reaction between hydrogen peroxide and hydrogen iodide.<br>5. Study the kinetics of the saponification of ethyl acetate.<br>6. Investigate the reaction between acetone and iodine.<br>7. Investigate the adsorption of oxalic acid from aqueous solution by activated charcoal.<br>8. Verify the Freundlich and Langmuir isotherms for adsorption of acetic acid on activated charcoal.<br>9. Determination of Molecular weight of polymers by viscosity measurements.<br><br>*Any other experiment related to chemical kinetics carried out in the class.* |

**Reference Books**

| S.No. | Author(s) | Title of the Book | Publisher |
|---|---|---|---|
| 1 | J.B. Yadav | Practical Physical Chemistry | Krishna |
| 2 | B. D. Khosla, V. C. Garg, & A. Gulati, | Senior Practical Physical Chemistry | R. Chand & Co. New Delhi (2011) |
| 3 | V. D. Athawale, & P. Mathur, | Experimental Physical Chemistry | New Age International: New Delhi (2001) |

**Course Outcomes and Mapping**

At the end of the course, the students will be able to

**CO1.** Understand the basic procedures for carrying out a physical chemistry practical like preparation and standardisation of solutions, handling the equipments and measuring with precision.

**CO2.** Correlate the theoretical and practical aspects and know about the limits of the experimental error.

**CO3.** Determine the various physical parameters for the various problems under study.

**CO4.** Verify various laws studied in the theory part.

| | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 | PSO7 |
|---|---|---|---|---|---|---|---|
| CO1 | 1 | 3 | 3 | 3 | 3 | 3 | 3 |
| CO2 | 2 | 2 | 3 | 3 | 3 | 2 | 2 |
| CO3 | 2 | 3 | 3 | 2 | 2 | 3 | 3 |
| CO4 | 2 | 3 | 3 | 1 | 2 | 2 | 3 |

| I.K. GUJRAL PUNJAB TECHNICAL UNIVERSITY<br>DEPARTMENT OF CHEMISTRY | | | | |
|---|---|---|---|---|
| **Course Name** | **B.Sc.(Honours) Chemistry** | | | |
| **Subject Code:** | **BHCP219-19** | | | |
| **Subject Title:** | **BASIC ANALYTICAL CHEMISTRY LAB-III** | | | |
| **Contact Hours:** | **L:0** | **T:0** | **P:4** | **Credits:2** |
| **Examination Duration (hours)** | **3** | | | |
| **Objective(s):** | To provide students practical knowledge and skills about various topics taught in theory class of basic analytical chemistry, which in turn will enhance their problem solving and analytical skills. | | | |

**Details of the Course**

| Unit | Contents |
|---|---|
| | 1. Importance of significant figures and standard deviations<br>2. Determination of pH of soil samples.<br>3. Estimation of Calcium and Magnesium ions as Calcium carbonate by complexometric titration.<br>4. Determination of pH, acidity and alkalinity of a water sample.<br>5. Determination of dissolved oxygen (DO) of a water sample.<br>6. Identification of adulterants in some common food items like coffee powder, asafoetida, chilli powder, turmeric powder, coriander powder and pulses, etc.<br>7. Analysis of preservatives and colouring matter.<br>8. Paper chromatographic separation of mixture of metal ion ($Fe^{3+}$ and $Al^{3+}$).<br>9. Analysis of deodorants and antiperspirants, Al, Zn, boric acid, chloride, sulphate.<br>10. Spectrophotometric determination of Iron in Vitamin / Dietary Tablets.<br>11. Spectrophotometric Identification and Determination of Caffeine and Benzoic Acid in Soft Drink. |

**Reference Books**


1. Harris, D. C. *Quantitative Chemical Analysis*, W. H. Freeman.
2. Dean, J. A. *Analytical Chemistry Notebook*, McGraw Hill.


**Course Outcomes and Mapping**

At the end of the course, the students will be able to

**CO1.** Identify the adulterants in common food items.
**CO2.** Analyse samples of soil (pH) and water (pH, acidity, alkalinity etc)
**CO3.** Learn the paper chromatographic technique for separation of metal ions.
**CO4.** Learn the spectrpphotometric determination of compounds in commercial products.

| | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 | PSO7 |
|---|---|---|---|---|---|---|---|
| CO1 | 1 | 3 | 3 | 3 | 3 | 3 | 3 |
| CO2 | 2 | 2 | 3 | 3 | 3 | 2 | 2 |
| CO3 | 2 | 1 | 2 | 2 | 2 | 1 | 1 |
| CO4 | 2 | 3 | 3 | 1 | 2 | 2 | 3 |

| I.K. GUJRAL PUNJAB TECHNICAL UNIVERSITY<br>DEPARTMENT OF CHEMISTRY | | | | |
|---|---|---|---|---|
| **Course Name** | **B.Sc. (Honours) Chemistry** | | | |
| **Subject Code:** | **UGCA1921** | | | |
| **Subject Title:** | **Software Engineering** | | | |
| **Contact Hours:** | **L:3** | **T:1** | **P:0** | **Credits:4** |
| **Examination Duration (hours)** | **3** | | | |
| **Objective(s):** | - | | | |

**Course Outcomes:** Students will be able to

| CO# | Course outcomes |
|---|---|
| CO1 | Highlight the need of software engineering |
| CO2 | Outline the phases and activities involved in the conventional software life cycle models |
| CO3 | Design documents for various phases of software life cycle. |
| CO4 | Compute the complexity of the software based on multiple metrices. |
| CO5 | Identify the tools needed for different types of documents required in software engineering. |

| Detailed contents | Contact hours |
|---|---|
| **Unit 1**<br><br>The Nature of Software, Need of Software Engineering, Prescriptive Process Models, Specialized Process Models, The Unified Process. [CO1] | 10 |
| **Unit 2**<br><br>Role of a system analyst, SRS, Properties of a good SRS document, functional and non-functional requirements, Decision tree and Decision table, Formal Requirements Specification, Software Cost Estimation. [CO2] | 10 |

| | |
|---|---|
| **Unit 3**<br><br>Software design and its activities, Preliminary and detailed design activities, Characteristics of a good software design, Features of a design document, Cohesion and Coupling, Structured Analysis, Function Oriented Design, Object-Oriented Design. [CO3] | 12 |
| **Unit 4**<br><br>Testing Fundamentals, Unit Testing, Integration Testing, Validation Testing, System Testing, Maintenance and Reengineering, Measures, Metrics, and Indicators, Software Measurement, Metrics for Requirements Model, Metrics for Design Model, Metrics for Testing, Metrics for Maintenance. [CO4] [CO5] | 12 |

**Text Books:**


1. Software Engineering–A Practitioner's Approach, Roger S.Pressman, Seventh Edition, McGrawHill, 2010.


**Reference Books:**


1. An Integrated Approach to Software Engineering, Pankaj Jalota, Third Edition, Narosa Publishing House, 2005
2. Software Engineering, Ian Sommerville, Ninth Edition, Addison-Wesley, 2011

# Semester V

| I.K. GUJRAL PUNJAB TECHNICAL UNIVERSITY<br>DEPARTMENT OF CHEMISTRY | | | | |
|---|---|---|---|---|
| **Course Name** | **B.Sc. (Honours) Chemistry** | | | |
| **Subject Code:** | **BHCL301-25** | | | |
| **Subject Title:** | **Inorganic Chemistry-IV (Organometallic Chemistry and Reaction Mechanism)** | | | |
| **Contact Hours:** | **L:3** | **T:1** | **P:0** | **Credits:4** |
| **Examination Duration (hours)** | **3** | | | |
| **Objective(s):** | 1. To provide students with a comprehensive understanding of organometallic compounds, including their bonding, structure, electron counting, and reactivity.<br>2. To develop knowledge of reaction kinetics and mechanisms in coordination chemistry. | | | |

**Details of the Course**

| Unit | Contents | Contact Hours |
|---|---|---|
| I | **Introduction of Organometallic Compounds:** Definition and classification of organometallic compounds on the basis of bond type, Concept of hapticity of organic ligands, 18 electron rule, electron count, Compliance and violation of 18-electron rule.<br>**Metal carbonyls I:** General methods of preparation (direct combination, reductive carbonylation, thermal and photochemical decomposition) of mono and binuclear carbonyls of 3d series, Bonding in metal carbonyls, Bonding modes of carbonyls, pi-acceptor behaviour of CO (MO diagram of CO to be discussed),<br>synergic effect and use of IR data to explain extent of back bonding. | 10 |
| II | **Metal carbonyls II:** Reactions of Metal Carbonyls: Displacement reactions, additions reaction, redox reactions. Structures of mononuclear, binuclear, trinuclear and tetranuclear carbonyls. Electron count of mononuclear, polynuclear and substituted metal carbonyls of 3d series.<br>**Metal olefin complexes**: Introduction, Models of ethylene-metal bonding and MO treatment, Synthesis of metal-alkene complexes, Reactions of metal bound alkenes: Zeise's salt: Preparation and structure, evidences of synergic effect and comparison of synergic effect with that in carbonyls. | 11 |
| III | **Metal Alkyls:** Important structural features of methyl lithium (tetramer) and trialkyl aluminium (dimer), concept of multicentre bonding in these compounds. Role of triethylaluminium in polymerisation of ethene (Ziegler-Natta Catalyst). Species present in ether solution of Grignard reagent and their structures, Schlenk equilibrium.<br>**Metallocenes and sandwich complexes**: Structure of the metallocenes , Redox properties of the sandwich metallocenes ,Metallocene synthesis, Chemical properties of Metallocenes, Triple- and multiple-decker | 12 |

| | | |
|---|---|---|
| | sandwich complexes, Non-sandwich metallocenes derivatives, Metal-bis-arene sandwich complexes, Cylopentadienyl-metal-arene complexes. Preparations of Metal-carbene complexes, Metal-carbyne complexes, structures and reactions. | |
| IV | **Reaction Kinetics and Mechanism:** Introduction, Substitution reactions in octahedral complexes: Dissociative (SN1) and associative mechanism (SN2), types of intermediates in SN1 and SN2. Lability and inertness of coordination complexes, Interpretation of lability and inertness of transition metal complexes using valence bond theory and Crystal field theory.<br>Acid hydrolysis of octahedral complexes: Mechanism, when inert ligand without pi donor and acceptor, with intert ligand, pi donor and pi acceptor.<br>Base hydrolysis of octahedral complexes: Base hydrolysis and conjugate base hydrolysis.<br>Substitution reactions in square planar complexes: Trans-effect, theories of *trans*-effect, mechanism of nucleophilic substitution in square planar complexes. | 12 |

