B.Sc. Chemistry Program
(w.e.f. Session 2024-2025)
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. **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. **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. **Exit Criteria 156 Credits** **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. DSE -Discipline Specific Elective									

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-V**	Inorganic Chemistry - I	4	0	0	4	25	75	100
2.	DSC-A2 / Major	**CHU-103-V**	Physical Chemistry - I	4	0	0	4	25	75	100
3.	DSC-A3/ Major	**CHU-105-V**	Inorganic Chemistry Lab - I	0	0	4	2	15	35	50
4.	DSC-A4/ Major	**CHU-107-V**	Physical Chemistry Lab - I	0	0	4	2	15	35	50
5.	MIC-1 / Minor	**OSU-115-V/ OSU-117-V**	Basic Algebra / Physics-I	4	0	0	4	25	75	100
6.	MDC-1/ Multidisciplinary	**JMU-101-V**	Introduction to Communication	3	0	0	3	25	75	100
7.	AEC-1/ Ability Enhancement	**AEC-101-V**	Writing Skills and the Art of Rhetoric (WSAAR)	2	0	0	2	25	75	100
8.	SEC1-1/ Skill Enhancement	**CHU-109-V**	Instrumentation Skills-I	2	0	0	2	25	75	100
9.	SEC1-2/ Skill Enhancement	**CHU-111-V**	Instrumentation Skills Lab-I	0	0	2	1	15	35	50
10.	VAC-1/ Value Added Courses	**VAC-101-V**	Environmental Studies – I (EVS-I)	2	0	0	2	25	75	100
			Total	**21**	**0**	**10**	**26**	**220**	**630**	**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-V**	Organic Chemistry - I	4	0	0	4	25	75	100
2.	DSC-A2 / Major	**CHU-104-V**	Physical Chemistry – II	4	0	0	4	25	75	100
3.	DSC-A3/ Major	**CHU-106-V**	Organic Chemistry Lab – I	0	0	4	2	15	35	50
4.	DSC-A4/ Major	**CHU-108-V**	Physical Chemistry Lab – II	0	0	4	2	15	35	50
5.	MIC-2 / Minor	**OSU-120-V OSU-118-V**	Elementary Calculus Physics-II/	4	0	0	4	25	75	100
6.	MDC-2/ Multidisciplinary	OSU-122-V OSU-124-V OSU-126-V OSU-128-V	Journalism-II/ Economics-II/ Finance-II/ Management-II/	3	0	0	3	25	75	100
7.	AEC-2/ Ability Enhancement	**AEC-102-V**	Communication, Meditation, and Resolution (CMR)	2	0	0	2	25	75	100
8.	SEC2-1/ Skill Enhancement	**CHU-110-V**	Instrumentation Skills-II	2	0	0	2	25	75	100
9.	SEC2-2/ Skill Enhancement	**CHU-112-V**	Instrumentation Skills Lab-II	0	0	2	1	15	35	50
10.	VAC-2/ Value Added Courses*	**AEC-117-V/ VAC-308-V/ VAC-104-V**	Yoga and Meditation Universal Human Values Indian Knowledge System	2	0	0	2	25	75	100
	***Select any one course**		**Total**	**21**	**0**	**10**	**26**	**220**	**630**	**850**
11.	Internship in Industry / University**			0	0	8	4	-	-	-

Semester - 3										
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-201-V**	Inorganic Chemistry - II	4	0	0	4	25	75	100
2.	DSC-A2/ Major	**CHU-203-V**	Organic Chemistry – II	4	0	0	4	25	75	100
3.	DSC-A3/ Major	**CHU-205-V**	Physical Chemistry – III	4	0	0	4	25	75	100
4.	DSC-A4/ Major	**CHU-207-V**	Organic Chemistry Lab – II	0	0	4	2	15	35	50
5.	DSC-A5/ Major	**CHU-209-V**	Physical Chemistry Lab - III	0	0	4	2	15	35	50
6.	MIC-3 / Minor	**MTU-211-V** / **OSU-215-V**	Linear Algebra / Physics-III/	4	0	0	4	25	75	100
7.	MDC-3/ Multidisciplinary	**JMU-101-V**	Introduction to Communication	2	0	0	2	25	75	100
8.	AEC-3/ Ability Enhancement	**AEC-103-V**	Effective Corporate Communication	2	0	0	2	25	75	100
9.	SEC-3/ Skill Enhancement	**CHU-211-V**	Analytical Lab – I	0	0	4	2	15	35	50
10.	VAC-3/ Value Added Courses*	**AEC-117-V/ VAC-308-V/ VAC-104-V**	Yoga and Meditation Universal Human Values Indian Knowledge System	2	0	0	2	25	75	100
	***Select any one course**		**Total**	**22**	**0**	**12**	**28**	**220**	**630**	**850**

