"Implementation of Four Year Under Graduate Programme (FYUGP) in State Universities of Jharkhandregulations,2024"

As per provisions of NEP-2020

To be implemented

from

Academic Year 2025-26

Vinoba Bhave University, Hazaribag

Subject: **Chemistry**

SEMESTER-I

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1. Major course- Code-MJ 1: (Credit: Theory-03, Practical-01)

Marks: 15 (5 Attd. + 10 SIE: 1Hr) + 60 (ESE: 3Hrs) = 75	**Pass Marks: Th (MSE + ESE) = 30**

Instruction to Question Setter for

Semester Internal Examination (SIE10+5=15marks):

The Semester Internal Examination shall have two components.

(a)One Semester Internal Examination Written Test (SIE) of 10 Mark.

(b)Class Attendance Score (CAS) including the behaviour of the student towards teachers and other students of the College of 5 marks .End Semester Examination (ESE 60 marks):

There will be two groups of questions **A** and **B**. **Group A is compulsory** which will contain three questions. **Question No.1 will be very short answer type** consisting of five questions of 1 mark each. **Question No. 2 & 3 will be short answer type** of 5 marks. Group B will contain descriptive type five questions of fifteen marks each, out of which any three are to be answered.

Note: *There may be subdivisions in each questions asked in theory examination.*

BASIC CHEMISTRY-I **Theory: 45 Lectures**

Course Objectives:

On completion of this course, the students will be able to understand:

1. Atomic theory and its evolution.
2. Learning scientific theory of atoms, concept of wave function.
3. Elements in periodic table; physical and chemical characteristics, periodicity.
4. To predict the atomic structure based on accepted models.
5. To understand atomic theory of matter, composition of atom.
6. Identity of given element, relative size, charges of proton, neutron and electrons, and their assembly to form different atoms.
7. Defining isotopes, isobars and isotones.
8. Physical and chemical characteristics of elements in various groups and periods according to ionic size, charge, etc. and position in periodic table.
9. Kinetic molecular model of a gas.

Course Learning Outcomes:

On successful completion of this course the students should be able to know:

1. Electronic configuration of various elements in periodic table.
2. Predicting structure of molecules.
3. Kinetic theory and behaviour of real gases.

Course Outlines:

Atomic Structure, periodicity of elements, Kinetic molecular model of a gas, behaviour of real gases.

Course Content:

Unit-1 Atomic Structure: (15 classes of 60 minutes duration each)

Recapitulation of theory of atomic struture. Wave mechanics: de Broglie equation, Heisenberg's Uncertainty Principle and its significance, Schrödinger's wave equation, significance of ψ and ψ^2. Eigen value and eigen function. Quantum numbers and their significance. Normalized, orthogonal and orthonormal wave functions. Sign of wave functions. Radial and angular wave functions for hydrogen atom. Radial and angular distribution curves. Shapes of s, p, d and f orbitals. Contour boundary and probability diagrams. Pauli's Exclusion Principle, Hund's rule of maximum multiplicity, Aufbau principle and its limitations, Variation of orbital energy with atomic number.

Unit-2 Periodicity of Elements: (15 classes of 60 minutes duration each)

The long form of periodic table and classification of elements in s, p, d and f blocks. Detailed discussion of the following properties of the elements with reference to *s* & *p*-block.

a. Effective nuclear charge, shielding or screening effect, Slater rules, variation of effective nuclear charge in periodic table.
b. Atomic (Covalent, van der Waal and Metallic) radii
c. Ionic (octahedral and tetrahedral) and crystal radii.
d. Ionization enthalpy, Successive ionization enthalpies and factors affecting ionization enthalpy. Applications of ionization enthalpy.
e. Electron gain enthalpy, trends of electron gain enthalpy.
f. Electronegativity and its scale: Pauling, Mullikan, Allred Rochow scales, Applications of electronegativity, bond order and hybridization, group electronegativity. Sanderson electron density ratio.
g. Variable elcetrovalency, inert pair effect

Unit-3 Kinetic molecular model of a gas: **(7 classes of 60 minutes duration each)**

Postulates of kinetic theory of gases 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 σ 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 equi-partition of energy, degrees of freedom and molecular basis of heat capacities.

Unit-4 Behaviour of real gases: (8 classes of 60 minutes duration each)

Deviations from ideal gas behaviour, compressibility factor, and its variation with pressure for different gases. Causes of deviation from ideal behaviour. van der Waals equation of state, its derivation and application in explaining real gas behaviour; van der Waals equation expressed in virial form, Boyle temperature. Isotherms of real gases and their comparison with van der Waals isotherms, continuity of states, critical state, critical and van der Waals constants, law of corresponding states.

Reference Books:

1. Lee, J.D. Concise Inorganic Chemistry,Wiley,5thEd^{n}.
2. Douglas, B.E., McDaniel, D.H., AlexanderJ.J., Concepts & Models of Inorganic Chemistry, (ThirdEdition) John Wiley & Sons,1999.
3. Atkins, P.W.and De Paula, J. PhysicalChemistry, TenthEdition, Oxford University Press, 2014.
4. Rodger, G.E. Inorgani and Solid-State Chemistry, Cengage Learning, 2002.
5. Douglas, B.E ; McDaniel D.H. & Alexander, J.J. Concepts & Models of Inorganic Chemistry 3rd Ed., John Wiley Sons,N.Y.1994.
6. Rodger, G.E. Inorganic and Solid-State Chemistry, Cengage Learning India Edition, 2002.
7. Miessler, G.L. & Donald, A .Tarr. Inorganic Chemistry Fourth Ed., Pearson, 2010

CHEMISTRY PRACTICAL- MJ 1 LAB (Credit: Practical-01)

Practical (ESE: 2Hrs) =25 Marks	**Pass Marks: Practical (ESE) = 10**
Internal Examination=0 Marks	

Instruction to Question Setter for
End Semester Examination (ESE):
There will be one Practical Examination of 2Hrs duration. Evaluation of Practical Examination may be as per the following guidelines:

Experiment	*= 15 marks*
Practical record notebook	*= 05 marks*
Viva-voce	*= 05 marks*

PRACTICALS: **Hours: 30**

(A) **Titrimetric Analysis**
- (i) Calibration and use of apparatus.
- (ii) Preparation of solutions of different Molarity/Normality of titrants.
- (iii) Use of primary and secondary standard solutions.
- (iv) Standardizations of Potassium permanganate solution using oxalic acid

(B) **Acid-Base Titrations**
- (i) Standardizations of sodium hydroxide solution by supplied sulphuric acid solution
- (ii) Standardizations of sodium carbonate solution using HCl acid solution

(C) Determination of surface tension using stalgmometer (drop formation method)

Reference text:

1. Mendham, J, A. I. Vogel's *Quantitative Chemical Analysis* Sixth Edition, Pearson, 2009.
2. Svehala, G and Sivasankar I.B, Vogel's Qualitative Inorganic Analysis, Pearson India 2012.

SEMESTER-II

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2. Major course- Code-MJ 2: (Credit: Theory-3, Practical-1)

Marks: 15 (5 Day -to- day Attd). + 10 (written SIE: 1.5Hr) + 60 (ESE: 3Hrs) = 75 **Pass Marks: Th (MSE + ESE) = 30**

Instruction to Question Setter for

Semester Internal Examination (SIE10+5=15marks):

The Semester Internal Examination shall have two components.

(a)One Semester Internal Examination Written Test (SIE) of 10 Mark.

(b)Class Attendance Score (CAS) including the behaviour of the student towards teachers and other students of the College of 5 marks .End Semester Examination (ESE 60 marks):

There will be two groups of questions **A** and **B**. **Group A is compulsory** which will contain three questions. **Question No.1 will be very short answer type** consisting of five questions of 1 mark each. **Question No. 2 & 3 will be short answer type** of 5 marks. Group B will contain descriptive type five questions of fifteen marks each, out of which any three are to be answered.

Note: *There may be subdivisions in each questions asked in theory examination.*

BASIC CHEMISTRY-II **Theory: 45 Lectures**

Course Objectives:

On successful completion of this course the students should be able to understand:

1. Basics of organic molecules, structure, bonding, reactivity and reaction mechanisms.
2. Stereo chemistry of organic molecules : conformation and configuration, asymmetric molecules and nomenclature.
3. Understanding hybridization and geometry of atoms, 3-D structure of organic molecules, identifying chiral centers.
4. About solid and liquid state.

Course Learning Outcomes:

On successful completion of this course the students should be able to know:

1. Design and syntheses of organic molecules..
2. Advanced softwares / Models used for predicting stereochemistry / study of energy minimization of organic molecules.
3. The structure of solid and liquid.