**Text Books**

| S.No. | Author(s) | Title of the Book | Publisher/Year |
|---|---|---|---|
| 1 | Huheey, J.E. | Inorganic Chemistry | Prentice Hall, 1993 |
| 2 | Puri, B.R., Sharma, L.R. and Kalia, K.C. | Principles of Inorganic Chemistry | Milestone |

**Reference Books**

1

| S.No. | Author(s) | Title of the Book | Publisher/Year |
|---|---|---|---|
| 1 | C.E.A. salzer | Organometallics: A Concise Introduction | 2nd Edn., 1992. |
| 2 | B. D. gupta and A.J. Elias | Basic Organometallic Chemistry, Concept, Synthesis and Application, 2ndEdn | 1992 |
| 3 | Lippard, S.J. & Berg, J.M. | Principles of Bioinorganic Chemistry | Panima Publishing Company 1994 |
| 4 | Cotton, F.A. & Wilkinson, G. | Advanced Inorganic Chemistry | Wiley-VCH, 1999 Purcell |
| 5 | Spessard, Gary O., &Gary L. Miessler | Organometallic Chemistry | Prentice-Hall, 1996 |
| 6 | Miessler, G. L. & Donald, A. Tarr | Inorganic Chemistry 4th Ed. | Pearson, 2010 |

**Course Outcomes and Mapping**

At the end of the course, the student will be able to

CO1. Understand the fundamental concepts of various concepts involved in organometallic compounds
CO2. Learn different methods of preparations and various chemical reactions of organometallic compounds
CO3. Understand the kinetics involved in the different reactions.
CO4. Learn about the catalytic applications of organometallic compounds.

| | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 | PSO7 |
|---|---|---|---|---|---|---|---|
| CO1 | 1 | 2 | 3 | 2 | 3 | 1 | 2 |
| CO2 | 2 | 3 | 3 | 3 | 2 | 3 | 2 |
| CO3 | 3 | 2 | 3 | 2 | 2 | 2 | 2 |
| CO4 | 3 | 2 | 3 | 2 | 3 | 2 | 3 |

| I.K. GUJRAL PUNJAB TECHNICAL UNIVERSITY<br>DEPARTMENT OF CHEMISTRY | | | | |
|---|---|---|---|---|
| **Course Name** | **B.Sc. (Honours) Chemistry** | | | |
| **Subject Code:** | **BHCL302-25** | | | |
| **Subject Title:** | **Organic Chemistry-III (Heterocyclic Chemistry)** | | | |
| **Contact Hours:** | **L:3** | **T:1** | **P:0** | **Credits:4** |
| **Examination Duration (hours)** | **3** | | | |
| **Objective(s):** | The objective of this course is to develop basic understanding of heterocyclic chemistry. Emphasis is given on the most important heterocyclic systems particularly five and six-membered heterocyclic systems, small ring heterocycles as well as fused heterocyclic systems. | | | |

**Details of the Course**

| Unit | Contents | Contact Hours |
|---|---|---|
| I | **Introduction and Five-Membered Aromatic Heterocyclic Systems**<br>*Introduction to heterocyclic compounds:* classification, Systematic (Hantzsch-Widman System), trivial and replacement nomenclature system for monocyclic and fused heterocycles.<br>*Aromaticity in heterocycles*: Relationship with carbocyclic aromatic compounds and structural criteria, structure of six-membered and five membered rings with one heteroatom.<br><br>Structure, aromaticity, synthesis and chemical reactions of Pyrrole, Furan and Thiophene: Electrophilic substitution reactions in five-membered heteroaromatic systems. Synthesis of five-membered heterocycles: Paal–Knorr synthesis, Knorr pyrrole and Hanzsch synthesis of pyrrole, furan and thiophene.<br><br>Applications of five-membered heterocycles in pharmaceuticals and natural products. | 12 |
| II | **Six-Membered Aromatic Heterocyclic Systems**<br>Aromaticity and electronic structure of six-membered heterocyclic compounds. Structure, synthesis and chemical reactions of: Pyridine, Pyridazine, Pyrimidine and Pyrazine. Electrophilic and nucleophilic substitution reactions in pyridine and diazines. Hantzsch synthesis of pyridine.<br>Structure and biological significance of purines and pyrimidines. Chemistry of biologically important heterocyclic compounds: adenine, guanine, uracil, thymine and caffeine.<br>Applications of six-membered heterocycles in medicinal chemistry and biomolecules. | 11 |
| III | **Non-Aromatic Heterocyclic Systems**<br>Introduction to non-aromatic and saturated heterocyclic compounds. Ring strain and reactivity of small-ring heterocycles. Structure, synthesis and reactions of three-membered heterocycles: Oxirane (epoxide), Aziridine, Thiirane. Ring-opening reactions of three-membered heterocycles. | 10 |

| | | |
|---|---|---|
| | Introduction to four-membered heterocycles: Oxetane, Azetidine, Thietane (Synthesis and reactions).<br>Conformations and stereochemistry of six-membered saturated heterocycles: piperidine, morpholine and 1,4-dioxane. Introduction to stereoelectronic and anomeric effects in heterocyclic systems. | |
| IV | **Benzo-Fused Heterocyclic Systems and Applications**<br>*Structure, aromaticity, synthesis and chemical reactions of benzo-fused heterocyclic compounds:* Indole, Quinoline, Isoquinoline, Benzofuran, Benzothiophene. Electrophilic and nucleophilic substitution reactions in benzo-fused heterocyclic systems. Oxidation and reduction reactions of benzo-fused heterocycles.<br>Heterocyclic compounds in medicinal chemistry, dyes, agrochemicals and conducting materials. *Introduction to green approaches in heterocyclic synthesis:* microwave-assisted and solvent-free synthesis methods. | 12 |

**Text Books**

| S.No. | Author(s) | Title of the Book | Publisher/Year |
|---|---|---|---|
| 1. | R.R. Gupta, M. Kumar and V. Gupta | Heterocyclic Chemistry I, II & III | Springer |
| **Reference Books** | | | |
| 1 | J. A. Joule, K. Mills and G. F. Smith | Heterocyclic Chemistry, 3rd & 5th edition | A John Wiley & Sons, Ltd., Publication |
| 2 | T. L. Gilchrist | Heterocyclic Chemistry | Longman Scientific Technical |
| 3 | T. Eicher, S. Hauptmann, and A. Speicher | The chemistry of Heterocyclic Chemistry | Wiley-VCH |
| 4 | G. R. Newkome and W.W. Paudler, | Contemporary Heterocyclic Chemistry | Wiley-Inter Science |
| 5 | R. M. Acheson | An Introduction to Heterocyclic Compounds | John Wiley |
| 6 | A. Paquett | Heterocyclic Chemistry | - |

**Course Outcomes and Mapping**

At the end of the course, the student will be able to

CO1. Know about the most important heterocyclic ring systems containing heteroatom and their systems of nomenclature and numbering.

CO2. Understand and discuss the reactivity and stability of hetero aromatic compounds.

CO3. Study the important synthetic routes and reactivity for five and six member hetero aromatic compounds.

CO4. Understand the important chemical properties of five and six member hetero aromatic compounds.

CO5. Learn the synthesis and chemical reactions of small ring and Benzo-fused heterocycles.

| | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 | PSO7 |
|---|---|---|---|---|---|---|---|
| CO1 | 4 | 1 | 3 | - | 1 | 3 | 1 |
| CO2 | 4 | 1 | 3 | - | 2 | 3 | - |
| CO3 | 3 | 3 | 2 | - | 3 | 2 | 1 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| CO4 | 3 | 3 | 2 | - | 3 | 2 | 1 |
| CO5 | 2 | 3 | 3 | - | 2 | 3 | - |

| I.K. GUJRAL PUNJAB TECHNICAL UNIVERSITY<br>DEPARTMENT OF CHEMISTRY | | | | |
|---|---|---|---|---|
| **Course Name** | **B.Sc. (Honours) Chemistry** | | | |
| **Subject Code:** | **BHCL303-19** | | | |
| **Subject Title:** | **QUANTUM CHEMISTRY** | | | |
| **Contact Hours:** | **L:3** | **T:1** | **P:0** | **Credits:4** |
| **Examination Duration (hours)** | **3** | | | |
| **Objective(s):** | This course will equip students with the necessary knowledge concerning the quantum mechanical concepts in chemistry. The problem solving skills of students are expected to be enhanced through due weightage given to numerical problems in each unit. | | | |

**Details of the Course**

| Unit | Contents | Contact Hours |
|---|---|---|
| I | Classical Mechanics vs quantum mechanics, Postulates of quantum mechanics, quantum mechanical operators, Schrödinger equation and its application to free particle and particle-in-a-box, quantization of energy levels, zero-point energy and Heisenberg Uncertainty principle; wavefunctions, probability distribution functions, nodal properties, Extension to two and three dimensional boxes, separation of variables, degeneracy.<br><br>Qualitative treatment of simple harmonic oscillator model of vibrational motion: Setting up of Schrödinger equation and discussion of solution and wavefunctions. Vibrational energy of diatomic molecules and zero-point energy. | 13 |
| II | Rigid rotator model of rotation of diatomic molecule. Schrödinger equation, transformation to spherical polar coordinates. Separation of variables. Spherical harmonics. Discussion of solution.<br><br>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) Radial and angular parts of the hydrogen atomic wave functions (atomic orbitals) and their variations for 1s, 2s, 2p, 3s, 3p and 3d orbitals. Significance of Quantum numbers. | 10 |
| III | Chemical bonding: Covalent bonding, valence bond and molecular orbital approaches, LCAO-MO treatment of H2. Bonding and antibonding orbitals. Qualitative extension to $H2^{+}$.<br>Qualitative description of LCAO-MO treatment of diatomic molecules: Term symbols and Molecular orbital for homonuclear and heteronuclear (CO, HF, LiH) molecules.<br>Comparison of LCAO-MO and VB treatments of H2 (only wavefunctions, detailed solution not required) and their limitations. | 10 |

| | | |
|---|---|---|
| IV | **Photochemistry**<br>Characteristics of electromagnetic radiation, Lambert-Beer's law and its limitations, physical significance of absorption coefficients. Laws, of photochemistry, quantum yield, actinometry, examples of low and high quantum yields, photochemical equilibrium and the differential rate of photochemical reactions, photosensitised reactions, quenching. Role of photochemical reactions in biochemical processes, photostationary states, chemiluminescence. | 12 |

**Reference Books**

| S.No. | Author(s) | Title of the Book | Publisher/Year |
|---|---|---|---|
| 1 | G.M. Barrow | Physical Chemistry | Tata McGraw-Hill: New Delhi (2007) |
| 2 | A. K. Chandra | Introductory Quantum Chemistry | Tata McGraw-Hill (2001). |
| 3 | J. E. House | Fundamentals of Quantum Chemistry 2nd Ed. | Elsevier: USA (2004). |
| 4 | J. P. Lowe & K.Peterson, | Quantum Chemistry | Academic Press (2005). |
| 5 | G.W. Castellan | Physical Chemistry 4th Ed | Narosa (2004) |

**Course Outcomes and Mapping**

At the end of the course, the student will be able to

**CO1.** be able to explain how quantum mechanical systems differ from classical systems.

**CO2.** interpret the physical significance of the wave functions and energy levels derived by solving the time-independent Schrödinger equation.

