# B.Sc. Chemistry Program
# (w.e.f. Session 2026-2027)
# Scheme

## 3/4-Year Degree Program as per NEP-2020

## DEPARTMENT OF CHEMISTRY

## J. C. Bose University of Science and Technology, YMCA, Faridabad

## NH-2, Sector-6, Haryana Pin-121006

**B.Sc. (Hons.) Chemistry**

Chemistry is one of the branches of science dealing with the structure and behavior of nature with molecular perspective to understand scientific reasoning. The course includes many concepts, such as Nano chemistry, supramolecular chemistry, quantum chemistry, biological chemistry etc. Chemistry is fast moving from being a descriptive field to an exact science, a transition that will increasingly require input from all branches of science.

Apart from chemistry, students will also be able to learn Physics, Mathematics and other subjects in this course. In addition, the well-equipped teaching and research laboratories will facilitate the students to develop experimental, analytical and conceptual skills and build their interest in the field of research.

The program and the curriculum are ideally designed for academic as well as research growth.

**PROGRAM OBJECTIVES**

- Producing graduates who are well grounded in the fundamentals of Chemistry and acquisition of the necessary skills, in order to use their knowledge in Chemistry in a wide range of practical application.
- Help to become creative chemist to become successful in a wide range of professions where logical approach is required.
- To create general understanding about different chemical interactions to build a solid foundation in the subject.
- Bachelor of Science in chemistry gives multiple career options for the students to their interest.
- To familiarize the student with different instruments like U.V. spectrophotometer, refractometer, pH meter polarometer

It also promotes research and creative activities of students by providing exposure to the realm of physical science and technical expertise. The B.Sc. (Hons.) programme in chemistry is designed to provide a thorough basic knowledge in Chemistry at the under graduate level. Apart from the general topics in Chemistry, many of the new topics included in the syllabus keeps the students abreast with the latest developments taking place in the field. Also the experiments chosen for each practical course is such that they bring out the concept of application of the theory in a practical situation. It also helps in creative thinking and self-learning.

**PROGRAM OUTCOMES**

After completion of the program, the students will:

- Have sufficient understanding of the basic concepts in chemical processes.
- Be able to learn computer Science/Mathematics/Chemistry/Electronics as an elective subject apart from Chemistry as a major subject.
- Be able to communicate effectively by oral, computing and graphical means.
- Become successful professionals by demonstrating logical and analytical thinking abilities.
- Enable to describe and apply the basic principles of chemistry and to carry out practical techniques important in chemical analysis.
- Provide a systematic understanding of core chemistry concepts, principles and theories along with their applications.

| Semester Wise Credits Distribution | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | **Discipline Specific Major** | **Minor/DSE#** | **Multidisciplinary** | **Ability Enhancement Courses** | **Skill Enhancement Courses** | **Value Added Courses** | **Internship** | **Research Project/ Dissertation** | **Total Credits** |
| **I** | 12 | 4 | 3 | 2 | 3 | 2 | - | - | 26 |
| **II** | 12 | 4 | 3 | 2 | 3 | 2 | - | - | 26 |
| *A Student exiting the program after securing 52 credits will be awarded **UG Certificate in Chemistry** provided he/she secures 4 credits in work-based vocational courses offered during the summer term or an internship in Industry / University.<br>**Exit Criteria 52+4=56 credits** | | | | | | | | | |
| **III** | 16 | 4 | 2 | 2 | 2 | 2 | - | - | 28 |
| **IV** | 18 | 4 | - | 2 | 2 | 2 | - | - | 28 |
| **A Student exiting the program after securing 108 credits will be awarded UG Diploma in Chemistry provided he/she secures an additional 4 credits in a skill-based Summer Internship in Industry/ University during the first-year or second-year summer term.**<br>**Exit Criteria 108+4=112 Credits** | | | | | | | | | |
| **V** | 12 | 6 # | - | - | 4 | - | 4 | - | 26 |
| **VI** | 12 | 6 # | - | - | 4 | - | - | - | 22 |
| **A Student who wants to undertake a 3-year UG program will be awarded BSc Chemistry upon securing 142 credits.**<br>**Exit Criteria 156 Credits**<br><br>**Students who secured 75 % and above marks till VI semester shall be eligible to opt for 'BSc Chemistry Hons with Research' Programme** | | | | | | | | | |
| **VII** | 18/12 | 4 # | - | - | - | - | - | 0/6 | 22 |
| **VIII** | 18/12 | 4 # | - | - | - | - | - | 0/6 | 22 |
| **Total** | **118/106** | **16 / 20 #** | **8** | **8** | **18** | **8** | **4** | **0/12** | **200** |
| **A Student will be awarded UG Degree BSc Chemistry (Hons) / BSc Chemistry (Hons. with Research) upon securing 200 credits.**<br>DSE -Discipline Specific Elective | | | | | | | | | |

Important instructions regarding weightage of Internal and External Assessment and components in the internal assessment and their respective weightage-

**Summary of marks distribution and weightage**

| Sr. No. | Component | Total Marks | Internal Weightage | External Weightage |
|---|---|---|---|---|
| | | | Total=40 Marks | Total= 60 Marks |
| 1. | Theory | 100 | Sessional= 25** Marks<br>PBL# = 15 Marks | Assessment will be done through external examination |
| 2. | Practical## | 50 | Total= 25 Marks | Total = 25 Marks |
| | | | Internal viva=10<br>Cont. Eval. =10<br>Lab record=5 | Viva = 10<br>Execution = 10<br>Written = 5 |
| 3. | Industrial training/ internship | No change is recommended in this component of assessment. | | |

*These marks are mere indicative which means some theory or practical may have marks other than 100 or 50, however, internal distribution of marks will remain in the same proportionate as given in above Table.

**The assessment of 25 marks will be based on one mid semester examination and the question paper will have atleast 04 questions covering approximately 50 % of the syllabus.

# Project Based Learning (PBL) may contain the following components.

1. Assignments
2. Quiz
3. Surprise Test
4. Mini Projects
5. Tutorials
6. Case Studies
7. Visit to site/Company/Laboratories
8. Field Work
9. Seminars

| Semester - 1 | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Sr. No.** | **Category** | **Course Code** | **Course Title** | **Hours per week** | | | **Credits** | **Marks for Sessional** | **Marks for End Term Examination** | **Total** |
| | | | | **L** | **T** | **P** | | | | |
| 1. | DSC-A1 / Major | CHU-101-V1 | Inorganic Chemistry - I | 4 | 0 | 0 | 4 | 40 | 60 | 100 |
| 2. | DSC-A2 / Major | CHU-103-V1 | Physical Chemistry - I | 4 | 0 | 0 | 4 | 40 | 60 | 100 |
| 3. | DSC-A3/ Major | CHU-105-V1 | Inorganic Chemistry Lab - I | 0 | 0 | 4 | 2 | 25 | 25 | 50 |
| 4. | DSC-A4/ Major | CHU-107-V1 | Physical Chemistry Lab - I | 0 | 0 | 4 | 2 | 25 | 25 | 50 |
| 5. | MIC-1 / Minor | OSU-115-V1/ OSU-117-V1 | Basic Algebra / Physics-I | 4 | 0 | 0 | 4 | 40 | 60 | 100 |
| 6. | MDC-1/ Multidisciplinary | JMU-101-V1 | Introduction to Communication | 3 | 0 | 0 | 3 | 40 | 60 | 100 |
| 7. | AEC-1/ Ability Enhancement | AEC-101-V1 | Writing Skills and the Art of Rhetoric (WSAAR) | 2 | 0 | 0 | 2 | 40 | 60 | 100 |
| 8. | SEC1-1/ Skill Enhancement | CHU-109-V1 | Instrumentation Skills-I | 2 | 0 | 0 | 2 | 40 | 60 | 100 |
| 9. | SEC1-2/ Skill Enhancement | CHU-111-V1 | Instrumentation Skills Lab-I | 0 | 0 | 2 | 1 | 25 | 25 | 50 |
| 10. | VAC-1/ Value Added Courses | VAC-101-V1 | Environmental Studies – I (EVS-I) | 2 | 0 | 0 | 2 | 40 | 60 | 100 |
| | | | Total | **21** | **0** | **10** | **26** | **355** | **495** | **850** |