Course Outlines:

1. Basics of Organic Chemistry, Stereochemistry, structure and properties of solid and liquid.

Course Content:

Unit-1 Basics of Organic Chemistry: (15 classes of 60 minutes duration each)

Recapitulation of Classification and Nomenclature, Electronic Displacements: Inductive and electromeric effects, resonance and mesomeric effects, hyperconjugation and their applications; Dipole moment; Organic acids and bases; their relative strength.

Homolytic and Heterolytic fission with suitable examples. Electrophiles and Nucleophiles.

Reaction Intermediates: Generation, shapes, stability and reactions of carbocations, carbanions, free radicals, carbenes, nitrenes and Benzyne.

Unit-2 Stereochemistry: (15 classes of 60 minutes duration each)

Concept of asymmetry and dissymmetry, Fischer, Newmann and Sawhorse projection formulae and their interconversions; Geometrical isomerism: cis–trans and, syn-anti isomerism E/Z notations with C.I.P rules.

Optical Isomerism: Optical Activity, Specific Rotation, Chirality / Asymmetry, Enantiomers, molecules with two or more chiral-centres, Distereoisomers, meso structures, Racemic mixtures and resolution, Relative and absolute configuration: D/L and R/S designations.

Unit 3 Solid state: (10 classes of 60 minutes duration each)

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. Various types of defects in crystals, Glasses and liquid crystals.

Unit-4 Liquid state: (05 classes of 60 minutes duration each)

Structure and physical properties of liquids; vapour pressure, surface tension, viscosity, and their dependence on temperature, Effect of addition of various solutes on surface tension.

Reference Books:

1. Morrison, R. N. & Boyd, R. N. Organic Chemistry, 6th Edn., Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
2. Pine S. H. Organic Chemistry, Fifth Edition, McGraw Hill, (2007)
3. F. A. Carey, Organic Chemistry, Seventh Edition, Tata McGraw Hill (2008).
4. J. Clayden, N. Greeves, S. Warren, Organic Chemistry, 2nd Ed., (2012), Oxford University Press.
5. F. A. Carey, R. J. Sundberg, Advanced Organic Chemistry, Part A: Structure and mechanism, Kluwer Academic Publisher, (2000).

CHEMISTRY PRACTICAL- MJ 2 LAB (Credit: Practical-01)

Practical (ESE: 2Hrs) =25 Marks	**Pass Marks: Practical (ESE) = 10**
Internal Examination=0 Marks	

Instruction to Question Setter for
End Semester Examination (ESE):
There will be one Practical Examination of 2Hrs duration. Evaluation of Practical Examination may be as per the following guidelines:

Experiment	*= 15 marks*
Practical record notebook	*= 05 marks*
Viva-voce	*= 05 marks*

PRACTICALS: **Hours: 30**

1. Checking the calibration of the thermometer.
2. Purification of organic compounds by crystallization using the following solvents:
   a.Water b. Alcohol c. Alcohol-Water
3. Determination of the melting points and boiling points of given organic compounds (using Kjeldahl method and electrically heated melting point apparatus) and effect of impurity on m.p. and b.p., calculation of % error.
4. Determination of viscosity of given liquid by Ostwald viscometer

Reference Books

1. 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.*PracticalOrganicChemistry, 5thEd.*,Pearson(2012).

SEMESTER III

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3. MAJOR COURSE- MJ 3: (Credits: Theory-03, Practicals-01)

Marks: 15 (5 Attd. + 10 SIE: 1Hr) + 60 (ESE: 3Hrs) = 75	Pass Marks: Th (MSE + ESE) = 30

Instruction to Question Setter for

Semester Internal Examination (SIE10+5=15marks):

The Semester Internal Examination shall have two components.

(a)One Semester Internal Examination Written Test (SIE) of 10 Mark.

(b)Class Attendance Score (CAS) including the behaviour of the student towards teachers and other students of the College of 5 marks .End Semester Examination (ESE 60 marks):

There will be two groups of questions **A** and **B**. **Group A is compulsory** which will contain three questions. **Question No.1 will be very short answer type** consisting of five questions of 1 mark each. **Question No. 2 & 3 will be short answer type** of 5 marks. Group B will contain descriptive type five questions of fifteen marks each, out of which any three are to be answered.

Note: *There may be subdivisions in each questions asked in theory examination.*

PHYSICAL CHEMISTRY I Theory: 45 Lectures

Course Objectives:

On completion of this course, the students will be able to understand:

1. Chemical equilibrium.
2. Symmetry of molecules.
3. Electrolytes and electrolytic dissociation, salt hydrolysis and acid-base equilibria.
4. Ionic equilibria - electrolyte, ionization, dissociation
5. Salt hydrolysis and its applications in chemistry.

Course Learning Outcomes:

On successful completion of this course the students should be able to know:

1. Numericals related to salt hydrolysis, ionic equilibria.
2. Chemical and ionic equilibrium.
3. Conductance and its applications.

Course Outlines: Chemical equilibrium, ionic equilibrium, molecular symmetry, point group.

Course Content:

Unit-1 Chemical Equilibria: (08 classes of 60 minutes duration each)

Reversible and irreversible reaction, Equilibrium and equilibrium constant, K_p, K_c and K_x and relation between them, Dependence of equilibrium constant on temperature (Kirchoff's equation), Le-chatellier's Principle and its applications, Relation between equilibrium constant and standard free energy change. Homogeneous and heterogeneous equilibria

Unit-2 Ionic Equilibria: **(20 classes of 60 minutes duration each)**

Strong and weak electrolytes, degree of ionization, factors affecting degree of ionization, Ostwald dilution law, Ionization constant of mono-, di- and tri- protic acids, ionic product of water, pH and pH scale, pH of strong and weak acids and bases, Common ion effect, Buffer solutions and its types, pH of buffer solutions (Henderson equation), buffer capacity, Applications of buffer solution, Solubility and solubility product in analytical chemistry, Hydrolysis of salts, degree of hydrolysis, Hydrolysis constants, P^H of solution of different types of salts, Theory of Indicators

Unit-3 Conductance: (10 classes of 60 minutes duration each)

Arrhenius theory of electrolytic dissociation. Conductivity, equivalent and molar conductivity and their variation with dilution for weak and strong electrolytes. Molar conductivity at infinite dilution. Kohlrausch law of independent migration of ions. Debye-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-4 Molecular symmetry: (07 classes of 60 minutes duration each)

Symmetry operation and symmetry elements, Matrix representation of symmetry elements, Points group, Multiplication table of C_{2v} and C_{3v} point group

Reference Books:

1. Atkins ,P.W. & Paula, J.de *Atkin's Physical Chemistry* 8th Ed., Oxford University Press (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* 3rdEd. Elsevier: NOIDA,UP (2009).
5. G.M.Barrow, Tata McGraw Hill (Fifth Edition) (2007)
6. Roy, B.N. Fundamentals of Classical and Statistical Wiley, 2001
7. *Commonly Asked Questions inThermodynamics.*CRC Press, 2011.

CHEMISTRY PRACTICAL- MJ 3 LAB (Credit: Practical-01)

Practical (ESE: 2Hrs) =25 Marks	**Pass Marks: Practical (ESE) = 10**
Internal Examination=0 Marks	

Instruction to Question Setter for
End Semester Examination (ESE):
There will be one Practical Examination of 2Hrs duration. Evaluation of Practical Examination may be as per the following guidelines:

Experiment	*= 15 marks*
Practical record notebook	*= 05 marks*
Viva-voce	*= 05 marks*

PRACTICALS: **Hours: 30**

1. Conductometric Titration :

i. Conductometric titration of strong acid vs strong base
ii. Conductometric titration of $AgNO_3$ vs KCl

2. pH metry

a. Effect on pH of addition of HCl/NaOH to solutions of acetic acid, sodium acetate and their mixtures.
b. Preparation of buffer solutions of different pH
   i. Sodium acetate-aceticacid
   ii. Ammonium chloride-ammonium hydroxide
c. Determine the strength of unknown solution of HCl titrating it with NaOH solution using P^H - meter.
d. Titrate a weak acid (eg. Acetic acid) potentiomerically and hence obtain dissociation constant of the acid.

ReferenceBooks

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).
3. Halpern, A.M. & McBane, G.C. *Experimental Physical Chemistry 3rdEd.;*W.H. Freeman &Co.: New York (2003).
4. Athawale V.D. and Mathur P. Experimental Physical Chemistry, NewAge International(2001)

4. MAJOR COURSE- MJ 4: (Credits: Theory-03, Practicals-01)

Marks: 15 (5 Attd. + 10 SIE: 1Hr) + 60 (ESE: 3Hrs) = 75	Pass Marks: Th (MSE + ESE) = 30

Instruction to Question Setter for

Semester Internal Examination (SIE10+5=15marks):

The Semester Internal Examination shall have two components.

(a)One Semester Internal Examination Written Test (SIE) of 10 Mark.