**CO3.** understand and be able to explain the origin of quantized energy levels.

**CO4.** relate the energy levels obtained as solutions to the time-independent Schrödinger equation for different systems with spectroscopic techniques.

**CO5.** Understand the origin of theories used to describe the covalent bonding especially for diatomic molecules.

**CO6.** learn the various laws of photochemistry and explain the various processes behind photochemical reactions.

| | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 | PSO7 |
|---|---|---|---|---|---|---|---|
| CO1 | 3 | 1 | 1 | - | 2 | 1 | 1 |
| CO2 | 3 | 2 | 3 | - | 1 | - | 1 |
| CO3 | 2 | 2 | 1 | - | 2 | 1 | 1 |
| CO4 | 3 | 2 | 2 | - | 2 | 1 | 1 |
| CO5 | 3 | 2 | 2 | - | 1 | - | 1 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| CO6 | 2 | 2 | 1 | - | 2 | 1 | 1 |

| I.K. GUJRAL PUNJAB TECHNICAL UNIVERSITY<br>DEPARTMENT OF CHEMISTRY | | | | |
|---|---|---|---|---|
| **Course Name** | **B.Sc. (Honours) Chemistry** | | | |
| **Subject Code:** | **BHCL304-19** | | | |
| **Subject Title:** | **ANALYTICAL CLINICAL BIOCHEMISTRY** | | | |
| **Contact Hours:** | **L:3** | **T:1** | **P:0** | **Credits:4** |
| **Examination Duration (hours)** | **3** | | | |
| **Objective(s):** | **Basic understanding of the structures, properties and functions of carbohydrates, lipids and proteins and the analysis of biochemistry of diseases using Blood and Urine.** | | | |

**Details of the Course**

| Unit | Contents | Contact Hours |
|---|---|---|
| I | **Carbohydrates:** Classification, Types and Biological importance of Monosaccharides, Disaccharides, Polysaccharides and Glycosaminoglycans. Metabolism, Cellular currency of energy (ATP), Glycolysis, Alcoholic and Lactic acid fermentations, Krebs cycle. Isolation and characterization of polysachharides. | 10 |
| II | **Proteins:** Classification, biological importance; Primary and secondary and tertiary structures of proteins- α-helix and β- pleated sheets, Isolation, characterization and denaturation of proteins.<br><br>**Enzymes:** Nomenclature, classification, Characteristics (mention of Ribozymes), Active site, Mechanism of enzyme action, Stereospecificity of enzymes, Coenzymes and cofactors, Enzyme inhibitors, effect of pH, temperature on enzyme activity, enzyme inhibition. Biocatalysis. | 11 |
| III | **Lipids:** Classification. Biological importance of triglycerides and phosphoglycerides and cholesterol; Lipid membrane, Liposomes and their biological functions and underlying applications.<br><br>**Lipoproteins:** Properties, functions and biochemical functions of steroid hormones. Biochemistry of peptide hormones.<br><br>**Nucleic Acids:** Structure of DNA (Watson-Crick model) and RNA, Genetic Code, Biological roles of DNA and RNA: Replication, Transcription and Translation, Introduction to Gene therapy. | 11 |

| | | |
|---|---|---|
| IV | **Biochemistry of disease:** A diagnostic approach by blood/ urine analysis.<br><br>**Blood:** Composition and functions of blood, blood coagulation. Blood collection and preservation of samples. Estimation and interpretation of data for blood sugar, urea, creatinine, cholesterol and bilirubin. Normal constituents of blood and their estimation and variation in pathological conditions - urea, uric acid, creatinine, glucose, bilirubin, total protein, albumin/globulin ratio. Lipid profile – cholesterol, triglycerides, lipoproteins - HDL and LDL.<br><br>**Urine:** Collection and preservation of samples. Normal composition of urine – volume, pH, colour, specific gravity. Constituents-urea, uric acid, creatinine, pigment. Abnormal constituents – glucose, albumin, ketone bodies, variations in urea, creatinine, pigments and their clinical significance in brief. Uremia, hyperuricemia, porphyria and factors affecting nitrogen balance. | 13 |

**Reference Books**


1. Lippincott's illustrated biochemistry – Champe and Harvey; 6th edition 2007.
2. D.Voet and J.G. Voet: Fundamentals of Biochemistry, John Wiley & Sons, USA 2004.
3. Albert L. Lehninger Principles of Biochemistry CBS Publishers & Distributors, New Delhi.
4. Nelson, D. L. & Cox, M. M. :Lehninger's Principles of Biochemistry 7th Ed., W. H. Freeman.
5. Berg, J. M., Tymoczko, J. L. & Stryer, L. Biochemistry 7th Ed., W. H. Freeman.
6. O. Mikes, R.A. Chalmers: Laboratory Handbook of Chromatographic Methods.
7. M.N.Chatterjea and Ranashinde: Text book of Medical biochemistry. Jaypee Brothers Medical Publisher (P) Ltd.


**Course Outcomes and Mapping**

At the end of the course, the student will be able to

CO1. Understand the structure & functions of Biomolecules.
CO2. An advanced understanding and applied knowledge of the theory of clinical biochemistry.
CO3. A critical understanding of how biochemical investigations are employed to develop a clinical diagnosis.
CO4. To gain knowledge and understanding of clinical disorders.
CO5. To gain knowledge of biological samples and their collection procedures.

| | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 | PSO7 |
|---|---|---|---|---|---|---|---|
| CO1 | 2 | 3 | 2 | 2 | 3 | 2 | 2 |
| CO2 | 2 | 3 | 3 | 3 | 2 | 3 | 3 |
| CO3 | 3 | 2 | 3 | 3 | 2 | 2 | 3 |
| CO4 | 3 | 2 | 3 | 2 | 3 | 2 | 3 |
| CO5 | 3 | 2 | 2 | 3 | 2 | 3 | 3 |

| I.K. GUJRAL PUNJAB TECHNICAL UNIVERSITY<br>DEPARTMENT OF CHEMISTRY | | | | |
|---|---|---|---|---|
| **Course Name** | **B.Sc. (Honours) Chemistry** | | | |
| **Subject Code:** | **BHCL305-25** | | | |
| **Subject Title:** | **INDUSTRIAL CHEMICALS AND ENVIRONMENT** | | | |
| **Contact Hours:** | **L:3** | **T:1** | **P:0** | **Credits:4** |
| **Examination Duration (hours)** | **3** | | | |
| **Objective(s):** | The objective of this course is to make students aware about the concepts of different gases and their industrial production, uses, storage and hazards; Manufacturing, applications, analysis and hazards of the Inorganic Chemicals, Preparation of Ultra-Pure metals for semiconducting technology, Air and Water pollution, control measures for Air and Water Pollutants, Catalyst and Biocatalyst, Energy and Environment. | | | |

**Details of the Course**

| Unit | Contents | Contact Hours |
|---|---|---|
| I | **Industrial Gases and Inorganic Chemicals**<br><br>*Industrial Gases:* Large scale production, uses, storage and hazards in handling of the following gases: oxygen, nitrogen, argon, neon, helium, hydrogen, acetylene, carbon monoxide, chlorine, fluorine and sulphur dioxide<br>*Inorganic Chemicals:* Manufacture, application, analysis and hazards in handling the following chemicals: hydrochloric acid, nitric acid, sulphuric acid, caustic soda, borax, bleaching powder, sodium thiosulphate, hydrogen peroxide, potassium dichromate and potassium permanganate.<br>*Industrial Metallurgy*: Preparation of ultrapure metals for semiconductor technology. | 12 |
| II | **Environment and its segments**<br><br>Ecosystems. Biogeochemical cycles of carbon, nitrogen and sulphur.<br><br>*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., Major sources of air pollution, Pollution by $SO_2$, $CO_2$, CO, $NO_x$, and $H_2S$ gases. Methods of estimation of CO, $NO_x$, $SO_x$ 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. | 11 |

| | | |
|---|---|---|
| III | **Water Pollution**<br><br>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.<br><br>Water purification methods. Effluent treatment plants (primary, secondary and tertiary treatment). Industrial effluents from the following industries and their treatment: electroplating, textile, tannery, dairy, petroleum and petrochemicals, Agro-fertilizer, etc.<br><br>Sludge disposal, Industrial waste management, incineration of waste. Water treatment and purification (reverse osmosis, electro dialysis, ion exchange). Water quality parameters for waste water, industrial water and domestic water. | 10 |
| IV | **Energy & Environment**<br><br>Sources of energy: Coal, petrol and natural gas. Nuclear Fusion / Fission, Solar energy, Hydrogen, geothermal, Tidal and Hydel, etc.<br><br>Nuclear Pollution: Disposal of nuclear waste, nuclear disaster and its management. E-waste and its Management<br><br>**Biocatalysis**<br><br>Introduction to biocatalysis: Importance in "Green Chemistry" and Chemical Industry. | 12 |

**Text Books**


1. Rose Philo K.J. & Joyes Jacob., (2023). Industrial Chemicals & Environment, Vishal Publishing Co.
2. Lawrence Stephenson (2022). Industrial chemicals and Environment (2022), Kaufman press


**Reference Books**


1. Manahan, S.E. (2017),Environmental Chemistry, CRC Press.
2. Buchel, K.H.; Moretto, H.H.; Woditsch, P.(2003),Industrial Inorganic Chemistry, Wiley-VCH.
3. De, A.K.(2012), Environmental Chemistry, New Age International Pvt., Ltd.
4. Khopkar, S.M.(2010), Environmental Pollution Analysis, New Age International Publisher.
5. Rai, G.D., Non-Conventinal Energy Resources, Khanna Publications.