| Semester - 2 | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Sr. No.** | **Category** | Course Code | Course Title | **Hours per week** | | | **Credits** | **Marks for Sessional** | **Marks for End Term Examination** | **Total** |
| | | | | **L** | **T** | **P** | | | | |
| 1. | DSC-A1 / Major | CHU-102-V1 | Organic Chemistry - I | 4 | 0 | 0 | 4 | 40 | 60 | 100 |
| 2. | DSC-A2 / Major | CHU-104-V1 | Physical Chemistry – II | 4 | 0 | 0 | 4 | 40 | 60 | 100 |
| 3. | DSC-A3/ Major | CHU-106-V1 | Organic Chemistry Lab – I | 0 | 0 | 4 | 2 | 25 | 25 | 50 |
| 4. | DSC-A4/ Major | CHU-108-V1 | Physical Chemistry Lab – II | 0 | 0 | 4 | 2 | 25 | 25 | 50 |
| 5. | MIC-2 / Minor | OSU-120-V1 OSU-118-V1 | Elementary Calculus Physics-II/ | 4 | 0 | 0 | 4 | 40 | 60 | 100 |
| 6. | MDC-2/ Multidisciplinary | OSU-122-V1 OSU-124-V1 OSU-126-V1 OSU-128-V1 | Journalism-II/ Economics-II/ Finance-II/ Management-II/ | 3 | 0 | 0 | 3 | 40 | 60 | 100 |
| 7. | AEC-2/ Ability Enhancement | AEC-102-V1 | Communication, Meditation, and Resolution (CMR) | 2 | 0 | 0 | 2 | 40 | 60 | 100 |
| 8. | SEC2-1/ Skill Enhancement | CHU-110-V1 | Instrumentation Skills-II | 2 | 0 | 0 | 2 | 40 | 60 | 100 |
| 9. | SEC2-2/ Skill Enhancement | CHU-112-V1 | Instrumentation Skills Lab-II | 0 | 0 | 2 | 1 | 25 | 25 | 50 |
| 10. | VAC-2/ Value Added Courses | AEC-117-V1/ VAC-308-V1/VAC-104-V1 | Yoga and Meditation Universal Human Values Indian Knowledge System | 2 | 0 | 0 | 2 | 40 | 60 | 100 |
| | | | **Total** | **21** | **0** | **10** | **26** | **355** | **495** | **850** |
| 11. | Internship in Industry / University** | | | 0 | 0 | 8 | 4 | - | - | - |

**Semester-I**

| Course Code | Name of Courses | Max Marks | Hrs. Per Week | Credit |
|---|---|---|---|---|
| CHU-101-V1 | Inorganic Chemistry - I | 40 + 60 = 100 | 4 | 4 |
| | | L – 4 | T - 0 | P - 0 |

**Course Objectives:**

- Learn basic concept of atom and its structure in detail.
- Arrangement of electrons in atom.
- Concept of s, p, d and f orbitals and their shape using.
- Understand nature of chemical bonding and concept of molecular orbitals

**Learning Outcomes:**

- The objective of the course is to make the students understand the basic concept of atom and atomic structure, periodic properties of elements and chemical bonding.

**Course Content:**

**Unit-I** **Atomic Structure: (15 Hrs)**

**Atomic Structure:** Recapitulation of 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, the 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; Pauli's Exclusion Principle, Hund's rule of maximum multiplicity, aufbau principle and its limitations.

**Unit-II** **Periodicity of Elements (15 Hrs)**

Brief discussion of the following properties of the elements, with reference to *s* & *p*-block and the trends shown. Effective nuclear charge, shielding or screening effect, Slater rules, variation of effective nuclear charge in periodic table. Atomic and ionic radii. Ionization enthalpy, Successive ionization enthalpies and factors affecting ionization enthalpy and trends in groups and periods. Electron gain entahlpy and trends in groups and periods. Electronegativity, Pauling's/ Allred Rochow's scales. Variation of electronegativity with bond order, partial charge, hybridization, group electronegativity.

**Unit-III** **Chemical Bonding-I (15 Hrs )**

Ionic bond: General characteristics, types of ions, size effects, radius ratio rule and its limitations. Packing of ions in crystals. Born-Landé equation with derivation and importance of Kapustinskii expression for lattice energy. Madelung constant, Born-Haber cycle and its application, Solvation energy; Covalent bond: Lewis structure, Valence Bond theory (Heitler-London approach). Energetics of hybridization, equivalent and non-equivalent hybrid orbitals. Bent's rule, Resonance and resonance energy, Molecular orbital theory. Molecular orbital diagrams of diatomic and simple polyatomic molecules $N_2$, $O_2$, $C_2$, $B_2$, $F_2$, CO, NO, and their ions; HCl (idea of s-p mixing and orbital interaction to be given). Formal charge, Valence shell electron pair repulsion theory (VSEPR), shapes of the following simple molecules and ions containing lone pairs and bond pairs of electrons: $H_2O$, $NH_3$, $PCl_3$, $PCl_5$, $SF_6$, $ClF_3$, $I_3^-$, $BrF_2^+$, $PCl_6^-$, $ICl_2^-$$ICl_4^-$ and $SO_4^{2-}$, Multiple bonding and bond lengths.

**Unit-IV** **Chemical Bonding-I (15 Hrs )**

Covalent character in ionic compounds, polarizing power and polarizability. Fajan's rules and consequences of polarization. Ionic character in covalent compounds: Bond moment and dipole moment. Percentage ionic character from dipole moment and electronegativity difference. Metallic Bond: Qualitative idea of valence bond and band theories. Semiconductors and insulators, defects in solids. Weak Chemical Forces: van der Waals forces, ion-dipole forces, dipole-dipole interactions, induced dipole interaction. Hydrogen bonding (theories of hydrogen bonding, valence bond treatment). Effects of weak chemical forces, melting and boiling points, solubility, energetics of dissolution process.

✓ Discussion on correlation of the course content with Ancient Indian Knowledge System

**Suggested Books/Reading:**


| | |
|---|---|
| 1. | Lee, J.D. Concise Inorganic Chemistry, Pearson Education 2010 |
| 2. | Huheey, J.E., Keiter, E.A., Keiter, R. L., Medhi, O.K. Inorganic Chemistry, Principles of Structure and Reactivity, Pearson Education 2006. |
| 3. | Douglas, B.E. and Mc Daniel, D.H., Concepts & Models of Inorganic Chemistry, Oxford, 1970 |
| 4. | Shriver, D.D. & P. Atkins, *Inorganic Chemistry 2nd Ed.,* Oxford University Press, 1994. |
| 5. | Day, M.C. and Selbin, J. Theoretical Inorganic Chemistry, ACS Publications 1962. |

**Summary of marks distribution and weightage**

| Sr. No. | Component | Total Marks | Internal Weightage | External Weightage |
|---|---|---|---|---|
| | | | Total=40 Marks | Total= 60 Marks |
| 1. | Theory | 100 | Sessional= 25** Marks<br>PBL# = 15 Marks | Assessment will be done through external examination |

# Project Based Learning (PBL) may contain the following components.

1. Assignments
2. Quiz
3. Surprise Test
4. Mini Projects
5. Tutorials
6. Case Studies
7. Visit to site/Company/Laboratories
8. Field Work
9. Seminars

**Semester-I**

| Course Code | Name of Courses | Max Marks | Hrs. Per Week | Credit |
|---|---|---|---|---|
| CHU-103-V1 | Physical Chemistry - I | 40 + 60 = 100 | 4 | 4 |
| | | L – 4 | T - 0 | P - 0 |

**Course Objectives:**

The objective of the course is to make the students understand the different states of matter and various laws governing the properties of solid, liquid and gaseous state. Emphasis will also be on the basic concept of ionic equilibrium and its applications.

**Learning Outcomes:**

- Learn the states of matter in detail.
- Laws governing the solid, liquid and gaseous state.
- Have a deep-understanding methods to study the solid, liquid and gaseous state.
- Concept of ionic equilibria and its applications.

**Course Content:**

**Unit-I** **Gaseous state (18 Hrs)**

Kinetic molecular model of a gas: postulates and derivation of the kinetic gas equation; collision frequency; collision diameter; mean free path and viscosity of gases, including their temperature and pressure dependence, relation between mean free path and coefficient of viscosity, calculation of ζ from η; variation of viscosity with temperature and pressure. 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, degrees of freedom and molecular basis of heat capacities; Behaviour of real gases: Deviations from ideal gas behaviour, compressibility factor, Z, and its variation with pressure and temperature for different gases. Causes of deviation from ideal behaviour. van der Waals equation of state, its derivation and application in explaining real gas behaviour, calculation of Boyle temperature. Isotherms of real gases and their comparison with van der Waals isotherms, continuity of states, critical state, relation between critical constants and van der Waals constants, law of corresponding states.

**Unit-II** **Liquid state (6 Hrs)**

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.

**Unit-III** **Solid state (16 Hrs)**

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, CsCl and KCl.

**Unit-IV** **Ionic equilibria (20 Hrs)**

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 and diprotic acids. Salt hydrolysis-calculation of hydrolysis constant, degree of hydrolysis and pH for different salts. Buffer solutions; derivation of Henderson equation and its applications. 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.