(b)Class Attendance Score (CAS) including the behaviour of the student towards teachers and other students of the College of 5 marks .End Semester Examination (ESE 60 marks):

There will be two groups of questions **A** and **B**. **Group A is compulsory** which will contain three questions. **Question No.1 will be very short answer type** consisting of five questions of 1 mark each. **Question No. 2 & 3 will be short answer type** of 5 marks. Group B will contain descriptive type five questions of fifteen marks each, out of which any three are to be answered.

Note: *There may be subdivisions in each questions asked in theory examination.*

INORGANIC CHEMISTRY I **Theory: 45 Lectures**

Course Objectives:

On completion of this course, the students will be able to understand:

1. bonding between atoms, molecules, interaction, and energetics
2. Hybridization and shapes of atomic, molecular orbitals, bond parameters, bond-distances and energies.
3. Valence bond theory incorporating concepts of hybridization predicting geometry of molecules.
4. Importance of hydrogen bonding, metallic bonding.
5. Organic and Inorganic polymers.

Course Learning Outcomes:

On successful completion of this course the students shouldbe able to know:

1. Predicting structure of molecules
2. How hydrogen bonding, metallic bonding is important in common materials' scientific applications to material fabrication.
3. Inorganic Polymers and their uses.

Course Outlines: Covalent bond, Metallic Bond, Weak Chemical Forces, Inorganic Polymers.

Course Content

Unit-1 Ionic bond: (06 classes of 60 minutes duration each)

General characteristics, size effects, radius ratio rule and its limitations. Packing of ions in crystals. Born-Landé equation with derivation, expression for lattice energy, Madelung constant, Born-Haber cycle and its application, Solvation energy.

Unit-2 Covalent bond: (24 classes of 60 minutes duration each)

Lewis structure, Valence Shell Electron Pair Repulsion Theory (VSEPR), Shapes of simple molecules and ions containing lone and bond-pairs of electrons multiple bonding, sigma and pi-bond approach, Valence Bond theory, (Heitler-London approach). Hybridization containing s, p and s, p, d atomic orbitals, shapes of hybrid orbitals, Bents rule, Resonance and resonance energy, Molecular orbital theory. Molecular orbital diagrams of simple homonuclear and heteronuclear diatomic molecules, MO diagrams of simple tri and tetraatomic molecules N_2, O_2, C_2, B_2, F_2, CO, NO, and their ions; HCl, BeF_2, CO_2, HCHO, (idea of s-p mixing and orbital interaction to be given). Covalent character in ionic compounds, polarizing power and polarizability. Fajan rules, polarization. Ionic character in covalent compounds, Bond moment and dipole moment, ionic character from dipole moment and electronegativities.

Weak Molecular Forces: Van der Waals, ion-dipole, dipole-dipole, dipole - induced dipole interactions, Lenard-Jones 6-12 formula, effects of hydrogen bonding on melting and boiling points, solubility, dissolution

Unit-3 Metallic Bond: (05 classes of 60 minutes duration each)

Qualitative idea of free electron model,Valence bond model and molecular orbital model, Semiconductors, Insulators..

Unit-4 Inorganic Polymers: (10 classes of 60 minutes duration each)

Types of inorganic polymers, comparison with organic polymers, synthesis, structural aspects and applications of silicones and siloxanes. Borazines, silicates and phosphazenes, and polysulphates.

Reference Books:

1. Lee, J. D. Concise Inorganic Chemistry, Wiley, 5th Edn.
2. Douglas, B.E., McDaniel, D.H., Alexander J.J., Concepts & Models of Inorganic Chemistry, (Third Edition) John Wiley & Sons,1999.
3. Atkins, P. W. and De Paula, J. Physical Chemistry, Tenth Edition, Oxford University Press, 2014.
4. Rodger, G. E. Inorganic and Solid-State Chemistry, Cengage Learning, 2002.
5. Douglas, B.E; Mc Daniel, D.H. & Alexander, J.J. Concepts & Models of Inorganic Chemistry 3rd Ed., John Wiley Sons, N.Y. 1994.
6. Rodger, G.E. Inorganic and Solid-State Chemistry, Cengage Learning India Edition, 2002.
7. Miessler, G. L. & Donald, A. Tarr. Inorganic Chemistry Fourth Ed., Pearson, 2010.

CHEMISTRY PRACTICAL- MJ 4 LAB (Credit: Practical-01)
(Inorganic Chemistry)

Practical (ESE: 2Hrs) =25 Marks	**Pass Marks: Practical (ESE) = 10**
Internal Examination=0 Marks	

Instruction to Question Setter for
End Semester Examination (ESE):
There will be one Practical Examination of 2Hrs duration. Evaluation of Practical Examination may be as per the following guidelines:

Experiment	*= 15 marks*
Practical record notebook	*= 05 marks*
Viva-voce	*= 05 marks*

PRACTICALS: **Hours: 30**

(A) **Acid-Base Titrations**
- (i) Estimation of sodium carbonate and sodium bicarbonate present together in a mixture.
- (ii) Estimation of free alkali present in different soaps/detergents

(B) **Oxidation-Reduction Titrimetry**
- (i) Estimation of Fe(II) and oxalic acid 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 (diphenylamine, anthranilic acid) and external indicator.

(C**)** Estimation of copper in copper sulphate Iodometrically.

Reference text:

1. Mendham, J., A. I. Vogel's Quantitative Chemical Analysis Sixth Edition, Pearson, 2009.
2. Svehala G. and Sivasankar I. B, Vogel's Qualitative Inorganic Analysis, Pearson, India,2012.

SEMESTER IV

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5. MAJOR COURSE- MJ 5: (Credits: Theory-03, Practicals-01)

Marks: 15 (05 Attd. + 10 SIE: 1.5Hr) + 60 (ESE: 3Hrs) = 75	**Pass Marks: Th (MSE + ESE) = 30**

Instruction to Question Setter for

Semester Internal Examination (SIE10+5=15marks):

The Semester Internal Examination shall have two components.

(a)One Semester Internal Examination Written Test (SIE) of 10 Mark.

(b)Class Attendance Score (CAS) including the behaviour of the student towards teachers and other students of the College of 5 marks .End Semester Examination (ESE 60 marks):

There will be two groups of questions **A** and **B**. **Group A is compulsory** which will contain three questions. **Question No.1 will be very short answer type** consisting of five questions of 1 mark each. **Question No. 2 & 3 will be short answer type** of 5 marks. Group B will contain descriptive type five questions of fifteen marks each, out of which any three are to be answered.

Note: *There may be subdivisions in each questions asked in theory examination.*

Indian Knowledge System (IKS) in Chemistry **Theory 45Lectures**

Course Objective

On completion of this course, the students will be able to understand:

1. Starting knowledge of chemistry in ancient India.
2. Manuscripts written by different Maharshis.
3. Getting different types of knowledge about metals, non-metals, metallurgy, medicine .
4. Chemistry of aliphatic and alicyclic hydrocarbons.

Course learning Outcomes

On successful completion of this course the students shouldbe able to know:

1) To know the expertise of chemistry in ancient india.

2) Reactions and properties of carbon – carbon single bond and carbon – carbon multiple bond.

Course outline

1. Use of copper, bronze, zinc, iron, gold, silver, mercury, arsenic, lead.

Course Content

Unit-1 Introduction of Indian Knowledge System:
(05 classes of 60 minutes duration each)

- Meaning, definition and scope of IKS
- Vocabulary of IKS
- Characteristics of classification of IKS
- Vedas, Upnishads and Darshan – Philosophical Foundation of IKS
- Interdisciplinary approach of IKS
- Source of Indian traditional knowledge
- Holistic and Integral work view of Indian tradition

Unit-2 History of Metallurgy in India:
(10 classes of 60 minutes duration each)

Melting, Smelting, Roasting, Design of furnaces, Distillation etc., use of copper (Tambra), Bronze(Kansya), Brass, Iron (Louh), Zinc (Yashad), Gold (Swarna), Silver (Rajat), Mercury (Parad), Arsenic (Sankhya),Wootz Steel and Damascus Steel, Aranmula Mirror.

Unit-3 General principle of Metallurgy : (10 classes of 60 minutes duration each)

Redox equations, Standard Electrode Potential and its application to inorganic reactions. Occurrence of metals based on standard electrode potentials. Ellingham diagrams for reduction of metal oxides using carbon or carbon monoxide as reducing agent. Electrolytic Reduction, Hydrometallurgy. Methods of purification of metals: Electrolytic Kroll process, Parting process, van Arkel- de Boer process and Mond's process, Zone refining.

Unit-4 Chemistry of Aliphatic and Alicylic Hydrocarbon:
(20 classes of 60 minutes duration each)

A. Carbon-Carbon singal bonds

Chemistry of alkanes: Preparation of alkanes, Wurtz Reaction, Wurtz - Fittig Reactions, Corey-House reaction, Free radical substitution, Halogenation - relative reactivity and selectivity.