**Course Outcomes and Mapping**

At the end of the course, the student will be able to understand

**CO1.** different toxic gases and their toxicity hazards, Safe design systems for large scale production of Industrial gases.

**CO2.** manufacturing processes, handling and storage of inorganic chemicals and knowledge of Hazardous effects of the inorganic chemicals on human beings and vegetation.

**CO3.** the requirement of ultra-pure metals for the semiconducting technologies.

**CO4.** different sources, effects and control measures of air, water pollutants, water quality parameters, different methods of Treatment of effluents from different sources.

**CO5.** different sources of energy, source of nuclear waste and its disposal. Use of biocatalyst in chemical industries.

| | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 | PSO7 |
|---|---|---|---|---|---|---|---|
| CO1 | 3 | 3 | 3 | 4 | 2 | 3 | 1 |
| CO2 | 2 | 3 | 4 | 5 | 3 | 3 | 3 |
| CO3 | 3 | 3 | 3 | 2 | 2 | 2 | 2 |
| CO4 | 2 | 3 | 3 | 5 | 4 | 3 | 3 |
| CO5 | 3 | 2 | 4 | 5 | 3 | 4 | 3 |

| I.K. GUJRAL PUNJAB TECHNICAL UNIVERSITY<br>DEPARTMENT OF CHEMISTRY | | | | |
|---|---|---|---|---|
| **Course Name** | **B.Sc. (Honours) Chemistry** | | | |
| **Subject Code:** | **BHCL306-25** | | | |
| **Subject Title:** | **LIGAND FIELD THEORY** | | | |
| **Contact Hours:** | **L:3** | **T:1** | **P:0** | **Credits:4** |
| **Examination Duration (hours)** | **3** | | | |
| **Objective(s):** | To teach the concepts of ligand field theory and their applications. | | | |

**Details of the Course**

| Unit | Contents | Contact Hours |
|---|---|---|
| I | **Group Thoery:**<br>Symmetry elements, symmetry operations, point group determination(flow chart), order and class of point group, determination of reducible and irreducible representations, multiplication tables and derivation of character tables for $C_{2V}$, $C_{3V}$ etc. Great orthogonality theorem, Mullikens notation.<br><br>**Applications:** use of character table to find out the symmetry species of the normal modes of vibration of a molecule and to identify the infrared (IR) and Raman active modes. Use of group theory in determining and hybridization of atomic orbitals. | 13 |
| II | **Crystal Field Theory:** Evaluation of $V_{(x,\ y,\ z)}$, $V_{oct.}$, $V_{sq,\ pl.}$ and $V_{tetragonal}$, evaluation of $V_{oct.}$ in cartesian co- ordinates, effect of $V_{oct}$ on d-orbital wave functions.<br><br>**Interelectronic Repulsions:** Determination of microstates in electronic configuration of $p^n$ , $d^n$ and $f^n$. Atomic Term Symbols: spin-spin (s-s interaction), orbital-orbital (l-l coupling) and spin orbital coupling (L-S coupling and jj coupling schemes), determination of all the spectroscopic terms of $p^n$ , $d^n$ ions, determination of the ground state terms for $p^n$ , $d^n$ , $f^n$ ions using L.S. scheme, hole formulation, determination of total degeneracy of terms, spin orbit coupling parameters ($\lambda$) energy separation between different j states. | 10 |
| III | **Free Ions in Weak Crystal Field:** The effect of $V_{oct}$ on S, P, D and F terms (with help of the character table and qualitatively), splitting patterns of and G, H and I terms.<br><br>**Free Ions in Medium and Strong Crystal Fields**: Selection rules of elecronic transitions in transition metal complexes, ( Laporte allowed and forbidden, relaxation of the selection rule), splitting of Russell Saunders states of octahedral and tetrahedral crystal fields. Orgel diagrams from $d^1$- $d^9$ configuration, Transition from weak to strong | 10 |

| | | |
|---|---|---|
| | crystal fields, qualitative correlation diagram of octahedral and tetrahedral complexes of $d^1$- $d^9$ and $d^2$- $d^8$. | |
| IV | **Electronic Spectra of Transition Metal Complexes**:<br>Tanabe Sugano diagrams of $d^2$ ( interaction of $T_{1g}$ (P) and $T_{1g}$(F) terms). Variation of the Racah parameter, nephlauxetic effect, spectrochemical series, calculation of 10Dq and B, Jahn-Teller effect,<br>Discussion of electronic spectra of octahedral and tetrahedral metal ions of first series - low spin complexes of $Mn^{3+}$, $Mn^{2+}$, $Fe^{3+}$, $Co^{3+}$, $Fe^{2+}$, spectra of cis and trans$[Co(en)_2X_2]^+$ , $[Mn(H_2O)_6]^{2+}$, $CuSO_4.5H_2O$, second transition series - spectra of $K_3MoCl_6$ and $[Rh(NH_3)_6]^{3+}$, comparison of d – d band with f – f bands. | 12 |

**Text and Reference Books**


1. B.N. Figgis, Introduction to Ligand Field, Wiley Eastern.
2. A.B.P. Lever, Inorganic Electronic Spectroscopy, Elsevier.
3. A. Earnshaw, Introduction to Magnetochemistry, Academic Press.
4. J.E. Huheey, Inorganic Chemistry Principles of Structure and Reactivity, Harper Inter-Science.
5. R.S. Drago, Physical Method in Chemistry, W.B. Saunders Company.
6. F.A. Cotton and G. Wilkinson, Advanced Inorganic Chemistry, Wiley Inter- science.
7. F.A. Cotton, Chemical Application of Group Theory, Wiley Eastern.


**Course Outcomes and Mapping**

At the end of the course, the student will be able to

CO1. Understand the fundamental concepts of various aspects of Ligand Field Theory
CO2. Learn the different aspects of crystal field theory
CO3. Understand the effect of weak , medium and strong crystal field on free ions
CO4. Learn about the electronic spectra of transition metal complexes
CO5. Understand the factors affecting the electronic spectra of the complexes

| | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 | PSO7 |
|---|---|---|---|---|---|---|---|
| CO1 | 2 | 2 | 2 | 2 | 3 | 3 | 2 |
| CO2 | 2 | 3 | 3 | 3 | 2 | 3 | 3 |
| CO3 | 2 | 3 | 2 | 2 | 1 | 2 | 3 |
| CO4 | 2 | 3 | 3 | 2 | 2 | 2 | 2 |
| CO5 | 3 | 2 | 2 | 3 | 3 | 2 | 3 |

| I.K. GUJRAL PUNJAB TECHNICAL UNIVERSITY<br>DEPARTMENT OF CHEMISTRY | | | | |
|---|---|---|---|---|
| **Course Name** | **B.Sc. (Honours) Chemistry** | | | |
| **Subject Code:** | **BHCP307-25** | | | |
| **Subject Title:** | **Inorganic Chemistry Lab-IV (Volumetric Analysis Laboratory)** | | | |
| **Contact Hours:** | **L:0** | **T:0** | **P:4** | **Credits:2** |
| **Examination Duration (hours)** | **3** | | | |
| **Objective(s):** | To develop practical skills in volumetric analysis through oxidation-reduction, precipitation, and complexometric titrations for the quantitative estimation of various metal ions and compounds. | | | |

**Details of the Course**

| Unit | Contents |
|---|---|
| I | **Oxidation-Reduction Titrations**<br><br>Ceric Sulphate Titrations:<br>(i) Standardisation with Mohr's salt.<br>(ii) Determination of Cu(II)<br>(iii) Determination of oxalates.<br><br>**Precipitation Titrations**<br><br>(i) $AgNO_3$ standardisation by Mohr's method/by using absorption indicator.<br>(ii) Determination of chloride.<br>(iii) Volhard's method for chloride determination.<br><br>**Complexometric Titrations (EDTA)**<br><br>(i) Standardisation of EDTA with $Pb(NO_3)_2$ / $ZnSO_4.7H_2O$<br>(ii) Determination of $Mg^{2+}$<br>(iii) Determination of $Ca^{2+}$ (by substitution method).<br>(iv) Determination of total hardness of water (permanent and temporary)<br>(v) Determination of $Cu^{2+}$ and $Ni^{2+}$ by using masking reagent. |

**Reference Books**

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

**Course Outcomes and Mapping**

At the end of the course, the student will be able to
CO1. Understand the concept of quantitative analysis.
CO2. Learn to estimate the present cations through quantitative analysis
CO3. Understand the various techniques/principles involved in the quantitative analysis present metal ions.
CO4. Learn to perform the volumetric analysis using different methods.

| | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 | PSO7 |
|---|---|---|---|---|---|---|---|
| CO1 | 2 | 2 | 3 | 2 | 3 | 2 | 2 |
| CO2 | 2 | 2 | 3 | 3 | 3 | 3 | 2 |
| CO3 | 3 | 3 | 3 | 2 | 2 | 2 | 2 |
| CO4 | 2 | 3 | 1 | 3 | 2 | 2 | 3 |

| I.K. GUJRAL PUNJAB TECHNICAL UNIVERSITY<br>DEPARTMENT OF CHEMISTRY | | | | |
|---|---|---|---|---|
| **Course Name** | **B.Sc. (Honours) Chemistry** | | | |
| **Subject Code:** | **BHCP308-19** | | | |
| **Subject Title:** | **ORGANIC CHEMISTRY LAB-III: (Synthesis of organic compounds and their identifications)** | | | |
| **Contact Hours:** | **L:0** | **T:0** | **P:4** | **Credits:2** |
| **Examination Duration (hours)** | **3** | | | |
| **Objective(s):** | The objective of this course is to provide practical knowledge and illustrative experiments regarding synthesis, separation, purification and characterization of organic compounds. | | | |

**Details of the Course**

**Contents**

Organic Preparations

1. Selective reduction of 1,3-dinitrobenzene to *m*-nitroaniline.
2. Reduction of *p*-nitrobenzaldehyde by sodium borohydride.
3. Hydrolysis of amides and esters.
4. Semicarbazone of any one of the following compounds: acetone, ethyl methyl ketone, cyclohexanone, benzaldehyde.
5. S-Benzylisothiouronium salt of one each of water-soluble and water insoluble acids (benzoic acid, oxalic acid, phenyl acetic acid and phthalic acid).
6. Aldol condensation using either conventional or green method.
7. Benzil-Benzilic acid rearrangement.
8. Solvent-free Cannizzaro reaction of benzaldehyde.
9. Preparation of fluorescein from resorcinol and phthalic anhydride.
10. Synthesis of 2-phenylindole using Fischer Indole synthesis reaction.