✓ Discussion on correlation of the course content with Ancient Indian Knowledge System

**Suggested Books/Reading:**


| | |
|---|---|
| 1. | Atkins, P. W. & Paula, J. de Atkin's Physical Chemistry Ed., Oxford University Press 13 (2006). |
| 2. | Ball, D. W. Physical Chemistry Thomson Press, India (2007). |
| 3. | Castellan, G. W. Physical Chemistry 4th Ed. Narosa (2004). |
| 4. | Mortimer, R. G. Physical Chemistry 3rd Ed. Elsevier: NOIDA, UP (2009). |

**Summary of marks distribution and weightage**

| Sr. No. | Component | Total Marks | Internal Weightage | External Weightage |
|---|---|---|---|---|
| | | | Total=40 Marks | Total= 60 Marks |
| 1. | Theory | 100 | Sessional= 25** Marks<br>PBL# = 15 Marks | Assessment will be done through external examination |

# Project Based Learning (PBL) may contain the following components.

1. Assignments
2. Quiz
3. Surprise Test
4. Mini Projects
5. Tutorials
6. Case Studies
7. Visit to site/Company/Laboratories
8. Field Work
9. Seminars

**Semester-I**

| Course Code | Name of Courses | Max Marks | Hrs. Per Week | Credit |
|---|---|---|---|---|
| CHU-105-V1 | Inorganic Chemistry Lab-I | 25 + 25 = 50 | 4 | 2 |
| | | L – 0 | T - 0 | P - 4 |

**Course Objectives:**

- To teach skills of preparation of solutions and basics of Tritimetry and Acid Base analysis.

**Learning Outcomes:**

- Student will be able to prepare different molar/normal solutions, understanding of estimation methods and their applicability for laboratory handling.

**Course Content:**

**Unit-I** **Titrimetric Analysis**

Calibration and use of apparatus
(i) Preparation of solutions of titrants of different Molarity/Normality

**Unit-II** **Acid-Base Titrations**

Principles of acid-base titrations to be discussed.
(i) Estimation of sodium carbonate using standardized HCl solution.
(ii) Estimation of carbonate and hydroxide present in a solution together in a mixture.
(iii) Estimation of carbonate and bicarbonate present in a solution together in a mixture.
(iv) Estimation of free alkali present in different soaps/detergents

**Unit-III** **Oxidation-Reduction Titrimetry**

Principles of oxidation-reduction titrations (electrode potentials) to be discussed.
(i) Estimation of Fe(II) and oxalic acid present in a solution using standardized $KMnO_4$ solution
(ii) Estimation of oxalic acid and sodium oxalate in a given mixture.
(iii) Estimation of Fe(II) with $K_2Cr_2O_7$ using internal indicator (diphenylamine, N-phenylanthranilic acid) and discussion of external indicator present in a solution.

✓ Discussion on correlation of the course content with Ancient Indian Knowledge System

**Suggested Books/Reading:**

1. Vogel, A.I. A Textbook of Quantitative Inorganic Analysis, ELBS

**Summary of marks distribution and weightage**

| Sr. No. | Component | Total Marks | Internal Weightage | External Weightage |
|---|---|---|---|---|
| | | | Total= 25 Marks | Total= 25 Marks |
| 1. | Practical | 50 | Internal viva=10<br>Cont. Eval. =10<br>Lab record=5 | Viva = 10<br>Execution = 10<br>Written = 5 |

**Semester-I**

| Course Code | Name of Courses | Max Marks | Hrs. Per Week | Credit |
|---|---|---|---|---|
| CHU-107-V1 | Physical Chemistry Lab-I | 25 + 25 = 50 | 4 | 2 |
| | | L – 0 | T - 0 | P - 4 |

**Course Objectives:**

- To invoke physical property analysis and teach handling of glass apparatus for physical parameter measurements.
- To understand signatures of crystalline system and get practical understanding
- To imbibe Acid-Base handlining and their key aspect of acid-base analysis.

**Learning Outcomes:**

- Student will be able to characterize liquid properties, crystalline system and acid/bases

**Course Content:**

| | |
|---|---|
| **Unit-I** | **Surface tension and Viscosity measurement** |

1. Determine the surface tension by (i) drop number (ii) drop weight method in a solution.
2. Study the variation of surface tension with different concentration of detergent solutions. Determine CMC.
3. Determination of co-efficient of viscosity of an unknown aqueous solution.
4. Study the variation of co-efficient of viscosity with different concentration of Poly Vinyl Alcohol (PVA) and determine molar of PVA.
5. Study the variation of viscosity with different concentration of sugar solution.

| | |
|---|---|
| **Unit-II** | **Solid State** |

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

| | |
|---|---|
| **Unit-III** | **pH metry** |

a. Study the effect of addition of HCl/NaOH on pH to the solutions of acetic acid, sodium acetate and their mixtures.
b. Preparation of buffer solutions of different pH values: (i) Sodium acetate-acetic acid, (ii) Ammonium chloride-ammonium hydroxide
c. pH metric titration of (i) strong acid with strong base, (ii) weak acid with strong base.
d. Determination of dissociation constant of a weak acid.
Any other experiment carried out in the class.

✓ Discussion on correlation of the course content with Ancient Indian Knowledge System

**Suggested Books/Reading:**


| | |
|---|---|
| 1. | Khosla, B. D.; Garg, V. C. & Gulati, A. Senior Practical Physical Chemistry, R. Chand & Co.: New Delhi (2011). |
| 2. | Garland, C. W.; Nibler, J. W. & Shoemaker, D. P. Experiments in Physical Chemistry 8th Ed.;McGraw-Hill: New York (2003). |


**Summary of marks distribution and weightage**

| Sr. No. | Component | Total Marks | Internal Weightage | External Weightage |
|---|---|---|---|---|
| | | | Total= 25 Marks | Total= 25 Marks |
| 1. | Practical | 50 | Internal viva=10<br>Cont. Eval. =10<br>Lab record=5 | Viva = 10<br>Execution = 10<br>Written = 5 |

**Semester-I**

| Course Code | Name of Courses | Max Marks | Hrs. Per Week | Credit |
|---|---|---|---|---|
| CHU-109-V1 | Instrumentation Skills-I | 40+ 60 = 100 | 2 | 2 |
| | | L – 2 | T - 0 | P - 0 |

**Course Objectives:**

- To revise error estimation, and qualitative and quantitative aspects of analysis.
- To study aspects of chemical system and solvent extraction.
- To learn the theory and practice of chromatography.

**Learning Outcomes:**

- Ability to derive physical chemistry laws & functions and learning of solving physical chemistry numerical.
- Apply equilibrium aspects to deduce effects of chemical reaction parameters and estimation of molecular mass of solute.

**Course Content:**

**Unit-I** **Chemical Preparations (7 Hrs)**

SI Units and Derived units of Mass, Length, Time, Temperature, Amount of substance, Electrical current and Luminous intensity), Conversion between units, Significant figures, Concentration Terms, and their applicability; Qualitative and quantitative aspects of analysis:

**Unit-II** **Analytical Approach (8 hrs)**

Sampling, evaluation of analytical data, errors, accuracy and precision, methods of their expression, methods for determination of uncertainty, normal law of distribution in indeterminate errors, Statistical treatment of measurement data by means of different hypothesis testing (for example Q test, t-tests, F-tests and ANOVA) and linear regression statistical test of data and confidence intervals.

**Unit-III** **Solvent extraction (7 hrs)**

A. Solvent extraction: Distribution law, determination of distribution ratio, Mechanism of extraction: extraction by solvation and chelation, Techniques of extraction: batch extraction, continuous extraction, discontinuous extraction, counter current batch, continuous and counter-current extractions. Qualitative and quantitative aspects of solvent extraction: extraction of metal ions from aqueous solution, extraction of organic species from the aqueous and nonaqueous media.

**Unit-IV** **Chromatography (8 hrs)**

Theory and practice: Introduction, chromatography (elution time and volume) capacity factor, column efficiency and resolution, sample preparation; Techniques of paper chromatography: Experimental modifications, various modes of development, nature of paper, detections of spots, retardation factors, factors that affect the reproducibility of Rf values (due to paper, solvent system, sample, development procedures), selection of solvent, quantitative analysis, and applications; Thin layer chromatography: Stationary phase, adsorbents, liquid phase support, plate preparation, mobile phase, sample application, development, saturation of chamber, detection of spot, Rf values (effect of adsorbent, solvent, solute, development process), quantitative analysis, applications.

✓ Discussion on correlation of the course content with Ancient Indian Knowledge System

**Suggested Books/Reading:**

1. D. A. McQuarrie and J. D. Simon, "Physical Chemistry. A Molecular Approach" University Science Books, Sausalito 1997.
2. Ira N. Levine, "Physical Chemistry" Tata McGraw-Hill Education, 2011.
3. P.W. Atkins and Julio de Paula, "Physical Chemistry", 8th Ed., W. H. Freeman Publication, 2006.
4. G.M. Barrow, "Physical Chemistry" Tata McGraw-Hill Education, 2008.
5. Castellan, G. W. Physical Chemistry 4th Ed., Narosa (2004).

**Summary of marks distribution and weightage**

| Sr. No. | Component | Total Marks | Internal Weightage | External Weightage |
|---|---|---|---|---|
| | | | Total=40 Marks | Total= 60 Marks |
| 1. | Theory | 100 | Sessional= 25** Marks<br>PBL# = 15 Marks | Assessment will be done through external examination |

# Project Based Learning (PBL) may contain the following components.

1. Assignments
2. Quiz
3. Surprise Test
4. Mini Projects
5. Tutorials
6. Case Studies
7. Visit to site/Company/Laboratories
8. Field Work
9. Seminars

| Semester-I | | | | |
|---|---|---|---|---|
| **Course Code** | **Name of Courses** | **Max Marks** | **Hrs. Per Week** | **Credit** |
| **CHU-111-V1** | **Instrumentation Skills Lab-I** | **25 + 25 = 50** | **2** | **1** |
| | | **L – 0** | **T - 0** | **P - 2** |

**Course Objectives:**

- To give hands-on training and practice chemical laboratory analytical tools.
- To learn handling of spectrophotometers and basics of its sample preparations and analysis.