Semester - 4										
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-202-V**	Inorganic Chemistry - III	4	0	0	4	25	75	100
2.	DSC-A2/ Major	**CHU-204-V**	Organic Chemistry – III	4	0	0	4	25	75	100
3.	DSC-A3/ Major	**CHU-206-V**	Physical Chemistry – IV	4	0	0	4	25	75	100
4.	DSC-A4/ Major	**CHU-208-V**	Inorganic Chemistry Lab – II	0	0	4	2	15	35	50
5.	DSC-A5/ Major	**CHU-210-V**	Organic Chemistry Lab – III	0	0	4	2	15	35	50
6.	DSC-A6/ Major	**CHU-212-V**	Physical Chemistry Lab – IV	0	0	4	2	15	35	50
7.	MIC-4 / Minor	**OSU-202-V** / **OSU-204-V**	Introduction to Differential Equations / Physics-IV/	4	0	0	4	25	75	100
8.	AEC-4/ Ability Enhancement	**AEC-107-V**	Hindi	2	0	0	2	25	75	100
9.	SEC-4/ Skill Enhancement	**CHU-214-V**	Statistical Analysis for Chemists	2	0	0	2	25	75	100
10.	VAC-4/ Value Added Courses	**VAC-201-V**	EVS-II	2	0	0	2	25	75	100
			Total	**22**	**0**	**12**	**28**	**220**	**630**	**850**
11.	Summer Internship in Industry / University**			0	0	8	4	-	-	-

Semester-I

Course Code	Name of Courses	Max Marks	Hrs. Per Week	Credit
CHU-101-V	Inorganic Chemistry - I	25 + 75 = 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 ψ^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.

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.

Semester-I

Course Code	Name of Courses	Max Marks	Hrs. Per Week	Credit
CHU-103-V	Physical Chemistry - I	25 + 75 = 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.

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).

Semester-I

Course Code	Name of Courses	Max Marks	Hrs. Per Week	Credit
CHU-105-V	Inorganic Chemistry Lab-I	15 + 35 = 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.

Suggested Books/Reading:

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

Semester-I

Course Code	Name of Courses	Max Marks	Hrs. Per Week	Credit
CHU-107-V	Physical Chemistry Lab-I	15 + 35 = 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.

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).

Semester-I

Course Code	Name of Courses	Max Marks	Hrs. Per Week	Credit
CHU-109-V	Instrumentation Skills-I	15 + 35 = 50	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.

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).

Semester-I

Course Code	Name of Courses	Max Marks	Hrs. Per Week	Credit
CHU-111-V	Instrumentation Skills Lab-I	10 + 20 = 30	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)

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.

SEMESTER II

Semester-II				
Course Code	**Name of Courses**	**Max Marks**	**Hrs. Per Week**	**Credit**
CHU-102-V	**Organic Chemistry - I**	**25 + 75 = 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.

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).

Semester-II

Course Code	Name of Courses	Max Marks	Hrs. Per Week	Credit
CHU-104-V	Physical Chemistry - II	25 + 75 = 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.

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

Semester-II

Course Code	Name of Courses	Max Marks	Hrs. Per Week	Credit
CHU-106-V	Organic Chemistry Lab - I	15 + 35 = 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.

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)

Semester-II

Course Code	Name of Courses	Max Marks	Hrs. Per Week	Credit
CHU-108-V	Physical Chemistry Lab - II	15 + 35 = 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.

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)

Semester-II

Course Code	Name of Courses	Max Marks	Hrs. Per Week	Credit
CHU-110-V	Instrumentation Skills-II	15 + 35 = 50	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

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

Semester-II

Course Code	Name of Courses	Max Marks	Hrs. Per Week	Credit
CHU-112-V	Instrumentation Skills Lab-II	10 + 20 = 30	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.

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.

Semester-III

Course Code	Name of Courses	Max Marks	Hrs. Per Week	Credit
CHU-201-V	Inorganic Chemistry - II	25 + 75 = 100	4	4
		L – 4	T - 0	P - 0

Course Objectives:

The objective of the course is to help the students understand the basic concept of s & p block elements and metallurgy.

Learning Outcomes:

After the completion of the course, students will be able to,

- Understand general principles of metallurgy.
- Understand general characteristics and chemical properties of s & p block elements.
- Learn chemical and physical properties of hydrides, oxides, oxo and halides of various groups.
- Understand preparation, properties, structures of borazines, silicates, silicons, phosphonitrilic halides, interhalogens and pseudohalogen compounds and clatherate compounds of nobel gases.

Course Content:

Unit-I	General Principles of Metallurgy (6 Lectures)

Chief modes of occurrence of metals based on standard electrode potentials, Ellingham diagrams for reduction of metal oxides using carbon and carbon monoxide as reducing agent. Electrolytic Reduction, Hydrometallurgy with reference to cyanide process for silver and gold. Methods of purification of metals: Electrolytic process, van Arkel-de Boer process and Mond's process, Zone refining

Unit-II	Chemistry of s-Block Elements (22 Lectures)

(i) General characteristics: melting point, flame colour, reducing nature, diagonal relationships and anomalous behavior of first member of each group.
(ii) Reactions of alkali and alkaline earth metals with oxygen, hydrogen, nitrogen and water.
(iii) Common features such as ease of formation, thermal stability and solubility of the following alkali and alkaline earth metal compounds: hydrides, oxides, peroxides, superoxides, carbonates, nitrates, sulphates.
(iv) Complex formation tendency of s-block elements; structure of the following complexes: crown ethers and cryptates of Group I; basic beryllium acetate, beryllium nitrate, EDTA complexes of calcium and magnesium.
(v) Solutions of alkali metals in liquid ammonia and their properties.