The above derivatives should be prepared using 0.5-1g of the organic compound. The solid samples must be collected and may be used for recrystallization, melting point determination. All reactions in the following experiments are to be monitored by thin layer chromatography (TLC) and characteristic data (UV-visible/fluorescence, IR, NMR, MS) is to be explained.

**Reference Books**


| S.No. | Author(s) | Title of the Book | Publisher |
|---|---|---|---|
| 1 | Furniss, B. S., Hannaford, A. J., Smith, P. W. G. & | Vogel's Textbook of Practical Organic Chemistry, 5th Ed. | Pearson (1989) |

| | | | |
|---|---|---|---|
| | Tatchell, A. R. | | |
| 2 | F. G. Mann and B. C. Saunders | Practical Organic Chemistry | Longman, New York |
| 3 | Ahluwalia, V. K. & Aggarwal, R. | Comprehensive Practical Organic Chemistry: Preparation and Quantitative Analysis, | University Press (2000) |
| 4 | Ahluwalia, V. K. & Dhingra, S. | Comprehensive Practical Organic Chemistry: Qualitative Analysis | University Press (2000) |

**Course Outcomes and Mapping**

At the end of the course, the students will be able

**CO6.** To synthesise organic compounds by various approach.

**CO7.** To develop preparative skills for purification of organic compounds by crystallization method.

**CO8.** To separate the organic compound by thin layer chromatography technique.

**CO9.** To present their work with practical skills and the awareness of health and safety procedures.

**CO10.** To apply related experiments for their research work

| | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 | PSO7 |
|---|---|---|---|---|---|---|---|
| CO1 | 3 | 1 | 2 | - | 3 | 2 | - |
| CO2 | 2 | - | 3 | - | 3 | 3 | - |
| CO3 | 3 | 3 | 4 | - | 3 | 3 | - |
| CO4 | 3 | 4 | 3 | 4 | 4 | 5 | 4 |
| CO5 | 2 | 3 | 4 | 2 | 4 | 4 | 4 |

| I.K. GUJRAL PUNJAB TECHNICAL UNIVERSITY<br>DEPARTMENT OF CHEMISTRY | | | | |
|---|---|---|---|---|
| **Course Name** | **B.Sc. (Honours) Chemistry** | | | |
| **Subject Code:** | **UGCA1949** | | | |
| **Subject Title:** | **Cyber Laws & IPR** | | | |
| **Contact Hours:** | **L:3** | **T:1** | **P:0** | **Credits:4** |
| **Examination Duration (hours)** | **3** | | | |
| **Objective(s):** | - | | | |

**Course Outcomes:**

| CO# | Course outcomes |
|---|---|
| CO1 | Identify statutory, regulatory, constitutional, and organizational laws that affect the information technology professional. |
| CO2 | Categorize case law and common law to current legal dilemmas in the technology field. |
| CO3 | Outline the primary forms of intellectual property rights. |
| CO4 | Compare the different forms of intellectual property protection in terms of their key differences and similarities. |
| CO5 | Analyze the effects of intellectual property rights on society as a whole. |

| Detailed Contents | Contact hours |
|---|---|
| **Unit-I**<br><br>**Introduction**<br>Overview of Computer and Web Technology, Need for Cyber Law, Cyber Jurisprudence at International and Indian Level, Jurisdictional Aspects in Cyber Law Issues of jurisdiction in cyberspace, Types of jurisdiction, Minimum Contacts Theory, Sliding Scale Theory, Effects Test and International targeting, Jurisdiction under IT Act, 2000. [CO1] | 12 |
| **Unit-II**<br><br>**Cyber Crimes& Legal Framework**<br>Cyber Crimes against Individuals, Institution and State, Hacking, Digital Forgery, Cyber Stalking/Harassment, Ethics and Etiquettes of Cyber World, Cyber Pornography, Identity Theft & Fraud, Cyber Terrorism, Cyber Defamation, Right to Privacy and Data Protection on Internet, Concept of privacy, Threat to privacy on internet, Self-regulation approach to privacy.[CO2] | 12 |

| | |
|---|---|
| **Unit-III**<br><br>**Overview of Intellectual Property**<br>introduction and the need for intellectual property right (IPR), IPR in India – Genesis and Development IPR in abroad, Data Protection, Open Source Software, Macro economic impact of the patent system, Patent and kind of inventions protected by a patent, Patent document How to protect your inventions?, Granting of patent, Rights of a patent.[CO3] | 10 |
| **Unit-IV**<br><br>**Copyright, Related Rights and Trademarks**<br>What is copyright? Latest editions of Designs, what is covered by copyright? How long does copyright last? Why protect copyright? What are related rights?, Distinction between related rights and copyright?, What is a trademark? Rights of trademark?, What kind of signs can be used as trademarks?, types of trademark, function does a trademark perform, How is a trademark protected?, How is a trademark registered?[CO4][CO5] | 10 |

**Text Books**


1. Anirudh Rastogi. Cyber Law, LexisNexis.
2. Vakul Sharma. Information Technology Law and Practice Cyber Laws and Laws Relating to E-Commerce, Universal Law Publishing.
3. Pankaj Sharma. Information Security and Cyber Laws, Kataria, S. K., & Sons.
4. Navneet Nagpal. Intellectual Property Right, Ebooks2go Inc.
5. Dr. S.K. singh. Intellectual Property Rights, Central Law Agency.

# Semester VI

| I.K. GUJRAL PUNJAB TECHNICAL UNIVERSITY<br>DEPARTMENT OF CHEMISTRY | | | | |
|---|---|---|---|---|
| **Course Name** | **B.Sc. (Honours) Chemistry** | | | |
| **Subject Code:** | **BHCL311-19** | | | |
| **Subject Title:** | **Organic Chemistry-IV (Natural Products and Biochemistry)** | | | |
| **Contact Hours:** | **L:3** | **T:1** | **P:0** | **Credits:4** |
| **Examination Duration (hours)** | **3** | | | |
| **Objective(s):** | The objective of this course is to<br>1. impart knowledge of types, synthesis, isolation and physiological functions of alkaloids and terpenes<br>2. study the properties of lipids and enzymes and their importance in biological systems<br>3. understand the importance of high-energy compounds, electron transport chain and metabolic processes. | | | |

**Details of the Course**

| Unit | Contents | Contact Hours |
|---|---|---|
| I | **Alkaloids**<br>Natural occurrence, General structural features, Isolation and their physiological action, Hoffmann's exhaustive methylation, Emde's modification, Structure elucidation and synthesis of Hygrine and Nicotine. Medicinal importance of Nicotine, Hygrine, Quinine, Morphine, Cocaine, and Reserpine | 12 |
| II | **Terpenes**<br>Occurrence, classification, isoprene rule; Elucidation of structure and synthesis of Citral, Neral and α-terpineol.<br>**Lipids**<br>Introduction to oils and fats; common fatty acids present in oils and fats, Hydrogenation of fats and oils, Saponification value, acid value, iodine number. Reversion and rancidity | 12 |
| III | **Enzymes**<br>Introduction, classification and characteristics of enzymes, Salient features of active site of enzymes, Mechanism of enzyme action (taking trypsin as example), factors affecting enzyme action, coenzymes and cofactors and their role in biological reactions, specificity of enzyme action (including stereo specificity), enzyme inhibitors and their importance, phenomenon of inhibition (competitive, uncompetitive and non-competitive inhibition including allosteric inhibition). | 11 |
| IV | **Concept of Energy in Biosystems**<br>Cells obtain energy by the oxidation of foodstuff (organic molecules). Introduction to metabolism (catabolism, anabolism). | 10 |

| | | |
|---|---|---|
| | ATP: The universal currency of cellular energy, ATP hydrolysis and free energy change.<br>Agents for transfer of electrons in biological redox systems: $NAD^+$, FAD.<br>Conversion of food to energy: Outline of catabolic pathways of carbohydrate- glycolysis, fermentation, Krebs cycle.<br>Overview of catabolic pathways of fat and protein.<br>Interrelationship in the metabolic pathways of protein, fat and carbohydrate. Caloric value of food, standard caloric content of food types. | |

**Reference Books**

| S.No. | Author(s) | Title of the Book | Publisher/Year |
|---|---|---|---|
| 1 | Finar, I. L. | Organic Chemistry (Volume 2) | Dorling Kindersley (India) Pvt. Ltd. (Pearson Education). |
| 2 | Singh, J.; Ali, S. M. & Singh, J. | Natural Product Chemistry, 2010 | Prajati Parakashan |
| 3 | Agarwal O. P. | Natural Product (Volume 1) | Krishna Parakashan Publication |
| 4 | Berg, J. M., Tymoczko, J. L. and Stryer, L. | Biochemistry, VI$^{th}$ edition, 2006 | W. H. Freeman and Co. |
| 5 | Nelson, D. L., Cox, M. M. and Lehninger, A. L. | Principles of Biochemistry, IV$^{th}$ edition, 2009 | W. H. Freeman and Co. |
| 6 | Murray, R. K., Granner, D. K., Mayes, P. A. and Rodwell, V. W. | Harper's Illustrated Biochemistry, XXVIII edition, 2009 | Lange Medical Books/ McGraw-Hill. |

**Course Outcomes and Mapping**

At the end of the course, the student will be able to

**CO11.** Learn the different types of alkaloids and terpenes and their chemistry and medicinal importance

**CO12.** Understand the importance of natural compounds as lead molecules for new drug discovery.

**CO13.** Elaborate general methods of structural elucidation of compounds of natural origin.

**CO14.** Understand the fundamentals of lipids and enzyme structure and function.

**CO15.** learn the metabolism of carbohydrates through various anabolic and catabolic pathways like glycolysis, Kreb's cycle, Glycogen metabolism etc.

| | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 | PSO7 |
|---|---|---|---|---|---|---|---|
| CO1 | 4 | 3 | 3 | - | 1 | 4 | - |
| CO2 | 3 | 2 | 4 | - | 3 | 4 | - |
| CO3 | 3 | 2 | 4 | - | 3 | 4 | - |
| CO4 | 4 | 3 | 3 | - | 1 | 4 | - |
| CO5 | 4 | 3 | 3 | - | 1 | 4 | - |

| I.K. GUJRAL PUNJAB TECHNICAL UNIVERSITY<br>DEPARTMENT OF CHEMISTRY | | | | |
|---|---|---|---|---|
| **Course Name** | **B.Sc. (Honours) Chemistry** | | | |
| **Subject Code:** | **BHCL312-25** | | | |
| **Subject Title:** | **PHYSICAL CHEMISTRY-IV (Electrochemistry & Colloidal State)** | | | |
| **Contact Hours:** | **L:3** | **T:1** | **P:0** | **Credits:4** |
| **Examination Duration (hours)** | **3** | | | |
| **Objective(s):** | This course will equip students with the necessary knowledge concerning the fundamentals of electrochemistry and colloidal state, with regard to various theories developed and their applicability for various systems under consideration. The problem solving skills of students are expected to be enhanced through due weightage given to numerical problems in each unit. | | | |