**Learning Outcomes:**

- Student will be acquainted with separation methods and characterization of liquid samples/food samples.

**Course Content:**

**Unit-I** **Apparatus and Chemical Sstandards (15 Hrs)**

1. Use and calibration of volumetric glass apparatus (volumetric flasks, pipettes and burettes).
2. Preparing solutions: standard solutions, primary standards, secondary standards.
3. Handling of Vacuum Pump and filtration procedures

**Unit-II** **Chromatography (15 Hrs)**

1. Separation and identification of monosaccharides present in a given mixture by radial paper.
2. Separation of ortho-nitrophenol and para-nitrophenol by thin layer chromatography.
3. Separation of constituents of leaf pigments by thin layer chromatography.
4. Use of pH meter: determination of pH of given dilute solutions of shampoos and soaps
5. Determine the pH of the given aerated drinks fruit juices, shampoos, and soaps.
6. Separation of a mixture of two amino acids by ascending and horizontal paper chromatography
7. Separation of a mixture of two sugars by ascending paper chromatography
8. Separation of a mixture of o-and p-nitrophenol or o-and p-aminophenol by thin layer chromatography (TLC)

✓ Discussion on correlation of the course content with Ancient Indian Knowledge System

**Suggested Books/Reading:**

1. Higson, S. P.J. (2003), Analytical Chemistry, Oxford University Press.
2. Skoog, D.A.; West, D.M. (2003), Fundamentals of Analytical Chemistry, Brooks/Cole.
3. Christian, G.D.(2004), Analytical Chemistry, 6th Edition, John Wiley & Sons, New York.
4. Fifield,F.W.; Kealey, D. (2000), Principles and Practice of Analytical Chemistry, Wiley.
5. Harris, D. C. (2007), Exploring Chemical Analysis, W.H. Freeman and Co.

**Summary of marks distribution and weightage**

| Sr. No. | Component | Total Marks | Internal Weightage | External Weightage |
|---|---|---|---|---|
| | | | Total= 25 Marks | Total= 25 Marks |
| 1. | Practical | 50 | Internal viva=10<br>Cont. Eval. =10<br>Lab record=5 | Viva = 10<br>Execution = 10<br>Written = 5 |

# SEMESTER II

| Semester-II | | | | |
|---|---|---|---|---|
| **Course Code** | **Name of Courses** | **Max Marks** | **Hrs. Per Week** | **Credit** |
| **CHU-102-V1** | **Organic Chemistry - I** | **40 + 60 = 100** | **4** | **4** |
| | | **L – 4** | **T - 0** | **P - 0** |

**Course Objectives:**

The objective of the course is to have an understanding the structure and bonding in organic chemistry, electronic displacements, stereochemistry and chemistry of aliphatic and aromatic hydrocarbons.

**Learning Outcomes:**

- Know the basic concepts of organic chemistry.
- Understand the basics of reaction mechanism.
- Stereochemistry and optical isomerism in organic compounds.
- Understand the chemistry of aliphatic and aromatic hydrocarbons

**Course Content:**

**Unit-I** **Recapitulation of basics of Organic Chemistry (9 Hrs)**

Hybridization, Shapes of molecules Electronic Displacements: Inductive, electromeric, resonance and mesomeric effects, hyperconjugation
Dipole moment; Hydrogen bonding (Applications to be discussed with relevant topics)
Homolytic and Heterolytic fission with suitable examples. Curly arrow rules, formal charges; Electrophiles and Nucleophiles; Types, shape and relative stability of Carbocations, Carbanions, Free radicals and Carbenes.
Introduction to types of organic reactions: Addition, Elimination and Substitution reactions.

**Unit-II** **Stereochemistry (15 Hrs)**

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

**Unit-III** **Chemistry of Aliphatic Hydrocarbons (18 Hrs)**

**A. Carbon-Carbon sigma bonds**

General methods of preparation, physical and chemical properties of alkanes: Wurtz Reaction, Wurtz-Fittig Reactions, Free radical substitutions: Halogenation -relative reactivity and selectivity.

**B. Carbon-Carbon pi-bonds:**

General methods of preparation, physical and chemical properties of alkenes and alkynes, Mechanism of E1, E2, E1cb reactions. Saytzeff and Hofmann eliminations. Electrophilic additions their mechanisms (Markownikoff/ Anti Markownikoff addition), mechanism of oxymercuration-demercuration, hydroboration- oxidation, ozonolysis, reduction (catalytic and chemical), syn and anti-hydroxylation(oxidation). 1,2-and 1,4-addition reactions in conjugated dienes and Diels-Alder reaction; Allylic and benzylic bromination and mechanism, e.g. propene, 1-butene, toluene, ethyl benzene.
Reactions of alkynes: Acidity, Electrophilic and Nucleophilic additions. Hydration to form carbonyl compounds, Alkylation of terminal alkynes

**Unit-IV** **Conformational Analysis and Aromatic Hydrocarbons (18 Hrs)**

Conformational analysis of alkanes: Relative stability and Energy diagrams. Types of cycloalkanes and their relative stability, Baeyer strain theory Chair, Boat and Twist boat forms of cyclohexane with energy diagrams; Relative stability of mono substituted cycloalkanes.
**Aromaticity**: Hückel's rule, aromatic character of arenes, cyclic carbocations/carbanions and heterocyclic compounds with suitable examples. Electrophilic aromatic substitution: halogenation, nitration, sulphonation and Friedel-Craft's alkylation/acylation with their mechanism. Directing effects of the groups.

✓ Discussion on correlation of the course content with Ancient Indian Knowledge System

**Suggested Books/Reading:**


| | |
|---|---|
| 1. | Morrison, R. N. & Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education). |
| 2. | Eliel, E. L. &Wilen, S. H. Stereochemistry of Organic Compounds; Wiley: London, 1994 |
| 3. | Finar, I. L. Organic Chemistry (Volume 1), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education). |
| 4. | Kalsi, P. S. Stereochemistry Conformation and Mechanism; New Age International, 2005 |
| 5. | Finar, I. L. Organic Chemistry (Volume 2: Stereochemistry and the Chemistry of Natural Products), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education). |

**Summary of marks distribution and weightage**

| Sr. No. | Component | Total Marks | Internal Weightage | External Weightage |
|---|---|---|---|---|
| | | | Total=40 Marks | Total= 60 Marks |
| 1. | Theory | 100 | Sessional= 25** Marks<br>PBL# = 15 Marks | Assessment will be done through external examination |

# Project Based Learning (PBL) may contain the following components.

1. Assignments
2. Quiz
3. Surprise Test
4. Mini Projects
5. Tutorials
6. Case Studies
7. Visit to site/Company/Laboratories
8. Field Work
9. Seminars

**Semester-II**

| Course Code | Name of Courses | Max Marks | Hrs. Per Week | Credit |
|---|---|---|---|---|
| CHU-104-V1 | Physical Chemistry - II | 40 + 60 = 100 | 4 | 4 |
| | | L – 4 | T - 0 | P - 0 |

**Course Objectives:**

The objective of the course is to have an understanding concept of thermodynamics in chemistry, system of variable composition, chemical equilibrium, solutions and colligative properties

**Learning Outcomes:**

- Understand the basic concept of chemical thermodynamics and the laws governing.
- Learn the basics of systems of variable compositions.
- Learn the concept of chemical equilibrium.
- Learn solution and colligative properties.

**Course Content:**

**Unit-I** **Chemical Thermodynamics (36 Hrs)**

Intensive and extensive variables; state and path functions; isolated, closed, and open systems.
**First law:** Concept of heat, Q, work, W, internal energy, U, and statement of first law; enthalpy, H, the relation between heat capacities, calculations of Q, W, ΔU, and ΔH for reversible, irreversible, and free expansion of gases (ideal and van der Waals) under isothermal and adiabatic conditions. Thermochemistry: Heats of reactions: standard states; enthalpy of formation and enthalpy of combustion and its applications; effect of temperature (Kirchhoff's equations) and pressure on enthalpy of reactions.
**Second Law:** Concept of entropy; thermodynamic scale of temperature, statement of the second law of thermodynamics. Calculation of entropy change for reversible and irreversible processes.
**Third Law:** Statement of third law, concept of residual entropy, calculation of absolute entropy of molecules. Free Energy Functions: Gibbs and Helmholtz energy; variation of S, G, A with T, V, P; Free energy change and spontaneity. Relation between Joule-Thomson coefficient and other thermodynamic parameters; inversion temperature; Gibbs-Helmholtz equation; Maxwell relations; thermodynamic equation of state.

**Unit-II** **Systems of Variable Composition (8 Hrs)**

Partial molar quantities, dependence of thermodynamic parameters on composition; Gibbs Duhem equation, chemical potential of ideal mixtures, change in thermodynamic functions in mixing of ideal gases.