Unit-III	Chemistry of p-Block Elements - I (6 lectures)

Electronic configuration, atomic and ionic size, metallic/non-metallic character, melting point, ionization enthalpy, electron gain enthalpy, electronegativity, Allotropy of C, P, S; inert pair effect, diagonal relationship between B and Si and anomalous behaviour of first member of each group

Unit-IV	Chemistry of p-Block Elements -II (26 Lectures)

Structure, bonding and properties: acidic/basic nature, stability, ionic/covalent nature, oxidation/reduction, hydrolysis, action of heat of the following:
•Hydrides: hydrides of Group 13 (only diborane), Group 14, Group 15 (EH3 where E = N, P, As, Sb, Bi), Group 16 and Group 17.
•Oxides: oxides of phosphorus, sulphur and chlorine •Oxoacids: oxoacids of phosphorus and chlorine; peroxoacids of sulphur
•Halides: halides of silicon and phosphorus Preparation, properties, structure and uses of the following compounds:
•Borazine
•Silicates, silicones,
•Phosphonitrilic halides {(PNCl2)n where n = 3 and 4}
•Interhalogen and pseudohalogen compounds
•Clathrate compounds of noble gases, xenon fluorides (MO treatment of XeF2).

Suggested Books/Reading:

- Lee, J.D. Concise Inorganic Chemistry, Pearson Education 2010
- Douglas, B.E; Mc Daniel, D.H. & Alexander, J.J. Concepts & Models of Inorganic Chemistry 3rd Ed., John Wiley Sons, N.Y. 1994.
- Greenwood, N.N. & Earnshaw. Chemistry of the Elements, Butterworth- Heinemann. 1997.
- Miessler, G. L. & Donald, A. Tarr. Inorganic Chemistry 3rd Ed.(adapted), Pearson, 2009
- Shriver, D.F., Atkins P.W and Langford, C.H., Inorganic Chemistry 2nd Ed., Oxford University Press, 1994

Semester-III

Course Code	Name of Courses	Max Marks	Hrs. Per Week	Credit
CHU-203-V	Organic Chemistry - II	25 + 75 = 100	4	4
		L – 4	T - 0	P - 0

Course Objectives:

The objective of the course is to make the students understand the basic concept of some of the functional group chemistry, their methods of synthesis and chemical reactions.

Learning Outcomes:

- Learn preparations, properties and chemical reactivity of nitrogen containing functional groups, polynuclear hydrocarbons, heterocyclic compounds and natural products.
- Understand the formation of carbon-hetero atom multiple bond..
- Understand the stereochemical aspect of reaction mechanism
- Isolation techniques of natural products and the classical methods of structural elucidation.

Course Content:

Unit-I **Chemistry of Halogenated Hydrocarbons (16Hrs)**

Alkyl halides: Methods of preparation and properties, Nucleophilic substitution reactions – SN^1, SN^2 and SN^i mechanisms with stereochemical aspects and effect of solvent etc.; Nucleophilic substitution versus Elimination.
Aryl halides: Preparation (including preparation from diazonium salts) and properties, Nucleophilic aromatic substitution; SNAr, Benzyne mechanism.
Relative reactivity of alkyl, allyl, benzyl, vinyl and aryl halides towards nucleophilic substitution reactions.
Organometallic compounds of Mg (Grignard reagent) – Use in synthesis of organic compounds.

Unit-II **Alcohols, Phenols, Ethers and Epoxides (16 Hrs)**

Alcohols: Preparation, properties and relative reactivity of 1°, 2°, 3° alcohols, Bouvaelt BlancReduction; Oxidation of diols by periodic acid and lead tetraacetate, Pinacol-Pinacolone rearrangement; Phenols: Preparation and properties; Acidity and factors effecting it, Ring substitution reactions, Reimer–Tiemann and Kolbe's-Schmidt Reactions, Fries and Claisen rearrangements with mechanism; Ethers and Epoxides: Preparation and reactions with acids. Reactions of epoxides with alcohols, ammonia derivatives and $LiAlH_4$

Unit-III **Carbonyl Compounds (16 Hrs)**

Structure, Reactivity, Preparation and Properties; Nucleophilic additions, Nucleophilic addition elimination reactions with ammonia derivatives (with mechanism); Keto-enol tautomerism and concept of enol chemistry, Mechanisms of Aldol and Benzoin condensation, Knoevenagel condensation, Claisan-Schmidt, Perkin, Cannizzaro and Wittig reaction, Beckmann rearrangement, Haloform reaction, Baeyer Villiger oxidation, Clemmensen, Wolff-Kishner and Meervein-Pondorf-Verley (MPV) reduction. Addition reactions of α,β-unsaturated carbonyl compounds: Michael addition. Active methylene compounds: Preparation and synthetic applications of diethyl malonate and ethyl acetoacetate.

Unit-IV **Carboxylic Acids and their Derivatives (12 Hrs)**

General methods of preparation, Physical properties and reactions of monocarboxylic acids, Effect of substituents on acidic strength. Typical reactions of dicarboxylic acids, hydroxy acids and unsaturated acids. Preparation and reactions of acid chlorides, anhydrides, esters and amides; Comparative study of nucleophilic substitution at acyl group -Mechanism of acidic and alkaline hydrolysis of esters, Claisen condensation, Dieckmann and Reformatsky reactions, Hofmann- bromamide degradation and Curtius rearrangement.