**Details of the Course**

| Unit | Contents | Contact Hours |
|---|---|---|
| I | **Conductance:**<br>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 and its applications.<br><br>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: (i) degree of dissociation of weak electrolytes, (ii) ionic product of water (iii) solubility and solubility product of sparingly soluble salts, (iv) conductometric titrations and (v) hydrolysis constants of salts. Numericals | 12 |
| II | **Electrochemistry-I:**<br>Quantitative aspects of Faraday's laws of electrolysis, rules of oxidation/reduction of ions based on half-cell potentials, applications of electrolysis in metallurgy and industry.<br><br>Chemical cells, reversible and irreversible cells with examples. Electromotive force of a cell and its measurement, Nernst equation; Standard electrode (reduction) potential and its application to different kinds of half-cells. | 10 |
| III | **Electrochemistry-II:**<br>Application of EMF measurements in determining free energy, enthalpy and entropy of a cell reaction, (ii) equilibrium constants, and (iii) pH values. Latimer and Frost diagrams.<br>Concentration cells with and without transference, liquid junction potential; determination of activity coefficients and transference | 12 |

| | | |
|---|---|---|
| | numbers. Qualitative discussion of potentiometric titrations (acid-base, redox, precipitation). | |
| IV | **Colloidal State:**<br>Lyophilic and Lyophobic colloids, Preparation of Lyophobic Colloidal solutions, Purification of Colloidal Solutions, General Properties of Colloidal systems, Properties of hydrophobic colloidal systems; Electrical and Electrokinetic properties, DLVO theory of stability of lyophobic colloids, Coagulation of colloidal sols, determination of size of colloidal particles. Surfactants; HLB value and micelle formation, critical micelle concentration and factors effecting it, Thermodynamics of micellization.<br>Solubilization by surfactants, micellar catalysis. Emulsions-Types, Factors effecting and microemulsions. Gels-Preparation, Types and Applications. | 12 |

**Text Books**

| S.No. | Author(s) | Title of the Book | Publisher/Year |
|---|---|---|---|
| 1 | Puri, Sharma and Pathania | Principles of Physical Chemistry | Vishal Publishing Company |
| 2 | K L Kapoor | A Textbook of Physical Chemistry, Volume 3 | Mc Graw Hill Education |
| 3 | Gurtu and Gurtu | Advanced Physical Chemistry | Pragati Prakashan |

**Reference Books**

| S.No. | Author(s) | Title of the Book | Publisher/Year |
|---|---|---|---|
| 1 | P.W. Atkins & J. de Paula | Physical Chemistry 9$^{th}$ ed | Oxford University Press (2011) |
| 2 | S.H. Maron & C.F. Prutton | Principles of Physical Chemistry, 1$^{st}$ edition | Oxford and IBH (1958) |
| 3 | G.W. Castellan | Physical Chemistry, 4$^{th}$ edition | Narosa (2004) |
| 4 | I .N. Levine | Physical Chemistry 6$^{th}$ Ed., | Tata Mc Graw Hill (2010) |
| 5 | T. Engel & P. Reid | Physical Chemistry 3$^{rd}$ Ed. | Prentice-Hall (2012) |

**Course Outcomes and Mapping**

At the end of the course, the student will be able to

**CO1.** Understand and recognize the electrochemical processes and the equilibria involved in them.

**CO2.** discuss electrode potentials and relate it to cell thermodynamics

**CO3.** explain potentiometric methods and explain the types of indicator electrodes

**CO4.** evaluate conductivity measurements and titration curves to develop corelation with the practical part

**CO5.** Familiarise with the concept of colloidal state and its real life applications.

| | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 | PSO7 |
|---|---|---|---|---|---|---|---|
| CO1 | 3 | 1 | 1 | - | 2 | 1 | 1 |
| CO2 | 3 | 2 | 3 | - | 1 | - | 1 |
| CO3 | 2 | 2 | 1 | - | 2 | 1 | 1 |
| CO4 | 3 | 2 | 2 | - | 2 | 1 | 1 |
| CO5 | 3 | 2 | 2 | - | 1 | - | 1 |

| I.K. GUJRAL PUNJAB TECHNICAL UNIVERSITY<br>DEPARTMENT OF CHEMISTRY | | | | |
|---|---|---|---|---|
| **Course Name** | **B.Sc. (Honours) Chemistry** | | | |
| **Subject Code:** | **BHCL313-19** | | | |
| **Subject Title:** | **CATALYSIS IN ORGANOMETALLIC COMPOUNDS** | | | |
| **Contact Hours:** | **L:3** | **T:1** | **P:0** | **Credits:4** |
| **Examination Duration (hours)** | **3** | | | |
| **Objective(s):** | To teach the fundamental concepts of Catalysis and their applications. | | | |

**Details of the Course**

| Unit | Contents | Contact Hours |
|---|---|---|
| I | **Heterogeneous catalysis: -** Introduction, Concepts of heterogeneous catalysis, Important Reaction Types, Oxidative Addition and Reductive Elimination, Insertion Reactions, b-Hydride Elimination, Nucleophilic Attack on a Coordinated Ligand Transformation of hydrocarbons, Metathesis of alkanes, alkenes and alkynes, Oxidation of hydrocarbons, Alkene hydrogenation (Wilkinsons Catalyst), Hydroformylation (Co salts), Wacker Process, Synthetic gasoline (Fischer Tropsch reaction). | 12 |
| II | **Hydrogenation and hydroelementation of alkenes,** Hydrogenation of olefins, Asymmetric hydrogenation, Hydroboration of olefins, Hydrocyanation of olefins, Hydroamination of olefins and alkynes<br>**Transformations of alkenes and alkynes**: Ziegler-Natta-type olefin polymerization, Metathesis of alkenes, alkynes and cycloalkenes, Olefin dimerization and oligomerization, Olefin isomerization | 10 |
| III | **Bio-catalysis**<br>Introduction, Introduction to enzymes and enzyme catalysed reactions. Classification and mechanism of reaction. Purification and characterization of enzymes. Applications of enzymes in diagnostics, analysis, biosensors and other industrial processes and bio-transformations, Enzyme immobilization and concept of enzyme engineering. Nanobiocatalysis,<br>**Bio-organometallic chemistry**<br>Cobalamin: co-enzyme vitamin B12, Biological redox mediators, Examples of oxido-reductase enzymes: the mono-oxygenases, Nitrogen fixation by nitrogenase enzyme | 11 |
| IV | **Organometallic complexes in organic synthesis**<br>**Examples of applications**<br>Protection and stabilization of unsaturated organic derivatives and fragments.Nucleophilic and electrophilic reactions on hydrocarbon ligands, General methods of C-C bond formation<br>using the oxidative addition of an organic halide or a related | 12 |

| | | |
|---|---|---|
| | electrophile , Extension of palladium catalysis to the formation of C-O and C-N bonds, Oxidative coupling reactions of alkynes with other unsaturated fragments,for the formation of cyclic and heterocyclic compounds,Metal-carbene complexes in organic synthesis, Examples of asymmetric catalysis. | |

**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
4. Douglas, B. E.; McDaniel, D.H. & Alexander, J.J. Concepts and Models in Inorganic Chemistry3rd Ed., John Wiley and Sons, NY, 1994.
5. Greenwood, N.N. & Earnshaw, A. Chemistry of the Elements, Elsevier 2nd Ed, 1997 (Ziegler Natta Catalyst and Equilibria in Grignard Solution).
6. Lee, J.D. Concise Inorganic Chemistry 5th Ed., John Wiley and sons 2008.
7. Powell, P. Principles of Organometallic Chemistry, Chapman and Hall, 1988.
8. Shriver, D.D. & P. Atkins, Inorganic Chemistry 2nd Ed., Oxford University Press, 1994.
9. Basolo, F. & Person, R. Mechanisms of Inorganic Reactions: Study of Metal Complexes in Solution 2nd Ed., John Wiley & Sons Inc; NY.
10. Purcell, K.F. & Kotz, J.C., Inorganic Chemistry, W.B. Saunders Co. 1977
11. Miessler, G. L. & Donald, A. Tarr, Inorganic Chemistry 4th Ed., Pearson, 2010.
12. Collman, James P. et al. Principles and Applications of Organotransition Metal Chemistry. Mill Valley, CA: University Science Books, 1987.
13. Crabtree, Robert H. The Organometallic Chemistry of the Transition Metals. j New York, NY: John Wiley, 2000.
14. Spessard, Gary O., &Gary L. Miessler. Organometallic Chemistry. Upper Saddle River, NJ: Prentice-Hall, 1996.


**Course Outcomes and Mapping**

At the end of the course, the student will be able to

CO1. Understand the Organometallic chemistry
CO2. Understand the fundamental concepts of various concepts involved in catalysis.
CO3. Learn different application of catalysis in the synthesis of organic compounds.