**Unit-III** **Chemical Equilibrium (8 Hrs)**

Criteria of thermodynamic equilibrium, degree of advancement of reaction, chemical equilibria in ideal gases. Thermodynamic derivation of relation between Gibbs free energy of reaction and reaction quotient. Equilibrium constants and their quantitative dependence on temperature, pressure and concentration (Le Chatelier Principle, Quantitatively). Free energy of mixing and spontaneity. equilibrium between ideal gases and a pure condensed phase.

**Unit-IV** **Solutions and Colligative Properties (8 Hrs)**

Dilute solutions; lowering of vapour pressure, Raoult's and Henry's Laws and their applications. Thermodynamic derivation using chemical potential to derive relations between the four colligative properties [(i) relative lowering of vapour pressure, elevation of boiling point, (iii) Depression of freezing point, (iv) osmotic pressure] and amount of solute. Applications in calculating molar masses of normal, dissociated and associated solutes in solution.

✓ Discussion on correlation of the course content with Ancient Indian Knowledge System

**Suggested Books/Reading:**


1. Peter, A. & Paula, J. de. Physical Chemistry 9th Ed., Oxford University Press (2011).
2. Castellan, G. W. Physical Chemistry 4th Ed., Narosa (2004).
3. Rastogi, R.P and Mishra, R.R. An introduction to chemical Thermodynamics,1995.
4. Kapoor, K.L., A text book of physical chemistry, vol 2, McGraw Hill education

**Summary of marks distribution and weightage**

| Sr. No. | Component | Total Marks | Internal Weightage | External Weightage |
|---|---|---|---|---|
| | | | Total=40 Marks | Total= 60 Marks |
| 1. | Theory | 100 | Sessional= 25** Marks<br>PBL# = 15 Marks | Assessment will be done through external examination |

# Project Based Learning (PBL) may contain the following components.

1. Assignments
2. Quiz
3. Surprise Test
4. Mini Projects
5. Tutorials
6. Case Studies
7. Visit to site/Company/Laboratories
8. Field Work
9. Seminars

| Semester-II | | | | |
|---|---|---|---|---|
| **Course Code** | **Name of Courses** | **Max Marks** | **Hrs. Per Week** | **Credit** |
| **CHU-106-V1** | **Organic Chemistry Lab - I** | **25 + 25 = 50** | **4** | **2** |
| | | **L – 0** | **T - 0** | **P - 4** |

**Course Objectives:**

- The objective of the course is to have an understanding concept of fundamental lab practices of organic compounds, Organic Preparations and separations of organic compounds

**Learning Outcomes:**

- Student will be able to get acquainted with organic synthesis, crystallization of organic compounds and their identification

**Course Content:**

**Unit-I** **Basic Organic Lab Practices and Preparations (15 hrs)**

- Checking the calibration of the thermometer
- Purification of organic compounds by crystallization using the following solvents: a.Water b.Alcohol c.Alcohol-Water
- Determination of the melting points of unknown organic compounds (Kjeldahl method and electrically heated melting point apparatus)
- Effect of impurities on the melting point – mixed melting point of two unknown organic compounds
- Determination of boiling point of liquid compounds. (boiling point lower than and more than 100 °C by distillation and capillary method)
- Detection of extra elements

**Unit-II** **Organic Preparations and functional groups detection (15 hrs)**

- Organic Preparations
  - Bromination of acetanilide / aniline / phenol
  - Nitration of nitrobenzene / toluene.
- Detection of Nitrogen-containing functional groups – Amine, Nitro, purines, and amides.

✓ Discussion on correlation of the course content with Ancient Indian Knowledge System

**Suggested Books/Reading:**

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

**Summary of marks distribution and weightage**

| Sr. No. | Component | Total Marks | Internal Weightage | External Weightage |
|---|---|---|---|---|
| | | | Total= 25 Marks | Total= 25 Marks |
| 1. | Practical | 50 | Internal viva=10<br>Cont. Eval. =10<br>Lab record=5 | Viva = 10<br>Execution = 10<br>Written = 5 |

| Semester-II | | | | |
|---|---|---|---|---|
| **Course Code** | **Name of Courses** | **Max Marks** | **Hrs. Per Week** | **Credit** |
| **CHU-108-V1** | **Physical Chemistry Lab - II** | **25 + 25 = 50** | **4** | **2** |
| | | **L – 0** | **T - 0** | **P - 4** |

**Course Objectives:**

- The objective of the course is to have an understanding concept of Calorimetry and concept of thermodynamics from lab experiments.

**Learning Outcomes:**

- Student will understand electromagnetic spectrum and atomic/group signatures of wavelength.

**Course Content:**

**Unit-I** **Principle, working and applications of some basic instruments (7 hrs)**

Principle, construction, working and applications of some basic instruments/equipment's used in chemistry: Conductivity meter, Polarimeter, colorimeter and refractometer

**Unit-II** **Calorimetry (23 hrs)**

- Determination of heat capacity of a calorimeter for different volumes using (i) change of enthalpy data of a known system (method of back calculation of heat capacity of calorimeter from known enthalpy of solution of sulphuric acid or enthalpy of neutralization), and heat gained equal to heat lost by cold water and hot water respectively.
  - Determination of enthalpy of neutralization of hydrochloric acid with sodium hydroxide.
  - Determination of the enthalpy of ionization of ethanoic acid.
  - Determination of integral enthalpy (endothermic and exothermic) solution of salts.
  - Determination of basicity of a diprotic 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.
- Determination of enthalpy of hydration of salt.
- Study of the solubility of benzoic acid in water and determination of ΔH.
- Any other experiment carried out in the class.

✓ Discussion on correlation of the course content with Ancient Indian Knowledge System

**Suggested Books/Reading:**

1. Khosla, B. D.; Garg, V. C. & Gulati, A. Senior Practical Physical Chemistry, R. Chand & Co.: New Delhi (2011).
2. Athawale, V. D. & Mathur, P. Experimental Physical Chemistry New Age International: New Delhi (2001)

**Summary of marks distribution and weightage**

| Sr. No. | Component | Total Marks | Internal Weightage | External Weightage |
|---|---|---|---|---|
| | | | Total= 25 Marks | Total= 25 Marks |
| 1. | Practical | 50 | Internal viva=10<br>Cont. Eval. =10<br>Lab record=5 | Viva = 10<br>Execution = 10<br>Written = 5 |

| Semester-II | | | | |
|---|---|---|---|---|
| **Course Code** | **Name of Courses** | **Max Marks** | **Hrs. Per Week** | **Credit** |
| **CHU-110-V1** | **Instrumentation Skills-II** | **40 + 60= 100** | **2** | **2** |
| | | **L – 2** | **T - 0** | **P - 0** |

**Course Objectives:**

- To invoke optical methods and their application for photophysical characteristics of compounds.
- To teach spectroscopy of simple organic compound to understand UV-IR signatures.

**Learning Outcomes:**

- Student will be acquainted with UV-IR Spectroscopy method and characterization of optical active compounds using Optical Analytical Methods

**Course Content:**

| | |
|---|---|
| **Unit-I** | **Optical Analytical Methods and Applications (6 Hrs)** |

Origin of spectra, the interaction of radiation with matter, fundamental laws of spectroscopy and selection rules, validity of Beer-Lambert's law. General principles Introduction to absorption and emission spectroscopy.

| | |
|---|---|
| **Unit-II** | **UV Spectroscopy and applications (8 hrs)** |

Introduction: Electromagnetic radiations, regions of spectrum, basic features of spectroscopy, statement of Born-Oppenheimer approximation. Types of electronic transitions, λmax, Chromophores and Auxochromes, Bathochromic and Hypsochromic shifts, Intensity of absorption distinction between cis and trans isomers.

| | |
|---|---|
| **Unit-III** | **IR Spectroscopy and applications (10 hrs)** |

IR Spectroscopy: Fundamental and non-fundamental molecular, vibrations degrees of freedom, vibrational frequencies of functional group, 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.

| | |
|---|---|
| **Unit-IV** | **Redox and Coulometric Titration (6 Hrs)** |

Redox Principle, Redox Titration, Moisture Content Determination using Karl Fischer Titration, Principle, coulometric or volumetric, Classification of Karl Fischer Titration, Types of reagents, Karl Fischer Titrator, Instrumentation, Applications

✓ Discussion on correlation of the course content with Ancient Indian Knowledge System

**Suggested Books/Reading:**

1. Christian, Gary D; Analytical Chemistry, 6th Ed. John Wiley & Sons, New York,
2. Harris, Daniel C: Exploring Chemical Analysis, Ed. New York, W.H. Freeman, 2001.
3. Khopkar, S.M. Basic Concepts of Analytical Chemistry. New Age, International

**Summary of marks distribution and weightage**

| Sr. No. | Component | Total Marks | Internal Weightage | External Weightage |
|---|---|---|---|---|
| | | | **Total=40 Marks** | **Total= 60 Marks** |
| **1.** | **Theory** | **100** | **Sessional= 25** Marks<br>**PBL# = 15 Marks** | **Assessment will be done through external examination** |

# Project Based Learning (PBL) may contain the following components.

1. Assignments
2. Quiz
3. Surprise Test
4. Mini Projects
5. Tutorials
6. Case Studies
7. Visit to site/Company/Laboratories
8. Field Work
9. Seminars

| Semester-II | | | | |
|---|---|---|---|---|
| **Course Code** | **Name of Courses** | **Max Marks** | **Hrs. Per Week** | **Credit** |
| **CHU-112-V1** | **Instrumentation Skills Lab-II** | **25 + 25 = 50** | **2** | **1** |
| | | **L – 0** | **T - 0** | **P - 2** |

**Course Objectives:**

- To give hands-on training and practice chemical laboratory analytical tools and plotting of data.
- To learn handling of spectrophotometers and basics of its sample preparations and analysis.