Suggested Books/Reading:

1.	Morrison, R. N. & Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
2.	Finar, I. L. Organic Chemistry (Volume 1), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education)
3.	Graham Solomons, T.W. Organic Chemistry, John Wiley & Sons, Inc.
4.	Norman, R.O.C. & Coxon, J. M. Principles of Organic synthesis.

Semester-III

Course Code	Name of Courses	Max Marks	Hrs. Per Week	Credit
CHU-205-V	Physical Chemistry - III	25 + 75 = 100	4	4
		L – 4	T - 0	P - 0

Course Objectives:

The objective of the course is to make the students understand the basic concept of phase equilibria, electrochemical cells and surface chemistry.

Learning Outcomes:

- After the completion of the course, students will be able to, Learn basic concept of phase equilibria and their applications.
- Understand the qualitative and quantitative aspects of electrochemical cells.
- Understand the nature of adsorption and their qualitative analysis.
- Learn analytical concepts of various reactions through potentiometric titrations.

Course Content:

Unit-I	**Phase Equilibria (27 Lectures)**

Concept of phases, components and degrees of freedom, derivation of Gibbs Phase Rule for nonreactive and reactive systems; Clausius-Clapeyron equation and its applications to solid-liquid, liquid-vapour and solid-vapour equilibria, phase diagram for one component systems (H2O and S), with applications. Phase diagrams for systems of solid-liquid equilibria involving eutectic, congruent and incongruent melting points. Three component systems: triangular plots, water-chloroform-acetic acid system. Binary solutions: Gibbs-Duhem Margules equation, its derivation and applications to fractional distillation of binary miscible liquids (ideal and non ideal), azeotropes, lever rule, partial miscibility of liquids, CST, miscible pairs, steam distillation. Nernst distribution law: its derivation and applications

Unit-II	**Electrochemical Cells (12 Lectures)**

Rules of oxidation/reduction of ions based on half-cell potentials, applications of electrolysis in metallurgy and industry. 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.

Unit-III	**Application of EMF and Batteries (15 Lectures)**

Application of EMF measurements in determining (i) free energy, enthalpy and entropy of a cell reaction, (ii) equilibrium constants, and (iii) pH values, using hydrogen, quinone-hydroquinone, glass and SbO/Sb2O3 electrodes. Concentration cells with and without transference, liquid junction potential; determination of activity coefficients and transference numbers. Qualitative discussion of potentiometric titrations (acid-base, redox, precipitation), Primary and secondary batteries.

Unit-IV	**Surface Chemistry (6 Lectures)**

Physical adsorption, chemisorption, adsorption isotherms (Langmuir and Freundlich), nature of adsorbed state.

Suggested Books/Reading:

- Peter Atkins & Julio De Paula, Physical Chemistry 9th Ed., Oxford University Press (2010).
- Castellan, G. W. Physical Chemistry, 4th Ed., Narosa (2004).
- Physical Chemistry 6th Ed., Tata McGraw-Hill (2011). Metz, C. R. Physical Chemistry 2nd Ed., Tata McGraw-Hill (2009).
- Puri,B.R., Sharma,L.R., Pathania,M.S., Principles of Physical chemistry,Vishal· Publicating Co., 2016

Semester-III				
Course Code	**Name of Courses**	**Max Marks**	**Hrs. Per Week**	**Credit**
CHU-207-V	**Organic Chemistry Lab - II**	**15 + 35 = 50**	**4**	**2**
		L – 0	**T - 0**	**P - 4**

Course Objectives:

The objective of the course is to make the students understand the basic concept of functional group analysis and synthesis of organic compounds.

Learning Outcomes:

After the completion of the course, students will be able to,

- Detection of functional group in organic compounds,
- Hands-on-training of organic preparation.

Course Content:

Unit-I **Functional group tests**

- Functional group tests for alcohols, phenols, carbonyl and carboxylic acid group

Unit-II **Organic preparations**

B. Organic preparations:

- Acylation of one of the following amines (aniline, o-, m-, p- toluidines and o-, m-, p-anisidine) and one of the following phenols (β -naphthol, resorcinol, p- cresol).
- Oxidation of ethanol/ isopropanol (Iodoform reaction).
- Selective reduction of meta dinitrobenzene to m-nitroaniline.
- Hydrolysis of amides and esters.
- Semicarbazone of any one of the following compounds: acetone, ethyl methyl ketone, cyclohexanone, benzaldehyde.
- S-Benzylisothiouronium salt of one each of water soluble and water insoluble acids (benzoic acid, oxalic acid, phenyl acetic acid and phthalic acid).
- Aldol condensation using either conventional or green method.

(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 and melting point)

Suggested Books/Reading:

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

Semester-III

Course Code	Name of Courses	Max Marks	Hrs. Per Week	Credit
CHU-209-V	Physical Chemistry Lab - III	15 + 35 = 50	4	2
		L – 0	T - 0	P - 4

Course Objectives:

The objective of the course is to make the students understand the basic concept of phase equilibria, Potentiometry and Adsorption.