CO4. To Understand role of catalysis in biological model

| | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 | PSO7 |
|---|---|---|---|---|---|---|---|
| CO1 | 1 | 2 | 3 | 2 | 3 | 1 | 2 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| CO2 | 2 | 3 | 3 | 3 | 2 | 3 | 2 |
| CO3 | 3 | 2 | 3 | 2 | 2 | 2 | 2 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| CO4 | 3 | 2 | 3 | 2 | 3 | 2 | 3 |

| I.K. GUJRAL PUNJAB TECHNICAL UNIVERSITY<br>DEPARTMENT OF CHEMISTRY | | | | |
|---|---|---|---|---|
| **Course Name** | **B.Sc. (Honours) Chemistry** | | | |
| **Subject Code:** | **BHCL314-19** | | | |
| **Subject Title:** | **ANALYTICAL METHODS IN CHEMISTRY** | | | |
| **Contact Hours:** | **L:3** | **T:1** | **P:0** | **Credits:4** |
| **Examination Duration (hours)** | **3** | | | |
| **Objective(s):** | This course will equip students with the necessary knowledge concerning various analytical techniques, their sampling and sources of error etc. | | | |

**Details of the Course**

| Unit | Contents | Contact Hours |
|---|---|---|
| I | **Qualitative and quantitative aspects of analysis:**<br>Sampling, evaluation of analytical data, errors, accuracy and precision, methods of their expression, normal law of distribution if indeterminate errors, statistical test of data; F, Q and t test, rejection of data, and confidence intervals.<br>**Thermal methods of analysis:**<br>Theory of thermogravimetry (TG), basic principle of instrumentation. Techniques for quantitative estimation of Ca and Mg from their mixture. | 10 |
| II | **Optical methods of Analysis:**<br>Origin of spectra, interaction of radiation with matter, fundamental laws of spectroscopy and selection rules, validity of Beer-Lambert's law.<br><br>*UV-Visible Spectrometry:* Basic principles of instrumentation (choice of source, monochromator and detector) for single and double beam instrument;<br><br>*Basic principles of quantitative analysis:* estimation of metal ions from aqueous solution, geometrical isomers, keto-enol tautomers. Determination of composition of metal complexes using Job's method of continuous variation and mole ratio method.<br><br>*Infrared Spectrometry:* Basic principles of instrumentation (choice of source, monochromator & detector) for single and double beam instrument; sampling techniques. Structural illustration through interpretation of data, Effect and importance of isotope substitution. | 13 |
| III | **Flame Atomic Absorption and Emission Spectrometry:**<br>Basic principles of instrumentation (choice of source, monochromator, detector, choice of flame and Burner designs. Techniques of atomization and sample introduction; Method of background | 10 |

| | | |
|---|---|---|
| | correction, sources of chemical interferences and their method of removal. Techniques for the quantitative estimation of trace level of metal ions from water samples. | |
| IV | **Separation techniques:**<br><br>Solvent extraction: Classification, principle and efficiency of the technique. Mechanism of extraction: extraction by solvation and chelation.Technique of extraction: batch, continuous and counter current extractions.<br><br>Qualitative and quantitative aspects of solvent extraction: extraction of metal ions from aqueous solution, extraction of organic species from the aqueous and nonaqueous media.<br><br>Chromatography: Classification, principle and efficiency of the technique.Mechanism of separation: adsorption, partition & ion exchange. Development of chromatograms: frontal, elution and displacement methods.<br><br>Qualitative and quantitative aspects of chromatographic methods of analysis: IC, GLC, GPC, TLC and HPLC. | 12 |

**Reference Books**


**1.** Vogel, Arthur I: A Test book of Quantitative Inorganic Analysis (Rev. by G.H. Jeffery and others) 5th Ed. The English Language Book Society of Longman .

**2.** Willard, Hobert H. et al.: Instrumental Methods of Analysis, 7th Ed. Wardsworth Publishing Company, Belmont, California, USA, 1988.

**3.** Christian, Gary D; Analytical Chemistry, 6th Ed. John Wiley & Sons, New York, 2004.

**4.** Harris, Daniel C: Exploring Chemical Analysis, Ed. New York, W.H. Freeman, 2001.

**5.** Khopkar, S.M. Basic Concepts of Analytical Chemistry. New Age, International Publisher, 2009.

**6.** Skoog, D.A. Holler F.J. and Nieman, T.A. Principles of Instrumental Analysis, Thomson Asia Pvt. Ltd. Singapore.

**7.** Mikes, O. & Chalmes, R.A. Laboratory Hand Book of Chromatographic & Allied Methods, Elles Harwood Ltd. London.

**8.** Ditts, R.V. Analytical Chemistry – Methods of separation.

**Course Outcomes and Mapping**

At the end of the course, the student will be able to

**CO1.** explain the fundamentals of analytical chemistry and steps of a characteristic analysis

**CO2.** estimate kinds of errors in chemical analysis.

**CO3.** identify quality of experimental measurements.

**CO4.** interpret the sources of random errors and effects of random errors on analytical results.

**CO5.** Familiarise with various analytical techniques and compare them.

| | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 | PSO7 |
|---|---|---|---|---|---|---|---|
| CO1 | 3 | 1 | 1 | - | 2 | 1 | 2 |
| CO2 | 3 | 2 | 3 | - | 1 | - | 2 |
| CO3 | 2 | 2 | 1 | - | 2 | 1 | 2 |
| CO4 | 2 | 2 | 2 | - | 2 | 1 | 2 |
| CO5 | 3 | 2 | 2 | - | 3 | - | 2 |

| I.K. GUJRAL PUNJAB TECHNICAL UNIVERSITY<br>DEPARTMENT OF CHEMISTRY | | | | |
|---|---|---|---|---|
| **Course Name** | **B.Sc. (Honours) Chemistry** | | | |
| **Subject Code:** | **BHCL315-19** | | | |
| **Subject Title:** | **NANOCHEMISTRY** | | | |
| **Contact Hours:** | **L:3** | **T:1** | **P:0** | **Credits:4** |
| **Examination Duration (hours)** | **3** | | | |
| **Objective(s):** | • To learn the basic concepts of Nanochemistry and changes of chemical and physical properties due size reduction.<br>• To familiarize about the different chemical methods of synthesis, characterization, and different applications of nanomaterials | | | |

**Details of the Course**

| Unit | Contents | Contact Hours |
|---|---|---|
| I | Introduction to Nanomaterials: History-Feynman's hypothesis- scales of nanosystems- Moore's law, Classification of nanomaterials based on dimensions – one dimensional (1D), two dimensional (2D) and three dimensional (3D) nanomaterials, quantum dots, quantum wires, quantum core/shell structures, Different types of nanomaterials: Synthesis, properties and applications of fullerenes, carbon nanotubes and quantum dots, self-assembled monoayers, monolayer protected metal nanoparticles. | 10 |
| II | Chemical Routes for Synthesis of Nanomaterials: Chemical precipitation and co-precipitation; Sol-gel synthesis; Microemulsions or reverse micelles; Solvothermal synthesis; Thermolysis routes, Microwave heating synthesis; Sonochemical synthesis; Photochemical synthesis; Synthesis in supercritical fluids.<br><br>Organic nanoparticles: Size and shape control of nanoparticles and their characterization; inorganic-organic hybrid nanoparticles; Nanopolymers: Preparation and characterization of diblock Copolymer based nanocomposites; Applications of Nanopolymers in Catalysis. | 13 |
| III | Optical characterization: Absorption and photoluminescence (PL & PLE) spectroscopies, steady-state vs. fast spectroscopy, dynamic light scattering, Structural characterization: XRD, SEM, STEM, TEM, AFM, Deviations between bulk and near-surface crystal structures. | 12 |
| IV | Chemistry of small surfaces: Curvature and neighboring-charge effects on chemical reactivity and equilibria (pKa's, redox potentials), Applications in structural materials, lighting, energy conversion (Solar Cells) and catalysis applications, Environmental, safety, and ethical aspects of nanotechnology. | 10 |

| | | |
|---|---|---|
| | | |

**Reference Books**


1. C.N.R. Rao, H.C. Mult, A. Müller, A. K. Cheetham; The Chemistry of Nanomaterials: Synthesis, Properties and Applications, Wiley, 2004, ISBN:9783527306862.
2. G.B. Sergeev, K.J. Klabunde, Nanochemistry, Elsevier, 2013.
3. Robert Kelsall, Ian W. Hamley , Mark Geoghegan, Nanoscale Science and Technology, Wiley.
4. C Brechignac, P Houdy, M Lahmani, Nanomaterials and Nanochemistry, 2011, Wiley.


**Course Outcomes and Mapping**

At the end of the course, the student will be able to

CO1. Understand the fundamental concepts of nanomaterials.
CO2. Learn the different methods of chemical synthesis of nanoparticles.
CO3. Understand the basic techniques about the organic nanoparticles.
CO4. Learn about the various characterization techniques.
CO5. Understand the various applications of nanomaterials.

| | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 | PSO7 |
|---|---|---|---|---|---|---|---|
| CO1 | 1 | 2 | 2 | 2 | 3 | 1 | 2 |
| CO2 | 2 | 2 | 3 | 3 | 3 | 3 | 2 |
| CO3 | 1 | 3 | 2 | 2 | 1 | 2 | 3 |
| CO4 | 2 | 3 | 3 | 2 | 2 | 3 | 2 |
| CO5 | 2 | 2 | 3 | 3 | 3 | 2 | 3 |

| I.K. GUJRAL PUNJAB TECHNICAL UNIVERSITY<br>DEPARTMENT OF CHEMISTRY | | | | |
|---|---|---|---|---|
| **Course Name** | **B.Sc. (Honours) Chemistry** | | | |
| **Subject Code:** | **BHCL316-19** | | | |
| **Subject Title:** | **MOLECULAR MODELLING AND DRUG DESIGN** | | | |
| **Contact Hours:** | **L:3** | **T:1** | **P:0** | **Credits:4** |
| **Examination Duration (hours)** | **3** | | | |
| **Objective(s):** | • To learn the basic concepts of molecular modelling and drug designing using the different energy minimization methods.<br>• To understand the fundamentals of computer simulation. | | | |

**Details of the Course**

| Unit | Contents | Contact Hours |
|---|---|---|
| I | **Introduction to Molecular Modelling**: Introduction. Useful Concepts in Molecular Modelling: Coordinate Systems. Potential Energy Surfaces. Molecular Graphics. Surfaces. Computer Hardware and Software. The Molecular Modelling Literature.<br><br>**Force Fields: Fields.** Bond Stretching. Angle Bending. Introduction to nonbonded interactions. Electrostatic interactions. Van-der Waals Interactions. Hydrogen bonding in Molecular Mechanics. Force Field Models for the Simulation of Liquid Water. | 13 |
| II | **Energy Minimization and Computer Simulation:** Minimization and related methods for exploring the energy surface. Non-derivative method, First and second order minimization methods. Computer simulation methods. Simple thermodynamic properties and Phase Space. Boundaries. Analyzing the results of a simulation and estimating Errors. | 10 |
| III | **Molecular Dynamics & Monte Carlo Simulation:** Molecular Dynamics Simulation Methods. Molecular Dynamics using simple models. Molecular Dynamics with continuous potentials. Molecular Dynamics at constant temperature and pressure. Metropolis method. Monte Carlo simulation of molecules. Models used in Monte Carlo simulations of polymers. | 12 |
| IV | **Structure Prediction and Drug Design:** Structure prediction - Introduction to comparative Modeling. Sequence alignment. Constructing and evaluating a comparative model. Predicting protein structures by 'Threading', Molecular docking. Structure based de novo ligand design, Drug Discovery – Chemoinformatics – QSAR. | 10 |

**Reference Books**

1. A.R. Leach, Molecular Modelling Principles and Application, Longman, 2001.
2. J.M. Haile, Molecular Dynamics Simulation Elementary Methods, John Wiley and Sons, 1997.
3. Satya Prakash Gupta, QSAR and Molecular Modeling, Springer - Anamaya Publishers, 2008.