**Learning Outcomes:**

- Student will be able to handle spectrophotometer and will be able to understand significance of precision and its applications.

**Course Content:**

**Unit-I** **Apparatus and Chemical standards (15 Hrs)**

1. Plotting tools using MS Excel
2. Regression analysis and slope, intercept analysis of given data.
3. Background correction and its significance in analysis
4. Use of electronic balances and handling basics
5. Redox Principle, Moisture Content Determination using Karl Fischer Titration, Principle, Types of reagents, Karl Fischer Titrator, Instrumentation, Applications

**Unit-II** **UV-Visible Spectroscopy (15 Hrs)**

1. Determine the concentration of an unknown sample by using UV-Visible spectrophotometry.
2. To evaluate, λmax of the organic molecules in different solvents.
3. To understand the solvatochromism by UV-Visible spectroscopy.
4. To understand the effect of conjugation on the UV-Visible spectra of organic molecules.
5. Structural characterization of compounds by infrared spectroscopy.

✓ Discussion on correlation of the course content with Ancient Indian Knowledge System

**Suggested Books/Reading:**


1. Day. R. A.; Underwood, A. L. (1991), Quantitative Analysis, Prentice Hall of India.
2. Gordus, A. A. (1985), Outline of Analytical Chemistry, Tala McGraw-Hill.
3. Dean J. A. (1997), Analytical Chemistry Handbook, McGraw Hill.
4. Jeffery, G.H.; Bassett, J.; Mendham, J.; Denney, R.C. (1989), Vogel's Textbook of
5. Quantitative Chemical Analysis, John Wiley and Sons.


**Summary of marks distribution and weightage**

| Sr. No. | Component | Total Marks | Internal Weightage | External Weightage |
|---|---|---|---|---|
| | | | Total= 25 Marks | Total= 25 Marks |
| 1. | Practical | 50 | Internal viva=10<br>Cont. Eval. =10<br>Lab record=5 | Viva = 10<br>Execution = 10<br>Written = 5 |

| Semester- I | | | | |
|---|---|---|---|---|
| **Course** | **Name of Courses** | **Max Marks** | **Hrs. Per Week** | **Credit** |
| **OSU-115-V1** | **Basic Algebra** | **40+ 60= 100** | **4** | **4** |
| | | **L – 4** | **T - 0** | **P - 0** |

**Course Outcomes:**

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

- Gain the knowledge about the matrices
- Apply the knowledge of matrices in solving determinant, rank of amatrix and system of linear equations
- Learn about the set theory, relations and functions
- Apply the knowledge of relation and function in solving the problem

**Course Content:**

**Unit-I**

Concepts of Matrix, Types of matrices, Transpose of a matrix, Symmetric and skew symmetric matrices. Addition, multiplication and scalar multiplication of matrices, Concept of elementary row and column operations. Invertible matrices and inverse of a matrix using elementary operations.

**Unit-II**

Determinant of a square matrix (upto 3×3 matrices), Properties of determinants, Minors, Cofactors and applications of determinants in finding the area of a triangle, Adjoint and inverse of a squarematrix, Rank of a matrix, Consistency, Inconsistency and number of solutions of system of linear equations, Solving system of linear equations in two or three variables

**Unit-III**

Sets and their representations, Empty set, Finite and Infinite sets, Equal sets, Subsets, Power set, Universal set, Venn diagrams, Union and intersection of sets, Difference of sets, Complement of a set, Properties of Complement sets, Ordered pairs, Cartesian product of sets

**Unit-IV**

Definition of relation, pictorial diagrams, domain, co-domain and range of a relation, Function as a special kind of relation from one set to another, Pictorial representation of a function, domain, co- domain and range of a function, signum and greatest integer functions, Sum, difference, product and quotients of functions.

✓ Discussion on correlation of the course content with Ancient Indian Knowledge System

**Suggested Books/Reading:**

David C.Lay, Linear Algebra and its Applications(3rdEdition) Pearson Education Asia,IndianReprint,2007.

D. Poole, Linear Algebra: A Modern Introduction, 2nd Edition, Brooks/Cole, 2005.

Charles C. Pinter, A Book of Set Theory, Dover Publications, Inc., 2014.

Alexander Shen, N. K. Vereshchagin, Basic Set Theory, American Mathematical Soc., 2002

**Summary of marks distribution and weightage**

| Sr. No. | Component | Total Marks | Internal Weightage | External Weightage |
|---|---|---|---|---|
| | | | **Total=40 Marks** | **Total= 60 Marks** |
| **1.** | **Theory** | **100** | **Sessional= 25** Marks<br>**PBL# = 15 Marks** | **Assessment will be done through external examination** |

# Project Based Learning (PBL) may contain the following components.

1. Assignments
2. Quiz
3. Surprise Test
4. Mini Projects
5. Tutorials
6. Case Studies
7. Visit to site/Company/Laboratories
8. Field Work
9. Seminars

| Semester- II | | | | |
|---|---|---|---|---|
| **Course** | **Name of Courses** | **Max Marks** | **Hrs. Per Week** | **Credit** |
| **OSU-120-V1** | **Elementary Calculus** | **40 + 60 = 100** | **4** | **4** |
| | | **L – 4** | **T - 0** | **P - 0** |

**Course Outcomes:**

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

- Acquire the knowledge about differential calculus
- Understand the differentiation and maxima minima of functions
- Apply the knowledge of integral calculus
- Gain the knowledge of vector calculus

**Course Content:**

**Unit-I**

Limit, Continuity and differentiability of a function with examples, Derivative of sum, difference, product and quotient of functions, Derivatives of polynomial and trigonometric functions, Derivative of composite functions, Chain rule.

**Unit-II**

Derivatives of inverse trigonometric functions, derivative of implicit functions, Concepts of exponential, logarithmic functions and their derivatives, second order derivatives. Rate of change, Increasing/decreasing functions, Maxima and minima of a function.

**Unit-III**

Integration as inverse process of differentiation, Integration of a variety of functions by substitution, by partial fractions and by parts, Definite integrals as a limit of a sum, Basic properties of definite integrals and evaluation of definite integral.

**Unit-IV**

Vectors and scalars, magnitude and direction of a vector, Direction cosines/ratios of vectors, Types of vectors, position vector of a point, negative of a vector, components of a vector, addition of vectors, multiplication of a vector by a scalar, position vector of a point dividing a line segment in a given ratio, Scalar(dot) product of vectors, Vector (cross) product of vectors, scalar triple product.

✓ Discussion on correlation of the course content with Ancient Indian Knowledge System

**Suggested Books/Reading:**


1. G. B. Thomas and R.L.Finney,*Calculus*,9thEd.,PearsonEducation,Delhi,2005.
2. M. J. Strauss, G. L. Bradley and K. J. Smith, *Calculus,* 3rdEd., DorlingKindersley(India) P. Ltd.(Pearson Education), Delhi, 2007.
3. H. Anton, I. Bivens and S. Davis, Calculus, John Wiley and Sons Inc, 7/e (2011).
4. Shanti Narayan, Differential Calculus, S Chand Publisher.


**Summary of marks distribution and weightage**

| Sr. No. | Component | Total Marks | Internal Weightage | External Weightage |
|---|---|---|---|---|
| | | | **Total=40 Marks** | **Total= 60 Marks** |
| **1.** | **Theory** | **100** | **Sessional= 25** Marks**<br>**PBL# = 15 Marks** | **Assessment will be done through external examination** |

# Project Based Learning (PBL) may contain the following components.

1. Assignments
2. Quiz
3. Surprise Test
4. Mini Projects
5. Tutorials
6. Case Studies
7. Visit to site/Company/Laboratories
8. Field Work
9. Seminars

| Semester-I | | | | |
|---|---|---|---|---|
| **Course** | **Name of Courses** | **Max Marks** | **Hrs. Per Week** | **Credit** |
| **JMU-101-V1** | **Introduction to Communication** | **40 + 60 = 100** | **3** | **3** |
| | | **L – 3** | **T - 0** | **P - 0** |

**Course Objectives:**

1. Introduce basic aspects of communication, 2. To inculcate knowledge of communication types and Barriers; 3. To acquaint students with knowledge of the Communication Theories, 4. To orient students toward the Communication Models

**Course Outcomes:**

- Students would be able to introduce themselves to the nature of communication.
- Students would be able to inculcate knowledge of Communication types and barriers.
- Students would be able to develop knowledge of Communication theories.
- Students would be able to develop a knowledge of Communication models.