B. Carbon-Carbon multiple bonds

Preparation of alkenes and alkynes by elimination reactions, Mechanism of E1, E2, E1cb reactions. Saytzeff and Hofmann eliminations. Reactions of alkenes: Electrophilic additions their mechanisms (Markownikoff / Anti Markownikoff addition), mechanism of oxymercuration-demercuration, Acid catalysed hydration, 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. Reactions of alkynes: Acidity, Electrophilic and Nucleophilic additions.

Cycloalkanes and stability, Baeyer strain theory, Conformational analysis of ethane, n-butane and cyclohexane and mono- and di- substituted cyclohexane.

Reference Books:

1. Morrison, R. N. & Boyd, R. N. Organic Chemistry, 6th Edn., Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
2. Pine S. H. Organic Chemistry, Fifth Edition, McGraw Hill, (2007)
3. F. A. Carey, Organic Chemistry, Seventh Edition, Tata McGraw Hill (2008).
4. J. Clayden, N. Greeves, S. Warren, Organic Chemistry, 2nd Ed., (2012), Oxford University Press.
5. F. A. Carey, R. J. Sundberg, Advanced Organic Chemistry, Part A: Structure and mechanism, KluwerAcademic Publisher, (2000).

Reference Books:

1. A History of Hindu Chemistry by P. C. Ray, D.Sc., Professor of Chemistry, Presidency College, Calcutta. Published by Bengal Chemical and Pharmaceutical Works Ltd., Calcutta.
2. Science and Technology in Ancient Indian Text by Bal Ram Singh, Nath Girish & Umesh Kumar Singh.

CHEMISTRY PRACTICAL- MJ 5 LAB **(Credit: Practical-01)**
(Components of IKS in Chemistry)

Practical (ESE: 2Hrs) = 25 Marks	**Pass Marks: Practical (ESE) = 10**
Internal Examination = 0 Marks	

Instruction to Question Setter for
End Semester Examination (ESE):
There will be one Practical Examination of 2Hrs duration. Evaluation of Practical Examination may be as per the following guidelines:

Field Visit	*= 15 marks*
Practical record notebook	*= 05 marks*
Viva-voce	*= 05 marks*

PRACTICALS and Field Work: **Hours : 30**

1. To visit different libraries to collect minimum five components of IKS in chemistry.
2. To visit minimum one monumental place where proof with chemical perspective of articles are present.
3. Identification of medicinal plant in tribal areas of Jharkhand used by the tribals traditionally.

6. MAJOR COURSE- MJ 6: (Credits: Theory-03, Practicals-01)

Marks: 15 (5 Attd. + 10 SIE: 1Hr) + 60 (ESE: 3Hrs) = 75	Pass Marks: Th (MSE + ESE) = 30

Instruction to Question Setter for

Semester Internal Examination (SIE10+5=15marks):

The Semester Internal Examination shall have two components.

(a)One Semester Internal Examination Written Test (SIE) of 10 Mark.

(b)Class Attendance Score (CAS) including the behaviour of the student towards teachers and other students of the College of 5 marks .End Semester Examination (ESE 60 marks):

There will be two groups of questions **A** and **B**. **Group A is compulsory** which will contain three questions. **Question No.1 will be very short answer type** consisting of five questions of 1 mark each. **Question No. 2 & 3 will be short answer type** of 5 marks. Group B will contain descriptive type five questions of fifteen marks each, out of which any three are to be answered.

Note: *There may be subdivisions in each questions asked in theory examination.*

Organic Chemistry I Theory: 45 Lecture

Course Objectives:

On successful completion of this course the students should be able to understand:

1. Reactivity, stability of organic molecules, structure, stereochemistry.
2. Electrophile, nucleophiles, free radicals, electronegativity, resonance, and intermediates along the reaction pathways.
3. Mechanism of organic reactions (effect of nucleophile / leaving group, solvent), substitution *vs*. elimination.
4. Aromatic compounds and aromaticity, mechanism of aromatic reactions.

Course Learning Outcomes:

On successful completion of this course the students should be able toknow:

1. Design and synthesis of organic molecules.
2. Structure identification through IR, NMR and Mass spectroscopic data.
3. Lab/Instrumentation techniques used for analyzing reaction mechanisms.
4. Advanced softwares /Models used for predicting stereochemistry / study of energy minimization of organic molecules.

Course Outlines:

Aromatic Hydrocarbons, Chemistry of Halogenated Hydrocarbons.

Course Content:

Unit-1 Chemistry of Aromatic Hydrocarbons : (8 classes of 60 minutes duration each)

Aromaticity: Huckel's rule, aromatic character of arenes. Electrophilic aromatic substitution: halogenation, nitration, sulphonation and Friedel-Craft's alkylation / acylation with their mechanism. Directive influence of substituent groups, O/P ratio.

Unit-2 Chemistry of Halogenated Hydrocarbons:
(12 classes of 60 minutes duration each)

Alkyl halides*:* Methods of preparation, nucleophilic substitution reactions – S_N1, S_N2 and S_Ni mechanisms with stereochemical aspects and effect of solvent, nucleophiles and leaving group ; nucleophilicity vs basicity, nucleophilic substitution vs. elimination.

Aryl halides: Preparation, nucleophilic aromatic substitution; S_NAr1 and S_NAr2 , Benzyne mechanism. Relative reactivity of alkyl, allyl, vinyl and aryl halide towards electrophilic substitution.

Unit-3 Alcohols : (10 classes of 60 minutes duration each)
Alcohols*:* preparation, properties and relative reactivity of 1°, 2°, 3° alcohols, Bouvaelt-Blanc Reduction; Preparation and properties of glycols: Oxidation by periodic acid and lead tetraacetate, Pinacol-Pinacolone rearrangement.

Monohydric alcohols – preparation, properties and relative reactivity of 1°,2°,3°alcohols,

DihydricAlcohols: Methods of preparation ,chemical reactions of glycols- Oxidative cleavage (periodic acid and lead tetraacetate), Pinacol-Pinacolone rearrangement.

Trihydric alcohols - methods of preparation, chemical reactions of glycerol.

Unit-4 Phenols, Ethers and Epoxides: (15 classes of 60 minutes duration each)
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 $LiAlH_4$, ring opening of epoxide and regioselectivity.

Reference Books:

1. Morrison, R. N. & Boyd, R. N. *Organic Chemistry*, 6th Edn., Dorling Kindersley (India)Pvt. Ltd. (Pearson Education).
2. Pine S. H. Organic Chemistry, Fifth Edition, McGraw Hill, (2007)
3. F. A. Carey, Organic Chemistry, Seventh Edition, Tata McGraw Hill (2008).
4. J. Clayden, N. Greeves, S. Warren, Organic Chemistry, 2nd Ed., (2012), Oxford University Press.
5. F. A. Carey, R. J. Sundberg, Advanced Organic Chemistry, Part A: Structure and mechanism, Kluwer Academic Publisher, (2000).

CHEMISTRY PRACTICAL- MJ 6 LAB **(Credit: Practical-01)**
(Organic Chemistry)

Practical (ESE: 2Hrs) =25 Marks	**Pass Marks: Practical (ESE) = 10**
Internal Examination=0 Marks	

Instruction to Question Setter for
End Semester Examination (ESE):
There will be one Practical Examination of 2Hrs duration. Evaluation of Practical Examination may be as per the following guidelines:

Experiment	*= 15 marks*
Practical record notebook	*= 05 marks*
Viva-voce	*= 05 marks*

PRACTICALS: **Hours: 30**

1. Detection of elements and functional group in organic compounds
2. Chromatography
   a. Separation of a mixture of two amino acids by ascending and horizontal paper chromatography
   b. Separation of a mixture of two sugars by ascending paper chromatography
   c. Separation of a mixture of *o*-and *p*-nitrophenol or o-and p-aminophenol by thin layer chromatography (TLC).
3. Preparation of Aspirin
4. Bromination of Phenol

Reference Books

1. 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)

7. MAJOR COURSE- MJ 7: (Credits: Theory-03, Practicals-01)

Physical Chemistry II

Marks: 15 (5 Attd. + 10 SIE: 1Hr) + 60 (ESE: 3Hrs) = 75	Pass Marks: Th (MSE + ESE) = 30

Instruction to Question Setter for

Semester Internal Examination (SIE10+5=15marks):

The Semester Internal Examination shall have two components.

(a)One Semester Internal Examination Written Test (SIE) of 10 Mark.

(b)Class Attendance Score (CAS) including the behaviour of the student towards teachers and other students of the College of 5 marks .End Semester Examination (ESE 60 marks):

There will be two groups of questions **A** and **B**. **Group A is compulsory** which will contain three questions. **Question No.1 will be very short answer type** consisting of five questions of 1 mark each. **Question No. 2 & 3 will be short answer type** of 5 marks. Group B will contain descriptive type five questions of fifteen marks each, out of which any three are to be answered.