**Course Outcomes and Mapping**

At the end of the course, the student will be able to

CO1. Understand the fundamental concepts of molecular modelling.
CO2. Learn the different methods of energy minimization and computer simulation.
CO3. Understand the basic concepts of molecular dyanamics.
CO4. Learn about the various concepts of drug designing and molecular modelling.

| | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 | PSO7 |
|---|---|---|---|---|---|---|---|
| CO1 | 1 | 2 | 2 | 2 | 3 | 3 | 2 |
| CO2 | 2 | 2 | 2 | 3 | 3 | 2 | 2 |
| CO3 | 2 | 3 | 2 | 2 | 3 | 2 | 2 |
| CO4 | 2 | 3 | 3 | 1 | 2 | 3 | 3 |

| I.K. GUJRAL PUNJAB TECHNICAL UNIVERSITY<br>DEPARTMENT OF CHEMISTRY | | | | |
|---|---|---|---|---|
| **Course Name** | **B.Sc. (Honours) Chemistry** | | | |
| **Subject Code:** | **BHCP318-19** | | | |
| **Subject Title:** | **ORGANIC CHEMISTRY LAB-IV (Biochemical and Nanotechnology Lab)** | | | |
| **Contact Hours:** | **L:0** | **T:0** | **P:4** | **Credits:2** |
| **Examination Duration (hours)** | **3** | | | |
| **Objective(s):** | The objective of this course is to provide practical knowledge and illustrative experiments regarding study, estimation and isolation of bioorganic compounds. | | | |

**Details of the Course**

| S. No. | Contents |
|---|---|
| 1. | Estimation of glycine by Sorenson's formalin method. |
| 2. | Study of the titration curve of glycine. |
| 3. | Estimation of proteins by Lowry's method. |
| 4. | Study of the action of salivary amylase on starch at optimum conditions. |
| 5. | Effect of temperature on the action of salivary amylase. |
| 6. | Saponification value of an oil or a fat. |
| 7. | Determination of Iodine number of an oil/ fat. |
| 8. | Isolation and characterization of DNA from onion/ cauliflower/peas. |
| | Synthesis of Nanoparticles and their applications<br>(i) Green synthesis of silver nanoparticles using plant extract.<br>(ii) Preparation of Chitosan Nanoparticles and characterization using FTIR.<br>(iii) Synthesis of ZnO nanoparticles through non-aqueous route.<br>(iv) Synthesis of copper nanoparticles.<br>Application of synthesized nanoparticles in any two organic transformations / synthesis. |

**Reference Books**

| S.No. | Author(s) | Title of the Book | Publisher |
|---|---|---|---|
| 1 | Manual of Biochemistry Workshop, 2012, Department of Chemistry, University of Delhi. | | |
| 2 | Arthur, I. V. Quantitative Organic Analysis, Pearson. | | |

**Course Outcomes and Mapping**

At the end of the course, the students will be able

**CO11.** To study about properties of amino acids/proteins/enzymes.

**CO12.** To estimate amino acids/proteins by various methods.

**CO13.** To understand the isolation and characterisation of DNA.

**CO14.** To present their work with practical skills and the awareness of health and safety procedures.

**CO15.** To apply related experiments for their research work

| | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 | PSO7 |
|---|---|---|---|---|---|---|---|
| CO1 | 4 | 1 | 2 | - | 3 | 2 | - |
| CO2 | 3 | - | 3 | - | 3 | 3 | - |
| CO3 | 3 | 3 | 4 | - | 3 | 3 | - |
| CO4 | 3 | 2 | 3 | 4 | 4 | 5 | - |
| CO5 | 2 | 3 | 4 | 2 | 4 | 4 | - |

| I.K. GUJRAL PUNJAB TECHNICAL UNIVERSITY<br>DEPARTMENT OF CHEMISTRY | | | | |
|---|---|---|---|---|
| **Course Name** | **B.Sc. (Honours) Chemistry** | | | |
| **Subject Code:** | **BHCP319-25** | | | |
| **Subject Title:** | **PHYSICAL CHEMISTRY LAB-IV (Electrochemistry & Colloidal State Lab)** | | | |
| **Contact Hours:** | **L:0** | **T:0** | **P:4** | **Credits:2** |
| **Examination Duration (hours)** | **4** | | | |
| **Objective(s):** | To provide students practical knowledge and skills about various topics taught in theory class of physical chemistry, which in turn will enhance their problem solving and analytical skills. | | | |

**Details of the Course**

| Unit | Contents |
|---|---|
| | I. Determination of cell constant, equivalent conductance, degree of dissociation and dissociation constant of a weak acid.<br><br>II. Perform the following conductometric titrations:<br>(i) Strong acid vs. strong base<br>(ii) Weak acid vs. strong base<br>(iii) Mixture of strong acid and weak acid vs. strong base<br>(iv) Strong acid vs. weak base<br><br>III. Perform the following potentiometric titrations:<br>(i) Strong acid vs. strong base<br>(ii) Weak acid vs. strong base<br>(iii) Dibasic acid vs. strong base<br><br>IV. Preparation of colloidal solutions of Arsenious sulphide and Ferric hydroxide sols.<br>V. Study of Hardy – Schulze's rule for arsenious sulphide / Ferric hydroxide sols.<br>VI. To study the protective action of a hydrophilic colloid on the precipitation of hydrophobic colloid.<br><br>*Any other experiment related to electrochemistry carried out in the class.* |

**Reference Books**

| S.No. | Author(s) | Title of the Book | Publisher |
|---|---|---|---|
| 1 | J.B. Yadav | Practical Physical Chemistry | Krishna |
| 2 | B. D. Khosla, V. C. Garg, & A. Gulati, | Senior Practical Physical Chemistry | R. Chand & Co. New Delhi (2011) |
| 3 | V. D. Athawale, & P. Mathur, | Experimental Physical Chemistry | New Age International: New Delhi (2001) |

**Course Outcomes and Mapping**

At the end of the course, the students will be able to

**CO1.** Understand the basic procedures for carrying out a physical chemistry practical like preparation and standardisation of solutions, handling the equipments and measuring with precision.

**CO2.** Correlate the theoretical and practical aspects and know about the limits of the experimental error.

**CO3.** Determine the various physical parameters for the various problems under study.

**CO4.** Verify various laws studied in the theory part.

| | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 | PSO7 |
|---|---|---|---|---|---|---|---|
| CO1 | 1 | 3 | 3 | 3 | 3 | 3 | 3 |
| CO2 | 2 | 2 | 3 | 3 | 3 | 2 | 2 |
| CO3 | 2 | 3 | 3 | 2 | 2 | 3 | 3 |
| CO4 | 2 | 3 | 3 | 1 | 2 | 2 | 3 |

| I.K. GUJRAL PUNJAB TECHNICAL UNIVERSITY<br>DEPARTMENT OF CHEMISTRY | | | | |
|---|---|---|---|---|
| **Course Name** | **B.Sc. (Honours) Chemistry** | | | |
| **Subject Code:** | **UGCA1945** | | | |
| **Subject Title:** | **Artificial Intelligence** | | | |
| **Contact Hours:** | **L:3** | **T:1** | **P:0** | **Credits:4** |
| **Examination Duration (hours)** | **3** | | | |
| **Objective(s):** | - | | | |

**Course Outcomes:**

| CO# | Course outcomes |
|---|---|
| CO1 | Highlight the significance and domains of Artificial Intelligence and knowledge representation. |
| CO2 | Outline the advantages and disadvantages of various search techniques. |
| CO3 | Identify various Expert Systems and AI applications. |
| CO4 | Define the role of AI in different areas like NLP, Pattern Recognition etc. |
| CO5 | Select the right AI tool for different AI based applications. |

| Detailed Contents | Contact hours |
|---|---|
| **Unit-I**<br><br>**Introduction-**What is intelligence? Foundations of artificial intelligence (AI). History of AI. AI problems: Toy Problems, Real World problems- Tic-Tac-Toe, | 10 |
| Water Jug, Question-Answering, 8-puzzle, 8-Queens problem. Formulating problems, Searching for Solutions.[CO1]<br><br>**Knowledge Representation:** Propositional Logic, Propositional Theorem Proving-Inference and Proofs, Proof by Resolution, Horn Clauses and definite Clauses, Forward and Backward chaining; First order Logic, Inference in First Order Logic. [CO1] | |

| | |
|---|---|
| **Unit-II**<br><br>**Uncertain Knowledge and Reasoning:** Basic probability, Bayes rule, Belief networks, Default reasoning, Fuzzy sets and fuzzy logic.<br><br>**Structured Knowledge:** Associative Networks, Frame Structures, Conceptual Dependencies and Scripts. | **10** |
| **Unit-III**<br><br>**Uninformed Search strategies**- Breadth-first search, Uniform-cost search, Depth-first search, Depth-limited search, Iterative deepening depth-first search, Bidirectional search, Comparing uninformed search strategies.[CO2]<br>**Informed (Heuristic) Search Strategies**- Hill Climbing, Simulated Annealing, Genetic Algorithm, Greedy best-first search, A* and optimal search, Memory-bounded heuristic search.[CO2] | **12** |
| **Unit-IV**<br><br>**Natural language processing:** Grammars, Parsing.[CO4]<br><br>**Pattern Recognition:** Recognition and Classification Process-Decision Theoretic Classification, Syntactic Classification; Learning Classification Patterns, Recognizing and Understanding Speech. [CO5]<br><br>**Expert System Architectures:** Characteristics, Rule-Based System Architectures, Nonproduction System Architectures, Knowledge Acquisition and Validation.[CO3] | 12 |

**Text Books:**


1. Artificial Intelligence-A Modern Approach, Russel and Norvig, Prentice Hall.
2. Artificial Intelligence, Elaine Rich, Kevin Knight and SB Nair, 3 Ed.,Tata McGraw-Hill.
3. Artificial Intelligence And Expert Systems, D.W.Patterson, Prentice Hall.
4. Artificial Inteligence Structures and Strategies for complex Problem Solving, George F. Luger, Pearson Addison Wesley.

1. Artificial Intelligence-A New Synthesis, Nils J. Nilsson, Morgan Kaufmann Publishers.