**Course Content:**

| **Unit-I** | **Communication Basics** |
|---|---|

Communication: Definitions, Meaning and Scope; Elements, Processes and Functions; Communication and Information; Communication and Language; Essentiality of Communication In Social Groups

| **Unit-II** | **Communication Types and Barriers** |
|---|---|

Intrapersonal Communication, Interpersonal Communication; Group Communication, Mass Communication; Verbal Communication, Non-Verbal Communication; Barriers to Communication; Removal Of Barriers

| **Unit-III** | **Communication Theories** |
|---|---|

Media Theories, Four Theories of Press; Interactive Theory, Two-Step Flow (Opinion Leaders); Multi-Step Flow, Uses & Gratification Theory; Cultivation Theory; Agenda Setting Theory

| **Unit-IV** | **Communication Models** |
|---|---|

SMCR Model, Shannon & Weaver Model; Wilbur Schramm Model; Lasswell Model, Gate Keeping Model Etc.; Sadharanikaran Model of Communication; Relevance of Communication Theories To Journalism Practice;

**ASSIGNMENTS**

- Discuss basic communication processes as well as self-perception in communication
- Write an essay/article on Communication and Social group (500-800) words.
- Students will test the relevance of any one selected theory on the basis of survey and interaction, and present the result through ppt.
- Assignment on audience understanding

✓ Discussion on correlation of the course content with Ancient Indian Knowledge System

**Suggested Books/Reading:**


- McQuail Denis. Mass Communication Theory, 4th ed., Sage Publication Ltd., London, 2000.
- Rogers M. Everett. A History of Communication Study, New York, Free Press, 1997.
- Department of Communication and Media Technology Page 29
- Littlejohn, W. Stephen. Theories of Human Communication, 3rd ed., Belmont, California,1989.
- Mass communication in India by Keval J . Kumar - A Jaico Book
- Communication Mosaics: An Introduction to the Field of Communication, 2001 By Wood, Julia T, Wadsworth Adhikary, N. M. (2007d).
- Hindu awadharanamagairashabdiksanchar. In N. M. Adhikary, Sanchar shodhara media paryavekshan (pp. 139-180). Kathmandu: PrashantiPustakBhandar.
- Joshi, P.C., Communication & Nation – Building – Perspective and Policy, Publication Division, New Delhi.
- Malhan P.N., Communication Media, Yesterday, Today and Tomorrow, Publication Division, New Delhi.

**Summary of marks distribution and weightage**

| Sr. No. | Component | Total Marks | Internal Weightage | External Weightage |
|---|---|---|---|---|
| | | | Total=40 Marks | Total= 60 Marks |
| 1. | Theory | 100 | Sessional= 25** Marks<br>PBL# = 15 Marks | Assessment will be done through external examination |

# Project Based Learning (PBL) may contain the following components.

1. Assignments
2. Quiz
3. Surprise Test
4. Mini Projects
5. Tutorials
6. Case Studies
7. Visit to site/Company/Laboratories
8. Field Work
9. Seminars

**Semester-I**

| Course | Name of Courses | Max Marks | Hrs. Per Week | Credit |
|---|---|---|---|---|
| VAC-101-V1 | Environmental Studies-I | 40 + 60 = 100 | 2 | 2 |
| | | L – 2 | T - 0 | P - 0 |

**Course Objectives:**

The objective of the course is to have an understanding about humans and the environment, natural resources and sustainable development, environmental issues, conservation of biodiversity and ecosystems, case studies and field work.

**Course Outcomes:**

At the completion of this course, the learner will be able to:

- Analyse the evolution of human-environment interactions and evaluate the development of environmental thought from ancient to modern times.
- Identify types of natural resources and assess their sustainable utilization in the context of current environmental challenges.
- Examine key environmental issues at various spatial scales and their impact on ecosystems and human societies.
- Explain ecosystem structure and biodiversity conservation strategies with emphasis on Indian and global contexts.

**Course Content:**

**Unit-I** **Humans and the Environment** **(4 hrs)**

*The man-environment interaction*: Humans as hunter-gatherers, Mastery of fire, Origin of agriculture, Great ancient civilizations and the environment, Industrial revolution and its impact on the environment, Population growth and natural resource exploitation.

*The emergence of environmentalism*: Anthropocentric and eco-centric perspectives, The Club of Rome-Limits to Growth, UN Conference on Human Environment 1972, World Commission on Environment and Development, Rio Summit.

**Unit-II** **Natural Resources and Sustainable Development** **(8 hrs)**

Definition of resource; Classification of natural resources- biotic and abiotic, renewable and non-renewable.
*Biotic resources*: Major type of biotic resources- forests, grasslands, wetlands, wildlife and aquatic (fresh water and marine), Microbes as a resource.
*Water resources*: Types of water resources- fresh water and marine resources, Availability and use, Environmental impact of over-exploitation, issues and challenges, Water scarcity and stress, Conflicts over water.
*Soil and mineral resources*: Important minerals, Mineral exploitation, Environmental problems due to extraction of minerals and use, Soil as a resource and its degradation.
*Energy resources*: Sources of energy and their classification, renewable and non-renewable sources of energy, Conventional energy sources- coal, oil, natural gas, nuclear energy, non-conventional energy sources- solar, wind, tidal, hydro, wave, ocean thermal, geothermal, biomass, hydrogen and fuel cells, Implications of energy use on the environment.
*Introduction to sustainable development*: Sustainable Development, Sustainable Development Goals (SDGs)

**Unit-III** **Environmental Issues: Local, Regional and Global** **(6 hrs)**

Temporal and spatial extents of local, regional, and global phenomena.

*Pollution:* Types of Pollution air, noise, water, soil, municipal solid waste, hazardous waste, Transboundary air pollution, Acid rain, Smog.

*Land use and Land cover change:* land degradation, deforestation, desertification, urbanization. Global issues: Ozone layer depletion, Green-house effect, Global Warming, Climate change.

**Unit-IV** **Conservation of Biodiversity and Ecosystems** **(6 hrs)**

*Ecosystems and ecosystem services:* Concept, Structure and Functions of Ecosystem, Ecosystem types-forests, wetlands, grasslands, agriculture, coastal and marine; Ecosystem services.
*Biodiversity and its distribution:* Biodiversity as a natural resource, Levels and types of biodiversity, Biodiversity in India and the world, Biodiversity hotspots.
Threats to biodiversity, in-situ and ex-situ conservation approach, role of traditional knowledge, community-based conservation.

**Case Studies and Field Work** **(6 hrs)**

The students are expected to be engaged in some of the following or similar identified activities:

- Discussion on one national and one international case study related to the environment and sustainable development.

| | |
|---|---|
| • Field visits to identify local/regional environmental issues, make observations including data, collection and prepare a brief report.<br>• Documentation of campus biodiversity.<br>• Campus environmental management activities such as solid waste disposal, water management, and sewage treatment | |
| ✓ Discussion on correlation of the course content with Ancient Indian Knowledge System | |
| **Suggested Books/Reading:** | |
| • | 1. Barrow, C. J. (1999). Environmental management: Principles and practice, Routledge. |
| • | 2. Berrang-Ford, L., J.D. Ford & J. Paterson (2011). Are we adapting to climate change? Global Environmental Change-Human and Policy Dimensions 21: 25-33. |
| • | 3. Chiras, D. D and Reganold, J. P. (2010). Natural Resource Conservation: Management for a Sustainable Future. 10th edition, Upper Saddle River, N. J. Benjamin/Cummins/Pearson. |
| • | 4. De Anil, K. (2003). Environmental chemistry. New Age International. |
| • | 5. Gilbert M. Masters and W. P. (2008). An Introduction to Environmental Engineering and Science, Ela Publisher (Pearson) |
| • | 6. Kaushik, A., & Kaushik, C. P. (2006). Perspectives in environmental studies. New Age International. |
| • | 7. Krishnamurthy, K.V. (2003) Textbook of Biodiversity, Science Publishers, Plymouth, UK |
| • | 8. Rajagopalan, R. (2011). Environmental Studies: From Crisis to Cure. India: Oxford University Press. |
| • | 9. Simmons, I. G. (2008). Global Environmental History: 10,000 BC to AD 2000. Edinburgh University Press |

**Summary of marks distribution and weightage**

| Sr. No. | Component | Total Marks | Internal Weightage | External Weightage |
|---|---|---|---|---|
| | | | Total=40 Marks | Total= 60 Marks |
| 1. | Theory | 100 | Sessional= 25** Marks<br>PBL# = 15 Marks | Assessment will be done through external examination |

# Project Based Learning (PBL) may contain the following components.

1. Assignments
2. Quiz
3. Surprise Test
4. Mini Projects
5. Tutorials
6. Case Studies
7. Visit to site/Company/Laboratories
8. Field Work
9. Seminars

**Semester-I**

| Course | Name of Courses | Max Marks | Hrs. Per Week | Credit |
|---|---|---|---|---|
| AEC-101-V1 | Writing skills & the Art of Rhetoric | 40 + 60 = 100 | 2 | 2 |
| | | L – 2 | T - 0 | P - 0 |

**Course Objectives:**

1. To help students define, describe and articulate better. 2. To introduce students to the art of rhetoric. 3. To familiarize students with select genres of creative writing. 4. To guide students towards application of the techniques they have learnt.