Learning Outcomes:

After the completion of the course, students will be able to,

- Strengthen the quantitative and practical aspects of Potentiometry titration. .
- Understand the kinetics of adsorption.
- Understand the concept of equilibrium during phase transition.

Course Content:

Unit-I **Phase Equilibria:**

- Determination of critical solution temperature and composition at CST of the phenolwater system and to study the effect of impurities of sodium chloride and succinic acid on it.
- Phase equilibria: Construction of the phase diagram using cooling curves or ignition tube method: a. simple eutectic and b. congruently melting systems.
- Distribution of acetic/ benzoic acid between water and chloroform or cyclohexane.
- Study the equilibrium of at least one of the following reactions by the distribution method:
  (i) $I_2 (aq) + I^- (aq) \rightarrow I_3^- (aq)$
  (ii) $Cu^{2+}(aq) + nNH_3 \rightarrow Cu(NH_3)_n^{2+}$

Unit-II **Potentiometry and adsorption**

- Perform the following potentiometric titrations: i. Strong acid vs. strong base ii. Weak acid vs. strong base iii. Dibasic acid vs. strong base iv. Potassium dichromate vs. Mohr's salt.
- Verify the Freundlich and Langmuir isotherms of acetic acid on activated charcoal

Suggested Books/Reading:

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

Semester-III				
Course	**Name of Courses**	**Max Marks**	**Hrs. Per Week**	**Credit**
CHU-211-V	**Analytical Lab - I**	**15 + 35 = 50**	**4**	**2**
		L – 0	**T - 0**	**P - 4**

Course Content:

Unit-I	**(A) Iodo/Iodimetric Titrations**
(i) Estimation of Cu(II) and K2Cr2O7 using sodium thiosulphate solution (Iodometrically). (ii) Estimation of antimony in tartar-emetic iodometrically	
Unit-II	**(B) Complexometric titrations using disodium salt of EDTA**
(i) Estimation of Mg2+, Zn2+ (ii) Estimation of Ca2+	
Unit-III	**(C) Inorganic preparations**
(i) Cuprous Chloride, Cu2Cl2 (ii) Manganese(III) phosphate, MnPO4.H2O (iii)Aluminium potassium sulphate KAl(SO4)2.12H2O (Potash alum) or Chrome alum.	

Suggested Books/Reading:

- Vogel, A.I. A Textbook of Quantitative Inorganic Analysis, ELBS.
- Marr, G. and Rockett, R.W. Practical Inorganic Chemistry, Van Nostrand Reinhold. 1972.

SEMSESTER-IV

Semester-IV				
Course	**Name of Courses**	**Max Marks**	**Hrs. Per Week**	**Credit**
CHU-202-V	**Inorganic Chemistry - III**	**25 + 75 = 100**	**4**	**4**
		L – 4	**T - 0**	**P - 0**

Course Objectives:

The objective of the course is to make the students understand the coordination chemistry, study of dblock elements, actinoides and lanthanoides.

Learning Outcomes:

After the completion of the course, students will be able to,

- Learn coordination chemistry of transition metal complexes.
- Understand the chemistry of d-block elements.
- Understand chemistry of lanthanoides and actinoides.
- Learn the basics of inorganic reaction mechanism.

Course Content:

Unit-I **Coordination Chemistry (26 Lectures)**

Werner's theory, valence bond theory (inner and outer orbital complexes), electroneutrality principle and back bonding. Crystal field theory, measurement of 10 Dq (Δo), CFSE in weak and strong fields, pairing energies, factors affecting the magnitude of 10 Dq (Δo, Δt). Octahedral vs. tetrahedral coordination, tetragonal distortions from octahedral geometry Jahn-Teller theorem, square planar geometry. Qualitative aspect of Ligand field and MO Theory. IUPAC nomenclature of coordination compounds, isomerism in coordination compounds. Stereochemistry of complexes with 4 and 6 coordination numbers. Chelate effect, polynuclear complexes, Labile and inert complexes.

Unit-II **Substitution reactions (10 Lectures)**

Introduction to inorganic reaction mechanisms. Substitution reactions in square planar and octahedral complexes, Trans- effect, theories of trans effect.

Unit-III **Transition Elements (16 Lectures)**

General group trends with special reference to electronic configuration, colour, variable valency, magnetic and catalytic properties, ability to form complexes. Stability of various oxidation states and e.m.f. (Latimer diagrams) Different between the first, second and third transition series. Chemistry of Cr, Mn, Fe and Co in various oxidation states with special reference to the following compounds: peroxo compounds of chromium, potassium dichromate, potassium permanganate, potassium ferrocyanide, potassium ferricyanide, sodium nitroprusside and sodium cobaltinitrite.

Unit-IV **Lanthanoids and Actinoids (8 Lectures)**

Electronic configuration, oxidation states, colour, spectral and magnetic properties, lanthanide contraction, separation of lanthanides (ion-exchange method only).