Note: *There may be subdivisions in each questions asked in theory examination.*

Physical Chemistry II Theory: 45 Lectures

Course Objective

On successful completion of this course the students should be able to understand:

1. Solids, lattice parameters – its calculation, application of symmetry, solid characteristics of simple salts.
2. Laws of thermodynamics.
3. Colloidal nature of substance.

Course Learning Outcomes:

On successful completion of this course the studentsshould be able to know:

1. Determination of lattice parameters of given salt.
2. Study of X-Ray diffraction pattern and finding out reference from JCPDI file.
3. Use of thermo chemical equations for calculation of energy and related terms.
4. About Colloidals solution and their applications.

Course Outlines:

Solid state, laws of thermodynamics, colloids.

Course Content:

Unit-1 Introduction to thermodynamics: (10 classes of 60-minute duration each)

System, types of system; isolated, closed and open systems, Surrounding, Processes, types of processes, isothermal, adiabatic, isobaric, isochoric, cyclic, reversible and irreversible, Intensive and extensive properties, state and path functions.

Zeroth law of thermodynamics, *First law:* Concept of heat, *q*, work, *w*, internal energy (*U),*

and statement of first law; enthalpy (*H)*, relation between heat capacities, derivation of relation Cp – Cv = R, calculations of *q*, *w*, *U* and *H* for reversible, irreversible and free expansion of gases (ideal and van der Waals) under isothermal and adiabatic conditions.

Unit-2 Thermochemistry: (10 classes of 60 minutes duration each)

Enthalpy of reactions, Factor affecting enthalpy of reaction, effect of temperature (Kirchhoff's equations) and pressure, standard states; enthalpy of formation of molecules and ions and enthalpy of combustion and its applications; calculation of bond dissociation energy, bond energy and resonance energy from thermo chemical data.

Unit-3 Second Law: (15 classes of 60 minutes duration each)

Limitations of first law thermodynamics and need of second law of thermodynamics, Statements of second law of thermodynamics, carnot theorem, carnot cycle, thermodynamic scale of tempetature

Concept of entropy; molecular and statistical interpretation of entropy. Calculation of entropy change for reversible and irreversible processes, entropy of mixing of ideal gases.

Unit-4 Colloidal Chemistry: (10 classes of 60 minutes duration each)

Introduction, Types and Classification, lyophilic and lyophobic colloids, preparation of colloidal solution, Purification of colloids, properties of colloidal solution, optical property, Brownian movement, electrical property, Theory of electrical double layer, Origin of charge on colloids, Zeta potential, Electophoresis, Electro-osmosis, Stability and coagulation of colloidal solution, Hardy-Schulze law, Protection of colloids, Gold number, Emulsions, Micelles, CMC, Surfactants, Application of colloids.

Reference Books:

1. Atkins, P. W. & Paula, J. de *Atkin's Physical Chemistry* 8th Ed., Oxford University Press(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).5 G. M. Barrow, Tata McGraw Hill (Fifth Edition) (2007)
5. 5 Roy, B. N. Fundamentals of Classical and Statistical Thermodynamics Wiley, 20016 *Commonly Asked Questions in Thermodynamics.* CRC Press, 2011.

CHEMISTRY PRACTICAL- MJ 7 LAB (Credit: Practical-01)
(Physical Chemistry)

Practical (ESE: 2Hrs) =25 Marks	**Pass Marks: Practical (ESE) = 10**
Internal Examination=0 Marks	

Instruction to Question Setter for
End Semester Examination (ESE):
There will be one Practical Examination of 2Hrs duration. Evaluation of Practical Examination may be as per the following guidelines:

Experiment	= 15 marks
Practical record notebook	*= 05 marks*
Viva-voce	*= 05 marks*

PRACTICALS: **Hours: 30**

1. Determination of water equivalent of calorimeter
2. Determination of enthalpy of solution of KNO_3 .
3. Determination of enthalpy of neutralization of strong acid vs strong base.
4. Determination of enthalpy of neutralization of weak acid vs strong base.
5. Preparation of colloidal solution of Arsenic Sulphide

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Reference Books

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).
3. Halpern, A. M. & McBane, G. C. *Experimental Physical Chemistry 3rd Ed.;* W.H. Freeman &Co.: New York (2003).
4. Athawale V. D. amd Mathur P. Experimental Physical Chemistry, New Age International(2001)

SEMESTER V

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8. MAJOR COURSE- MJ 8: (Credits: Theory-03, Practicals-01)

Marks: 15 (5 Attd. + 10 SIE: 1Hr) + 60 (ESE: 3Hrs) = 75	**Pass Marks: Th (MSE + ESE) = 30**

Instruction to Question Setter for

Semester Internal Examination (SIE10+5=15marks):

The Semester Internal Examination shall have two components.

(a)One Semester Internal Examination Written Test (SIE) of 10 Mark.

(b)Class Attendance Score (CAS) including the behaviour of the student towards teachers and other students of the College of 5 marks .End Semester Examination (ESE 60 marks):

There will be two groups of questions **A** and **B**. **Group A is compulsory** which will contain three questions. **Question No.1 will be very short answer type** consisting of five questions of 1 mark each. **Question No. 2 & 3 will be short answer type** of 5 marks. Group B will contain descriptive type five questions of fifteen marks each, out of which any three are to be answered.

Note: *There may be subdivisions in each questions asked in theory examination.*

INORGANICCHEMISTRY-II Theory: 45 Lectures

Course Objectives:

After completion of the course, the learners shall be able to understand:

1. Chemistry of s and p-block elements.
2. Chemistry of noble gases.
3. Structure, bonding of s and p-block elements and their oxides / compounds.
4. Chemistry of boron compounds and their structures.
5. Chemistry of noble gases and their compounds; application of VSEPR theory in explaining structure and bonding.
6. Co-ordination compounds – its nomenclature, theories, d-orbital splitting in complexes, chelate.

Course Learning Outcomes:

On successful completion of this course the students should be able to know:

1. Bonding of various s and p-block elements.
2. Use of boron compounds.
3. IUPAC nomenclature of co-ordination compounds / complexes.
4. Prediction of structure of complexes using various theories; color and magnetic properties of different complexes.

CourseOutlines:

Chemistry of *s* and *p* Block Elements, Noble Gases, Coordination Chemistry.

Course Content:

Unit-1 Chemistry of *s* and *p* Block Elements: (15 classes of 6 minute duration each)

Inert pair effect, Relative stability of different oxidation states, diagonal relationship and anomalous behaviour of first member of each group. Allotropy and catenation. Complex formation tendency of *s* and *p* block elements.
Hydrides and their classification ionic, covalent and interstitial. Basic beryllium acetate and nitrate.
Structure, bonding, preparation, properties and uses: Boric acid and borates, boron nitrides, borohydrides (diborane), carboranes and graphitic compounds, silanes.

Oxides and oxoacids of nitrogen, Phosphorus and chlorine. Per-oxo acids of Sulphur inter-halogen compounds, poly- halide ions, pseudo-halogens.

Unit-2 Noble Gases: (07 classes of 60 minutes duration each)

Occurrence, separation of noble gases and uses, rationalization of inertness of noble gases, Clathrates; preparation and properties of XeF_2, XeF_4 and XeF_6; Bonding in noble gas compounds (Valence bond an MO treatment for XeF_2), Shapes of noble gas compounds (VSEPR theory).

Unit-3 Coordination Chemistry I : (18 classes of 60 minutes duration each)

Addition compounds, Double salts and Complex salts, Ligands and their clasiffictions, Co-ordination number and other related terms, Werner's theory, Sidgwick electronic concept, EAN rule, , valence bond theory (inner and outer orbital complexes), limitations of VBT, Crystal field theory, d-orbital splitting, weak and strong fields, pairing energies, factors affecting the magnitude of splitting energy (Δ or 10 Dq). Jahn-Teller distortion. Crystal Field Stabilization Energy (CFSE) in different strong and weak fields.

Variation of lattice energies, enthalpies of hydration, crystal radii in halides of first and second row transition metal series, Limitation of CFT, Spectro chemical series, Qualitative aspect of Ligand field theory, MO diagrams of octahedral and tetrahedral complexes with and without π bond representative co-ordination complexes,

Unit-4 Coordination Chemistry II : (05 classes of 60 minutes duration each)

IUPAC nomenclature of coordination compounds, isomerism in coordination compounds. Structural isomerism, Geometrical and Optical isomerism, Stereochemistry of complexes with the coordination number 4 and 6, Chelate effect.