**Course Outcomes:**

- Students will be able to define, describe and articulate better.
- Students will learn the art of rhetoric.
- Students will be practising writing in select genres of creative writing.
- Students will be able to apply the techniques they have learnt.

**Course Content:**

| Unit-I | Narration and Writing |
|---|---|

Define, Describe, Narrate and Argue; Articulating Questions and Innovative Thoughts; Narration: chronological order and achronological order; first-person, second-person and third person point of view in narration; key elements: plot, character, pov, setting and conflict; Storytelling, event news stories and Corporate Storytelling; problem-solution structures.

**Exercise:** *Ekphrasis*, Pictures: Describing scenes; Creating Stories out of words and pictures.

| Unit-II | Reasoning and Rhetoric |
|---|---|

Rhetoric, the art of persuasion; *ethos, logos and pathos*, Aristotle's triangle; Freytag's pyramid; reasoning; organizing; articulating; Synthesis; *Antanagoge*; *Hypophora*.

Recognize and evaluate the strength of an argument and its impact.

**Exercise:** Rhetorical and Oratorical Skills: Techniques for effective public speaking, both prepared and extemporaneous; Brainstorm ideas for your own short speech.

| Unit-III | Writing Features and Articles: Writing Features and Articles |
|---|---|

Op-Eds (Opinions and Editorials), Features; Articles; Topical Issues, Memes; Backgrounders; Memes; Idioms, Proverbs; Using Literary Devices and Figurative Language.

**Exercises:** Building Memes and Feature Writing

| Unit-IV | Performance and Drills |
|---|---|

Reading Drills; Speaking Drills; Team-Performance Drills; Solo Performance Drills; Apply the elements of rhetoric you have learned so far in the final draft of your op-ed and discussion.

✓ Discussion on correlation of the course content with Ancient Indian Knowledge System

**Suggested Books/Reading:**

- Aspects of the Novel by E.M.Forster
- The Rhetoric of Fiction by Wayne C Booth
- The Art of Rhetoric by Aristotle
- Writing Guide with Handbook by Michelle Bachelor Robinson, Spelman College Maria Jerskey
- The Oxford Essential Guide to Writing by Thomas S. Kane.

**Summary of marks distribution and weightage**

| Sr. No. | Component | Total Marks | Internal Weightage | External Weightage |
|---|---|---|---|---|
| | | | **Total=40 Marks** | **Total= 60 Marks** |
| **1.** | **Theory** | **100** | **Sessional= 25** Marks**<br>**PBL# = 15 Marks** | **Assessment will be done through external examination** |

# Project Based Learning (PBL) may contain the following components.

6. Assignments
7. Quiz
8. Surprise Test
9. Mini Projects
10. Tutorials
6. Case Studies
7. Visit to site/Company/Laboratories
8. Field Work
9. Seminars

**Semester-II**

| Course | Name of Courses | Max Marks | Hrs. Per Week | Credit |
|---|---|---|---|---|
| OSU-124-V1 | Economics-II | 40 + 60 = 100 | 3 | 3 |
| | | L – 3 | T - 0 | P - 0 |

**Course Objectives:**

To spread awareness about application of managerial, economics and mathematical concepts in business. The course focus on analyzing the cost and revenue concepts associated with the product, price determination on basis of market forces and studying effect of macroeconomic factors which takes in account country.

**Course Outcomes:**

This will help:

- To build an analytical ability in mind of a student.
- The students in taking decision regarding demand and supply forecasting, product determination on basis of market environment.
- This helps to build an ability to be a good entrepreneur by utilizing limited resources to satisfy unlimited wants.

**Course Content:**

**Unit-I**

Definition of economics, micro economics, macroeconomics, difference of micro and macro Economics, cardinal utility theory, indifference curve analysis, and theory of consumer choice. Concepts of consumer surplus

**Unit-II**

Demand, factors affecting demand, law of demand, demand elasticities, demand estimation, demand forecasting, and demand forecasting techniques. Analysis of production, including the law of variable proportions and laws of returns to scale.

**Unit-III**

Cost theory, covering traditional and modern approaches in both the short and long run. Economies and diseconomies of scale, revenue curves, and market structures. Price-output decisions under perfect competition, monopoly, monopolistic competition, and oligopoly.

**Unit-IV**

Factors influencing economic development and recent trends in the Indian economy. Business cycles and inflation including types and methods of control. Monetary and fiscal policies, India's balance of payments, trade deficits and their remedies, LPG reforms and foreign direct investment (FDI).

✓ Discussion on correlation of the course content with Ancient Indian Knowledge System

**Suggested Books/Reading:**


- 1. Hirschey , Mark, Managerial Economics, Thomson Learning, Bangalore
- 2. Monroe, Kent B., Pricing-Making Profitable Decisions, MacGraw-Hill, New York
- 3. Keat, Paul B., and Philip K.Y. Young, Managerial Economics – Economic Tools for Today's Decision Makers, Pearson Education, Delhi
- 4. Salvatore, Dominick, Managerial Economics in a Global Economy, Thomson Learning, Hyderabad
- 5. T.R. Jain, Managerial Economics, V.K. Publication


**Summary of marks distribution and weightage**

| Sr. No. | Component | Total Marks | Internal Weightage | External Weightage |
|---|---|---|---|---|
| | | | Total=40 Marks | Total= 60 Marks |
| 1. | Theory | 100 | Sessional= 25** Marks<br>PBL# = 15 Marks | Assessment will be done through external examination |

**Semester-II**

| Course | Name of Courses | Max Marks | Hrs. Per Week | Credit |
|---|---|---|---|---|
| **AEC-102-V1** | **Communication, Mediation and Resolution (CMR)** | **40 + 60 = 100** | **2** | **2** |
| | | **L – 2** | **T - 0** | **P - 0** |

**Course Objectives:**

- To orient students towards better interpersonal communication skills.
- To help students adopt the habit of rational thinking and reflection.
- To inculcate cognitive skills for better problem-solving.
- To guide students towards practising mediation and conflict-resolution.

**Course Outcomes:**

- Students will demonstrate great interpersonal communication skills.
- Students will adopt the habit of rational thinking and reflection.
- Students will adopt cognitive skills for better problem-solving.
- Students will practice communication for mediation and conflict-resolution.

**Course Content:**

**Unit-I** **Communication and Barriers to Communication:**

7C's of Communication, Win-Win Communication, Strategies for Effective Communication, Zero-Sum; Reasons for Conflict; Communication Barriers.

**Unit-II** **Critical Thinking and Cognitive Skills**

reason; analysis, synthesis, divide and rule; root- cause analysis; logic and logical fallacies.

Reasoning; Logic; Inductive and Deductive Reasoning; Logical fallacies: *Ad hominem*, straw man fallacy; bandwagon fallacy; hasty generalization; false dilemma; false dichotomy; *Tu Quoque*; circular reasoning and hasty generalization; Recognizing fallacies.

**Unit-III** **Mediation and Conflict-Resolution:**

Cognitive Skills and Critical thinking; Listening for key words, phrases and hints, Creative Communicating, Managing and celebrating Diversity, Adaptability and Negotiation; Dispute-resolution; arbitration; mediator's role; caucuses, third party, objectivity, impartiality, neutrality, offers, counter offers, questions, demands, and proposals, impasse, settlement. Brain storming, Problem solving strategies, Stress management, Significance of Collaboration, Confronting challenges.

**Unit-IV** **Mediation in Practice**

Exercises in role-playing and mediation and one case study assignment as directed by the teacher.

✓ Discussion on correlation of the course content with Ancient Indian Knowledge System

**Suggested Books/Reading:**


- 1. Hirschey , Mark, Managerial Economics, Thomson Learning, Bangalore
- 2. Monroe, Kent B., Pricing-Making Profitable Decisions, MacGraw-Hill, New York
- 3. Keat, Paul B., and Philip K.Y. Young, Managerial Economics – Economic Tools for Today's Decision Makers, Pearson Education, Delhi
- 4. Salvatore, Dominick, Managerial Economics in a Global Economy, Thomson Learning, Hyderabad
- 5. T.R. Jain, Managerial Economics, V.K. Publication

**Summary of marks distribution and weightage**

| Sr. No. | Component | Total Marks | Internal Weightage | External Weightage |
|---|---|---|---|---|
| | | | **Total=40 Marks** | **Total= 60 Marks** |
| **1.** | **Theory** | **100** | **Sessional= 25** Marks**<br>**PBL# = 15 Marks** | **Assessment will be done through external examination** |

# Project Based Learning (PBL) may contain the following components.

1. Assignments
2. Quiz
3. Surprise Test
4. Mini Projects
5. Tutorials
6. Case Studies
7. Visit to site/Company/Laboratories
8. Field Work
9. Seminars