Suggested Books/Reading:

- Purcell, K.F & Kotz, J.C., Inorganic Chemistry W.B. Saunders Co, 1977.
- Huheey, J.E., Inorganic Chemistry, Prentice Hall, 1993.
- Cotton, F.A. & Wilkinson, G., Advanced Inorganic Chemistry Wiley-VCH, 1999
- Basolo, F, and Pearson, R.C., Mechanisms of Inorganic Chemistry, John Wiley & Sons, NY, 1967.
- Greenwood, N.N. & Earnshaw A., Chemistry of the Elements, ButterworthHeinemann,1997.
- Miessler, G. L. &. Tarr, Donald A. Inorganic Chemistry 3rd Ed.(adapted), Pearson, 2009

Semester-IV

Course	Name of Courses	Max Marks	Hrs. Per Week	Credit
CHU-204-V	Organic Chemistry - III	25 + 75 = 100	4	4
		L – 4	T - 0	P - 0

Course Objectives:

The objective of the course is to make the students understand the properties, synthesis and chemical reactions of nitrogen containing functional groups, polynuclear hydrocarbons, heterocyclic compounds and alkaloids.

Learning Outcomes:

- Perform inter-conversions of various functional groups in organic chemistry.
- Learn the carbon-carbon bond formations, reactions with mechanistic understanding.
- Understanding the basics of alkaloids and terpenoids
- Learn the properties, synthesis and chemical reactions of halogen and/or oxygen containing functional groups in organic chemistry

Course Content:

Unit-I **Nitrogen containing Functional Groups (16 Hrs)**

Preparation and important reactions of nitro compounds, nitriles and isonitriles. Amines: Preparation and properties, Effect of substituent and solvent on basicity; Gabriel phthalimide synthesis, Carbylamine reaction, Mannich reaction, Hoffmann's exhaustive methylation, Hofmann-elimination reaction; Distinction between 1°, 2° and 3° amines with Hinsberg reagent and nitrous acid. Diazonium Salts: Preparation and their synthetic applications.
Polynuclear Hydrocarbons: Aromaticity of polynuclear hydrocarbons, structure elucidation of naphthalene; Preparation and properties of naphthalene, phenanthrene and anthracene.

Unit-II **Polynuclear Hydrocarbons (6 Hrs)**

Aromaticity of polynuclear hydrocarbons, structure elucidation of naphthalene; Preparation and properties of naphthalene, phenanthrene and anthracene.

Unit-III **Heterocyclic Compounds (22 Hrs)**

Classification and nomenclature, Structure, aromaticity in 5-numbered and 6-membered rings containing one heteroatom; Synthesis, reactions and mechanism of substitution reactions of: Furan, Pyrrole (Paal-Knorr synthesis, Knorr pyrrole synthesis, Hantzsch synthesis), Thiophene, Pyridine (Hantzsch synthesis), Indole (Fischer indole synthesis and Madelung synthesis), Quinoline and isoquinoline, (Skraup synthesis, Friedlander's synthesis, Knorr quinoline synthesis, Doebner- Miller synthesis, Bischler-Napieralski reaction, Pictet-Spengler reaction, Pomeranz-Fritsch reaction).

Unit-IV **Natural Products (16 Hrs)**

Alkaloids: Natural occurrence, General structural features, Isolation and their physiological action,Hoffmann's exhaustive methylation, Emde's modification; Structure elucidation and synthesis of Nicotine. Medicinal importance of Nicotine, Hygrine, Quinine, Morphine, Cocaine, and Reserpine.
Terpenes: Occurrence, classification, isoprene rule; Elucidation of stucture and synthesis of Citral.

Suggested Books/Reading:

1. Morrison, R. N. & Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
2. Acheson, R.M. Introduction to the Chemistry of Heterocyclic compounds, John Welly & Sons (1976).
3. Finar, I. L. Organic Chemistry (Volume 1), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
4. Graham Solomons, T.W. Organic Chemistry, John Wiley & Sons, Inc.
5. Finar, I. L. Organic Chemistry (Volume 2: Stereochemistry and the Chemistry of Natural Products), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
6. Clayden, J.; Greeves, N.; Warren, S.; Wothers, P.; Organic Chemistry, Oxford University Press.
7. Singh, J.; Ali, S.M. & Singh, J. Natural Product Chemistry, Prajati Parakashan (2010)

Semester-IV

Course	Name of Courses	Max Marks	Hrs. Per Week	Credit
CHU-206-V	Physical Chemistry - IV	25 + 75 = 100	4	4
		L – 4	T - 0	P - 0

Course Objectives:

The objective of the course is to make the students understand the basic concept of conductance, chemical kinetics and cartalysis.

Learning Outcomes:

After the completion of the course, students will be able to,

- Strengthen the quantitative and practical aspects of electrolytic conductance.
- Understand the kinetics of various reactions.
- Understand the nature of catalysts and enzymes.
- Understand the nature of biochemical and biophysical processes.

Course Content:

Unit-I **Electrochemistry-II (18 Hrs)**

Conductance: Quantitative aspects of Faraday's laws of electrolysis Arrhenius's theory of electrolytic dissociation. Conductivity, equivalent and molar conductivity and their variation with dilution for weak and strong electrolytes. Molar conductivity at 29 infinite dilutions. Kohlrausch law of independent migration of ions. Debye-Hückel-Onsager equation, Wien effect, Debye-Falkenhagen effect, Walden's rules. 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.

Unit-II **Chemical Kinetics (22 Hrs)**

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

Unit-III **Catalysis (8 Hrs)**

Catalysis: Types of catalyst, specificity and selectivity, mechanisms of catalyzed reactions at solid surfaces. Enzyme catalysis, Michaelis-Menten mechanism, acid-base catalysis.