ReferenceBooks:

1. Lee, J.D.*Concise Inorganic Chemistry*, ELBS, 1991.
2. Douglas, B.E; McDaniel, D.H. & Alexander, J.J. *Concepts & Models of Inorganic Chemistry3rd Ed.*John Wiley Sons, N.Y. 1994.
3. Greenwood, N.N., Earnshaw. *Chemistry of the Elements*, Butterworth- Heinemann. 1997.
4. Cotton, F.A. & Wilkinson, G. *Advanced Inorganic Chemistry*, Wiley,VCH,1999.
5. Rodger, G.E. *Inorganic and Solid State Chemistry*, Cengage Learning India Edition, 2002.
6. Miessler, G.L. & Donald, A. Tarr. *Inorganic Chemistry* Fourth Ed. , Pearson, 2010
7. Atkins, P. W and Shriver D. N. *Atkins' Inorganic Chemistry* 5th Ed. Oxford University Press (2010).
8. Purcell, K.F & Kotz, J.C. *Inorganic Chemistry* W.B. Saunders Co, 1977.Huheey, J.E., *Inorganic Chemistry*, Prentice Hall, 1993.
9. Lippard, S.J. & Berg, J.M. *Principles of Bioinorganic Chemistry* Panima Publishing Company1994.
10. Basolo, F and Pearson, R.C. *Mechanisms of Inorganic Chemistry*, John Wiley & Sons, NY, 1967.

CHEMISTRY PRACTICAL- MJ 8 LAB (Credit: Practical-01)
(Inorganic Chemistry)

Practical (ESE: 2Hrs) =25 Marks	**Pass Marks: Practical (ESE) = 10**
Internal Examination=0 Marks	

Instruction to Question Setter for
End Semester Examination (ESE):
There will be one Practical Examination of 2Hrs duration. Evaluation of Practical Examination may be as per the following guidelines:

Experiment	*= 15 marks*
Practical record notebook	*= 05 marks*
Viva-voce	*= 05 marks*

PRACTICALS: **Hours: 30**

(A) Inorganicpreparations

(i) Potassium trioxalatochromate(III)
(ii) Hexaamminecobalt(III) chloride
(iii) Preparation of Aluminium potassium sulphate (Potash alum) or Chrome alum.

ReferenceBooks:

1. Mendham, J. ,*A.I. Vogel's Quantitative Chemical Analysis* Sixth Edition Pearson,2009.
2. Vogel's *Qualitative Inorganic Analysis*, Revised by G. Svehla. Pearson Education, 2002.
3. Marr & Rockett *Practical Inorganic Chemistry*. John Wiley & Sons 1972.

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9. MAJOR COURSE- MJ 9: (Credits: Theory-03, Practicals-01)

Marks: 15 (5 Attd. + 10 SIE: 1Hr) + 60 (ESE: 3Hrs) = 75	**Pass Marks: Th (MSE + ESE) = 30**

Instruction to Question Setter for

Semester Internal Examination (SIE10+5=15marks):

The Semester Internal Examination shall have two components.

(a)One Semester Internal Examination Written Test (SIE) of 10 Mark.

(b)Class Attendance Score (CAS) including the behaviour of the student towards teachers and other students of the College of 5 marks .End Semester Examination (ESE 60 marks):

There will be two groups of questions **A** and **B**. **Group A is compulsory** which will contain three questions. **Question No.1 will be very short answer type** consisting of five questions of 1 mark each. **Question No. 2 & 3 will be short answer type** of 5 marks. Group B will contain descriptive type five questions of fifteen marks each, out of which any three are to be answered.

Note: *There may be subdivisions in each questions asked in theory examination.*

ORGANICCHEMISTRY-II Theory: 45 Lectures

CourseObjectives:

After completion of the course, the learners shall be able to understand:

1. Familiarization about classes of organic compounds and their methods of preparation.
2. Basic uses of reaction mechanisms.
3. Name reactions, uses of various reagents and the mechanism of their action.
4. Preparation and uses of various classes of organic compounds.
5. Organic chemistry reactions and reaction mechanisms.
6. Use of reagents in various organic transformation reactions.

Course Learning Outcomes:

On successful completion of this course the students should be able to know:

1. Elucidating reaction mechanisms for organic reactions.
2. Use of active methylene groups in organic mechanism and preparation of new organic compounds.

Course Outlines:

1. Alcohols, Phenols, Carbonyl Compounds, Carboxylic Acids and their Derivatives.

Course Content:

Unit-1 Carbonyl Compounds: (15 classes of 60 minutes duration each)

Preparation, Structure and reactivity; Nucleophilic additions, Nucleophilic addition-elimination reactions, Mechanism of Aldol and Benzoin condensations, Knoevenagel condensation, Claisen-Schmidt, Perkin, Cannizzaro and Wittig reactions, Beckmann and Benzil-Benzilic acid rearrangements, haloform reaction, α- substitution reactions, oxidations and reductions (Clemmensen, Wolff- Kishner, $LiAlH_4$, $NaBH_4$, MPV).

Test of carbonyl group – using 2,4-DNP, Distnctition between aldehyde and ketone.

Unit-2 Active methylene compounds: (10 classes of 60 minutes duration each)

Active methylene compounds, Keto-enol tautomerisn, preparation and synthetic applications of diethyl malonate (malonic ester) and ethyl acetoacetate (acetoacetic ester).

Unit-3 Carboxylic Acids: (10 classes of 60 minutes duration each)

Preparation, physical properties and reactions of monocarboxylic acids: Arndt-Eistert reaction, HVZ reaction, Schmidt rearrangement, Relative strengths of carboxylic acids and substituted carboxylic acids typical reactions of dicarboxylic acids, hydroxy acids and unsaturated acids: succinic, phthalic, lactic, malic, tartaric, citric, maleic and fumaric acids.

Unit-4 Derivatives of carboxylic acids: (10 classes of 60 minutes duration each)

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.

Test of –COOH, ester and amide group

Reference Books:

1. P Sykes, A Guide Book to Mechanism in Organic Chemistry, 6th Edition (1997), Orient Longman, New Delhi.
2. Morrison, R. T., Boyd, R. N., Bhatterjee, S.K., Organic Chemistry, 7th Edn., Pearson.
3. Acheson, R.M. *Introduction to the Chemistry of Heterocyclic compounds*, John Welly &Sons(1976).
4. Solomons, T.W., Fryhle Craig, *Organic Chemistry*, John Wiley & Sons, Inc (2009).
5. McMurry, J.E. *Fundamentals of Organic Chemistry*, 7th Ed. Cengage Learning India Edition,2013.
6. Kalsi, P. S. *Organic reacations and their mechanisms*, New Age Science (2010).
7. Clayden, J.; Greeves, N.; Warren, S.; Wothers, P.; *Organic Chemistry*, Oxford University PressInc., New York (2001).
8. Singh, J.; Ali, S.M. & Singh, J. *Natural Product Chemistry*, Prajati Parakashan (2010).
9. Bansal R. K. *Heterocyclic Chemistry: Syntheses, Reactions and Mechanisms*, New Age, ThirdEdition (1999).

09. CHEMISTRY PRACTICAL- MJ 9 LAB (Credit: Practical-01)
(Organic Chemistry)

Practical (ESE: 2Hrs) =25 Marks	**Pass Marks: Practical (ESE) = 10**
Internal Examination=0 Marks	

Instruction to Question Setter for
End Semester Examination (ESE):
There will be one Practical Examination of 2Hrs duration. Evaluation of Practical Examination may be as per the following guidelines:

Experiment	*= 15 marks*
Practical record notebook	*= 05 marks*
Viva-voce	*= 05 marks*

PRACTICALS: **Hours: 30**

1. Organic preparations:
   i. Oxidation of ethanol/ isopropanol (Iodoform reaction).
   ii. Bromination (any one)
      a. Acetanilide by conventional methods
      b. Acetanilide using green approach (Bromate-bromide method)
   iii. Nitration: (any one)
      a. Acetanilide/nitrobenzene by conventional method
      b. Salicylic acid by green approach (using ceric ammonium nitrate).
   iv. Semicarbazone of any one of the following compounds: acetone, ethyl methyl ketone, cyclohexanone, benzaldehyde.
   v. Aldol condensation with either conventional or green method.
   vi. Benzil-Benzilic acid rearrangement.

2. Collected solid samples may be used for recrystallization, melting point and TLC.

Reference Books :

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)
3. Ahluwalia, V.K. & Aggarwal, R. Comprehensive Practical Organic Chemistry: Preparation and Quantitative Analysis, University Press (2000)
4. Ahluwalia,V.K. & Dhingra, S. Comprehensive Practical Organic Chemistry: Qualitative Analysis, University Press (2000).
5. Vogel,A.I. *Quantitative Organic Analysis*, Part3, Pearson (2012).

10.MAJOR COURSE- MJ 10: (Credits: Theory-03, Practicals-01)

Marks: 15 (5 Attd. + 10 SIE: 1Hr) + 60 (ESE: 3Hrs) = 75	Pass Marks: Th (MSE + ESE) = 30

Instruction to Question Setter for

Semester Internal Examination (SIE10+5=15marks):

The Semester Internal Examination shall have two components.

(a)One Semester Internal Examination Written Test (SIE) of 10 Mark.

(b)Class Attendance Score (CAS) including the behaviour of the student towards teachers and other students of the College of 5 marks .End Semester Examination (ESE 60 marks):

There will be two groups of questions **A** and **B**. **Group A is compulsory** which will contain three questions. **Question No.1 will be very short answer type** consisting of five questions of 1 mark each. **Question No. 2 & 3 will be short answer type** of 5 marks. Group B will contain descriptive type five questions of fifteen marks each, out of which any three are to be answered.

note: *There may be subdivisions in each questions asked in theory examination.*

PHYSICALCHEMISTRY-III Theory:45 Lectures

Course Objectives:

After completion of the course, the learners shall be able to understand:

1. Third Law of thermodynamics and concepts.
2. Partial molar quantities and its attributes.
3. The concept of system, variables, heat, work, and laws of thermodynamics.
4. The concept of entropy; Calculation of entropy using 2nd law of thermodynamics.
5. The applications of thermodynamics, partial molar quantities.
6. EMF of a cell and cell reaction.

Course Learning Outcomes:

On successful completion of this course the students should be able to know:

1. Use of thermodynamics in explaining chemical behavior of solute / solvent and reactions.
2. Electrochemical cell.

Course Outlines:

Third law of thermodynamics, Free Energy Functions, Partial molar quantities.

Course Content:

Unit-1 Third law of thermodynamics: (5 classes of 60 minutes duration each)

Nernst heat theorem and origin of Third Law of thermodynamics, residual entropy, calculation of absolute entropy of molecules using Third Law of thermodynamics.

Unit-2 Free Energy Functions: (10 classes of 60minutesdurationeach)

Gibbs and Helmholtz free energy, variation of S, A, G, with T, V, P, Free energy change and spontaneity. Relation between and other thermodynamic parameters, inversion temperature, Gibbs-Helmholtz equation, Maxwell relations, thermodynamic equation of state, Thermodynamic criteria of spontaneity, Clausius-Claperon equation and its application.

Unit-3 Partial molar quantities: (10 classes of 60 minutes duration each)

Partial molar quantities, dependence of thermodynamic parameters on composition, chemical potential and its variation with temperature and pressure. Gibbs-Duhem equation, chemical potential of ideal mixtures, change in thermodynamic functions in mixing of ideal gases.

Unit-4 Electro chemical cells: (20 classes of 60 minutes duration each)

Electrode and electrode potential, reference electrode (S.H.E. and calomel electrode), standard electrode potential, types of electrodes, Galvanic cells, electrochemical cell and its significance, Nernst equations, types of electro chemical cells-chemical cells and concentration cells, concepts of E.M.F. of Galvanic cells, measurement of E.M.F., concentration and working of Galvanic cells, liquid junction potential and salt bridge, E.M.F. of concentration cells with and without transference, determination of equilibrium constant, ΔS, ΔG, ΔH of reaction, calculation of solubility of a sparingly soluble salt, valency of ions, determination of pH using hydrogen and quinhydron electrode, potentiometric titrations (qualitative treatment of acid-base and oxidation-reduction only.

ReferenceBooks:

1. Atkins P.and De Paula, J. *Physical Chemistry* Tenth Ed., OUP, 2014.
2. Castellan,G.W. *Physical Chemistry* 4th Ed., Narosa,2004.
3. Engel, T. and Reid, P. *Physical Chemistry* 3rd Ed., Prentice Hall, 2012.
4. McQuarrie, D.A. and Simon, J.D. *Molecular Thermodynamics* Viva Books, 2004.
5. Roy, B. N. *Fundamentals of Classical and Statistical Thermodynamics* Wiley, 2001
6. *Commonly Asked Questions in Thermodynamics*. CRC Press, 2011.
7. Levine, I.N. *Physical Chemistry* 6th Ed., Tata McGraw Hill, 2010.
8. Metz, C.R. *2000 Solved Problems in Chemistry,* Schaum Series, 2006.
9. Zundhal, S. S. *Chemistry concepts and applications* Cengage India, 2011
10. Ball, D. W. *Physical Chemistry* Cengage India, 2012.
11. Mortimer, R.G. *Physical Chemistry 3rd Ed.*, Elsevier: NOIDA, UP, 2009.
12. Levine,I.N.*Physical Chemistry 6thEd.,* TataMcGraw-Hill,2011

CHEMISTRY PRACTICAL- MJ 10 LAB (Credit: Practical-01)
(Physical Chemistry)

Practical (ESE: 2Hrs) =25 Marks	**Pass Marks: Practical (ESE) = 10**
Internal Examination=0 Marks	

Instruction to Question Setter for
End Semester Examination (ESE):
There will be one Practical Examination of 2Hrs duration. Evaluation of Practical Examination may be as per the following guidelines:

Experiment	*= 15 marks*
Practical record notebook	*= 05 marks*
Viva-voce	*= 05 marks*

PRACTICALS: **Hours: 30**

1. Determination of critical solution temperature and composition of the phenol-water system and to study the effect of impurities on it.
2. Determination of E.M.F. by Galvanic cell using potentiometer.
3. Potentiometric titration
    a) Strong acid Vs Strong base
    b) Week acid Vs strong base
    c) $K_2Cr_2O_7$ Vs mohr's salt

ReferenceBooks

1. Khosla, B. D.; Garg, V. C. & Gulati, A. *Senior Practical Physical Chemistry*, R. Chand, NewDelhi, 2011.
2. Garland,C.W.;Nibler,J.W.&Shoemaker,D.P. *Experiments in Physical Chemistry*, Eighth Edition, McGraw-Hill(2003).
3. Halpern, A.M.and McBane, G.C. *Experimental Physical Chemistry*,Third Edition, W, H.Freeman (2003).

11.MAJOR COURSE- MJ 11: (Credits: Theory-03, Practicals-01)

Marks: 15 (5 Attd. + 10 SIE: 1Hr) + 60 (ESE: 3Hrs) = 75	Pass Marks: Th (MSE + ESE) = 30

Instruction to Question Setter for

Semester Internal Examination (SIE10+5=15marks):

The Semester Internal Examination shall have two components.

(a)One Semester Internal Examination Written Test (SIE) of 10 Mark.

(b)Class Attendance Score (CAS) including the behaviour of the student towards teachers and other students of the College of 5 marks .End Semester Examination (ESE 60 marks):

There will be two groups of questions **A** and **B**. **Group A is compulsory** which will contain three questions. **Question No.1 will be very short answer type** consisting of five questions of 1 mark each. **Question No. 2 & 3 will be short answer type** of 5 marks. Group B will contain descriptive type five questions of fifteen marks each, out of which any three are to be answered.

note: *There may be subdivisions in each questions asked in theory examination.*

MOLECULAR SPECROSCOPY Theory: 45 Lectures

Course Objectives:

After completion of the course, the learners shall be able to understand:

1. Introduction of Spectroscopy and related terms.
2. The principle of microwave, IR, UV, NMR and Mass Spectrometry.

Course Learning Outcomes:

On successful completion of this course the students should be able to know:

1. The determination of bond length of rigid rotator and J_{max}.
2. Deviation due to non-rigid character.
3. Determination of force constant.
4. P Q R branches.
5. Raman effect.
6. FTIR technique.
7. Finger print region of IR.
8. NMR Spectrometry.
9. Franck-condon principle.
10. Woodward-Fieser rule.
11. Mass Spectrometry.

Course Outlines:

Microwave, IR, UV, NMR and Mass Spectrometry.

Course Content:

Unit-I: Introduction to Spectroscopy Terms: (05 classes of 60 minutes duration each)
Interaction of electromagnetic radiation with molecules and various types of spectra; Born- Oppenheimer approximation, signal to noise ratio, resolving power, width and intensity of spectral lines.

Microwave Spectroscopy:
Rotation spectroscopy: Types of rotating molecules, selection rules, the rigid diatomic rotator, population of rotational energy stats, multiplicity of stats, intensity of spectral lines with maximum intensity (J_{max}), determination of bond lengths of diatomic and linear triatomic molecules, isotopic substitution, determination of isotopic mass, non-rigid rotator, microwave oven.

Unit-2 Infrared Spectroscopy: (20 classes of 60 minutes duration each)
Vibrational spectroscopy: The simple harmonic oscillator, selection rules, Classical equation of vibration, computation of force constant, amplitude of diatomic molecular vibrations, anharmonicity, anharmonic oscillator, Morse potential, dissociation energies, fundamental frequencies, overtones, hot bands, degrees of freedom for polyatomic molecules, modes of vibration, concept of group frequencies. Vibration- rotation spectroscopy: diatomic vibrating rotator, P, Q, R branches, FTIR-introduction.