Unit-IV **Photochemistry (12 Hrs)**

Photochemistry: Characteristics of electromagnetic radiation, Lambert-Beer's law and its limitations, the 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.

Suggested Books/Reading:

- Atkins, P. W. & Paula, J. de Atkin's Physical Chemistry Ed., Oxford University Press 13 (2006).
- Ball, D. W. Physical Chemistry Thomson Press, India (2007).
- Castellan, G. W. Physical Chemistry 4th Ed. Narosa (2004).
- Mortimer, R. G. Physical Chemistry 3rd Ed. Elsevier: NOIDA, UP (2009).
- Engel, T. & Reid, P. Physical Chemistry 3rd Ed., Prentice-Hall (2012).
- Chemical Kinetics. Author, Keith J. Laidler. Edition, 2. Publisher, Tata McGraw-Hill, 1973
- Fundamentals Biochemistry 4th edition, Donald Voet, Judith G. Voet and Charlotte W. Pratt, John Wiley and Sons

Semester-IV					
Course	**Name of Courses**	**Max Marks**		**Hrs. Per Week**	**Credit**
CHU-208-V	**Inorganic Chemistry Lab - II**	**15 + 35 = 50**		**4**	**2**
		L – 0	**T - 0**		**P - 4**

Course Content:

Unit-I **Gravimetric Analysis:**

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

Unit-II **Inorganic Preparations:**

- Tetraamminecopper (II) sulphate, $[Cu(NH_3)_4]SO_4.H_2O$
- Acetylacetonate complexes of Cu^{2+}/Fe^{3+}
- Tetraamminecarbonatocobalt (III) nitrate
- Potassium tri(oxalato)ferrate(III)

Unit-III **Properties of Complexes**

i. Measurement of 10 Dq by spectrophotometric method
ii. Verification of spectrochemical series.

Synthesis of ammine complexes of Ni(II) and its ligand exchange reactions (e.g. bidentate ligands like acetylacetone, DMG, glycine) by substitution method

Suggested Books/Reading:

- Vogel, A.I. A Textbook of Quantitative Inorganic Analysis, ELBS.
- Marr, G. and Rockett, R.W. Practical Inorganic Chemistry, Van Nostrand Reinhold. 1972.

Semester-IV				
Course Code	**Name of Courses**	**Max Marks**	**Hrs. Per Week**	**Credit**
CHU-210-V	**Organic Chemistry Lab - III**	**15 + 35 = 50**	**4**	**2**
		L – 0	**T - 0**	**P - 4**

Course Objectives:

The objective of the course is to make the students understand the basic concept of functional group analysis and synthesis of organic compounds.

Learning Outcomes:

After the completion of the course, students will be able to,

- Detection of functional group in organic compounds,
- Hands-on-training in quantitative analysis in organic preparation.

Course Content:

Unit-I	**Functional group tests**

- Functional group tests for nitro, amine and amide groups group

Unit-II	**Qualitative analysis**

Qualitative analysis of unknown organic compounds containing simple functional groups (alcohols, carboxylic acids, phenols, carbonyl compounds and esters)

Suggested Books/Reading:

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

Semester-IV

Course	Name of Courses	Max Marks	Hrs. Per Week	Credit
CHU-212-V	Physical Chemistry Lab - IV	15 + 35 = 50	4	2
		L – 0	T - 0	P - 4

Course Objectives:

The objective of the course is to make the students understand the basic concept of conductance, chemical kinetics

Learning Outcomes:

After the completion of the course, students will be able to,
Strengthen the quantitative and practical aspects of electrolytic conductance.

- Understand the kinetics of various reactions.

Course Content:

Unit-I	Electrochemistry

Conductometry: 1. Determination of cell constant. 2. Determination of conductivity, molar conductivity, degree of dissociation and dissociation constant of a weak acid. 3. Perform the following conductometric titrations: i. Strong acid vs. strong base, ii. Weak acid vs. strong base, iii. Mixture of strong acid and weak acid vs. strong base, iv. Strong acid vs. weak base.

Unit-II	Chemical Kinetics (22 Hrs)

Chemical Kinetics: Study the kinetics of the following reactions. 1. Iodide-persulphate reaction (i) Initial rate method; (ii)Integrated rate method 2. Acid hydrolysis of methyl acetate with hydrochloric acid. 3. Saponification of ethyl acetate. 4. Comparison of the strengths of HCl and H2SO4 by studying kinetics of hydrolysis of methyl acetate.

Suggested Books/Reading:

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

Semester-IV				
Course	**Name of Courses**	**Max Marks**	**Hrs. Per Week**	**Credit**
CHU-214-V	**Statistical Analysis for Chemists**	**25 + 75 = 100**	**2**	**2**
		L – 2	**T - 0**	**P - 0**

Course Objectives:

- To improve learning of statistical tools for analysis of results being a chemist.
- To learn handling of data, and meaningful analysis using statistical methods.

Learning Outcomes:

- Students will be able to use statistical tools to get basic aspects of data handling and analysis.

Course Content:

Unit-I **Statistical Tools in Applied Chemistry (15 Hrs)**

The criteria for evaluation of an analytical method: Specificity, accuracy, precision, detection limit, quantitation limit, sensitivity, working range and linearity. Propagation Errors, Statistical process control analysis and control charts. Mean, mean or average of a data set, Standard deviation, Relative standard deviation, confidence interval, Regression analysis, Analysis of variance, Propagation of uncertainty, spectral data. Corrections and Clarifications, Blanks. limit of detection (LOD), limit of quantitation (LOQ), Calibration methods.

Unit-II **Statistical Charts and Non-linear regression (15 Hrs)**

Charting a Distribution, Histograms, X2-Test, Probability Charts, Conventional Control Charts (Shewhart Charts), Cunisum Charts. Nonlinear Regression - Linearization and Nonlinear Regression and Modeling. Nonlinear Fitting and log transformations, Residual Plots

Suggested Books/Reading:

- Statistical Methods in Analytical Chemistry, PETER C. MEIER, RICHARD E. ZUND, John Wiley and Sons, 2nd Ed. 2000
- https://chemlab.truman.edu/data-analysis/introduction-to-statistics-in-chemistry
- https://www.consol.ca/ - Statistics in Chemistry
- Statistical tools and approaches to validate analytical methods: methodology and practical examples
  Soumia Belouafa, et al. Int. J. Metrol. Qual. Eng., 8 (2017) 9 (DOI: https://doi.org/10.1051/ijmqe/2016030)

Semester- I

Course	Name of Courses	Max Marks	Hrs. Per Week	Credit
OSU-115-V	Basic Algebra	25 + 75 = 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 ofrelation, 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.

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

Semester- II

Course	Name of Courses	Max Marks	Hrs. Per Week	Credit
OSU-120-V	Elementary Calculus	25 + 75 = 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.

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.

Semester- III

Course	Name of Courses	Max Marks	Hrs. Per Week	Credit
MTU-211-V	Linear Algebra	25 + 75 = 100	4	4
		L – 4	T - 0	P - 0

Course Outcomes:

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

- Solve system of equations.
- Understand the basic concepts of vector spaces, linear independence and span of vectorsover a field.
- Learn about linear transformation and matrix representation of a linear transformation.
- Learn about inner product space.

Course Content:

Unit-I

Solving linear system of equations using Gaussian elimination, Gauss-Jordan row reduction, Eigen values, Eigenvectors, Eigenspace, Diagonalization, Characteristic polynomial of a matrix, Cayley- Hamilton theorem.

Unit-II

Vector spaces, Subspaces, Algebra of subspaces, Linear combination of vectors, Linear span, Lineardependence and independence, Bases and dimension.

Unit-III

Linear transformations, Null space, Range, Rank and nullity of a linear transformation, Matrix representation of a linear transformation, Composition of linear transformations and matrix multiplication, Invertibility and isomorphisms.

Unit-IV

Inner product space, The Gram-Schmidt orthogonalization process, normal and self-adjoint operators,unitary and orthogonal operators.

Suggested Books/Reading:

1. Stephen H. Friedberg, Arnold J. Insel and Lawrence E. Spence, Linear Algebra, 4th ed.Prentice-Hall of India Pvt. Ltd. New Delhi, 2003.
2. David C. Lay, Steven R. Lay and Judi J. McDonald, Linear Algebra and itsApplications, 5th ed. Pearson Education, 2016.
3. Bernard Kolman and David R. Hill, Introductory Linear Algebra with Applications, 7thed. Pearson Education, Delhi. First Indian Reprint 2003.

Semester-IV

Course	Name of Courses	Max Marks	Hrs. Per Week	Credit
OSU-202-V	Introduction to Differential Equations	25 + 75 = 100	4	4
		L – 4	T - 0	P - 0

Course Objectives:

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

- Know about Differential Equations
- Understand Linear and Exact Differential Equations
- Know about Second Order Differential Equations
- Solve ordinary differential equations by Variation of Parameter method

Course Content:

Unit-I

Differential Equations: Definition, Order and degree of a differential equation, General and particular solutions of a differential equation, Formation of differential equation whose general solution is given, Differential equations of first order and first degree, Solution of differential equations by method of separation of variables

Unit-II

Solution of Linear differential equations and equations reducible to linear form, Exact differential equations of first order, Integrating factor, First order higher degree differential equations solvable for x, y and p. Clairaut's form and singular solutions

Unit-III

Second order linear differential equations, Complete solutions of linear ordinary differential equations of second order with constant coefficients (Complementary Function + Particular Integral), Method of variation of parameter to find Particular Integral

Unit-IV

Transformations of the equation by changing the dependent/independent variable, Method of variationof parameters and method of undetermined coefficients

Suggested Books/Reading:

- Shepley L. Ross, Differential Equations, 3rd edition, 2007, Wiley India.
- M. D. Raisinghania, Advanced Differential Equations, S. Chand Publications.

Semester-I

Course	Name of Courses	Max Marks	Hrs. Per Week	Credit
JMU-101-V	Introduction to Communication	25 + 75 = 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:

1. Students would be able to introduce themselves to the nature of communication.
2. Students would be able to inculcate knowledge of Communication types and barriers.
3. Students would be able to develop knowledge of Communication theories.
4. 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

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.