Identification of Functional groups of various classes of organic compounds:
Infrared radiation and types of molecular vibrations, functional group and finger print region. IR spectra of alkanes, alkenes and simple alcohols (inter and intramolecular hydrogen bonding), aldehydes, ketones, carboxylic acids and their derivatives (effect of substitution on >C=O stretching absorptions).
Raman Spectroscopy: Introduction**,** Classical theory, Quantum theory, Concept of Polarization, Qualitative treatment of Rotational Raman effect, Effect of nuclear spin, Vibrational Raman spectra, Stokes and anti-Stokes lines, their intensity difference, rule of mutual exclusion.

Unit-3 UV spectroscopy (10 classes of 60 minutes duration each)
Electronic Spectroscopy: Franck-Condon principle, electronic transitions, singlet and triplet states, fluorescence and phosphorescence, dissociation and pre-dissociation.
Application of Woodward-Fieser rule in interpretation of Organic compounds: Application of visible, ultraviolet and infrared spectroscopy in organic molecules. Electromagnetic radiation, electronic transitions, λ_{max} & ε_{max}, chromophore, auxochrome, bathochromic and hypsochromic shifts. Application of electronic spectroscopy and Woodward rules for calculating λ_{max} of conjugated dienes and α, β – unsaturated compounds.

Unit 4 NMR (^{1}H and ^{13}C NMR): (10 classes of 60 minutes duration each)
Introduction, Theory of NMR, Relaxation process, numbers of signals, Chemical Shift, Application of Chemical Shifts, Splitting of signals, Spin-Spin coupling and OverHouser effect in interpretation of NMR spectra, Isotopic exchange.

ReferenceBooks:

1. Atkins P. and De Paula, J. Physical Chemistry Tenth Ed., OUP, 2014.
2. LevineI.N.,*Physical Chemistry*,Fourth Edition),McGraw-Hill(International),1995.
3. McQuarrieD.A.and SimonJ.D. *Physical Chemistry- A Molecular Approach*, University Science Books,1998
4. Rohatgi-Mukherjee K.K. Fundamentals of Photochemistry, New age (revised second edition).
5. Banwell,C.N. & McCash, E.M. *Fundamentals of Molecular Spectroscopy* 4th Ed.Tata McGraw-Hill: New Delhi (2006).
6. R.M. Silverstein, G.C. Bassler & T.C. Morrill*: Spectroscopic Identification of Organic Compounds*, John Wiley & Sons.
7. John R. Dyer, Applications of absorption spectroscopy of organic compounds, Prentice Hall India (2012).
8. H. Kaur, Spectroscopy, Pragati Prakashan.
9. Y.R. Sharma, Elementary Organic Spectroscopy, S. Chand & Company.

CHEMISTRY PRACTICAL- MJ 11 LAB (Credit: Practical-01)
(Spectroscopy)

Practical (ESE: 2Hrs) =25 Marks	**Pass Marks: Practical (ESE) = 10**
Internal Examination=0 Marks	

Instruction to Question Setter for
End Semester Examination (ESE):
There will be one Practical Examination of 2Hrs duration. Evaluation of Practical Examination may be as per the following guidelines:

Experiment	*= 15 marks*
Practical record notebook	*= 05 marks*
Viva-voce	*= 05 marks*

PRACTICALS: **Hours: 30**

1. Verification of Beer's Law - Determination of concentration of solution by colorimetry. (Instructor may explain the principle of using colorimeter, its handling drawing standard calibration curve, and its application in finding unknown concentration of dyes, concentration of metal solutions (*e.g.* Ni, Cu using appropriate reagent) from standard calibration curve.

2. **Qualitative semimicro analysis of mixtures**
Qualitative semimicro analysis of mixtures containing 3 anions and 3 cations. Emphasis should be given on understanding of the chemistry of different reactions.
Following radicals may be analyzed: Carbonate, nitrate, nitrite, sulphide, sulphate, sulphite, acetate, fluoride, chloride, bromide, iodide, borate, oxalate, phosphate, ammonium, potassium, lead, copper, cadmium, bismuth, tin, iron, aluminum, chromium, zinc, manganese, cobalt, nickel, barium strontium, calcium, magnesium.
Mixture containing one interfering anion or insoluble component ($BaSO_4$,$SrSO_4$, $PbSO_4$,CaF_2orAl_2O_3) **or** combination of anions e.g.$CO_3^{2-}$and SO_3^{2-}, NO_2^- and NO_3^-, Cl^- and Br^-, Cl^- and I^-, $Br^-$and I^-, NO_3^- and Br^-, NO_3^- and I^-.Spot analysis / tests should be done whenever possible.

Reference Books

1. Practicals in physical chemistry–a modern approach, P.S.Sindhu, Macmillan,
2. Experiments in Physical Chemistry, J.M.Wilson, R.J.Newcomb, A.R.Denaro, 2nd Edn., Elsevier.
3. Mendham,J.,*A.I.Vogel's Quantitative Chemical Analysis* Sixth Edition Pearson, 2009
4. Vogel's *Qualitative Inorganic Analysis*, Revised by G. Svehla. Pearson Education, 2002

SEMESTER VI

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12. MAJOR COURSE- MJ 12: (Credits: Theory-03, Practicals-01)

Marks: 15 (5 Attd. + 10 SIE: 1Hr) + 60 (ESE: 3Hrs) = 75	Pass Marks: Th (MSE + ESE) = 30

Instruction to Question Setter for

Semester Internal Examination (SIE10+5=15marks):

The Semester Internal Examination shall have two components.

(a)One Semester Internal Examination Written Test (SIE) of 10 Mark.

(b)Class Attendance Score (CAS) including the behaviour of the student towards teachers and other students of the College of 5 marks .End Semester Examination (ESE 60 marks):

There will be two groups of questions **A** and **B**. **Group A is compulsory** which will contain three questions. **Question No.1 will be very short answer type** consisting of five questions of 1 mark each. **Question No. 2 & 3 will be short answer type** of 5 marks. Group B will contain descriptive type five questions of fifteen marks each, out of which any three are to be answered.

note: *There may be subdivisions in each questions asked in theory examination.*

INORGANICCHEMISTRY-III Theory:45 Lectures

Course Objectives:

After completion of the course, the learners shall be able to understand:

1. Transition metals, its stability, color, oxidation states and complexes.
2. Lanthanides, Actinides.
3. Organo-metallic compounds and their uses.
4. The transition metals stability in reactions, origin of color and magnetic properties.
5. The separation of Lanthanoids and Actinoids, its color, spectra and magnetic behavior.

Course Learning Outcomes:

On successful completion of this course the students should be able to know:.

1. Prediction of structure of complexes using various theories; color and magnetic properties of different complexes.
2. Use of lanthanide / actinide compounds in industries.
3. Preparation and properties of organo-metallic compound.

Course Outlines: Transition and inner-transition elements, Lanthanids and Actinides, organometallic compound.

Course Content:

Unit-1 Transition Elements and their important compounds :
(20 classes of 60 minutes duration each)

General group trends with special reference to electronic configuration, colour, variable valency, magnetic and catalytic properties, and ability to form complexes. Stability of various oxidation states and e.m.f. (Latimer & Ebsworth diagrams). Difference between the first, second and third transition series. Some important compounds of Cr, Fe, Co and their roles as lab. Reagent. Chemistry of 3d metals: Oxidation states displayed by Cr, Fe, Co, Ni and Co. Peroxo compounds of Cr, $K_2Cr_2O_7$, $KMnO_4$, $K_4[Fe(CN)_6]$, sodium nitroprusside, $[Co(NH_3)_6]Cl_3$, $Na_3[Co(NO_2)_6]$.

Unit-3 Lanthanides and Actinides: (10 classes of 60 minutes duration each)
Electronic configuration, oxidation states, color, spectra and magnetic behavior, lanthanide contraction, separation of lanthanides (ion-exchange method only) and actinides.

Unit-4 Organometallic Compounds: (10classesof60minutesdurationeach)
Definition and classification of organometallic compounds on the basis of bond type.Concept of hapticity of organic ligands. Metal carbonyls: 18 electron rule, electron count of mononuclear, polynuclear and substituted metal carbonyls of 3d series. General methods of preparation (direct combination, reductive carbonylation, thermal and photochemical decomposition) of mono and binuclear carbonyls of 3d series.Structures of mononuclear and binuclear carbonyls of Cr, Mn, Fe, Co and Ni using VBT. pi-acceptor behaviour of CO (MO diagram of CO to be discussed), synergic effect and use of IR data to explain extent of back bonding.

Unit-5 Organic Reagents used in Inorganic Analysis:
(05 classes of 60 minutes duration each)

DMG, 8-Hydroxy Quinoline, Cupferon, α-Nitroso-β-Napthol, EDTA, 2, 4-DNP Hydrazine

Reference Books :

1. Lee, J.D. *Concise Inorganic Chemistry*, ELBS, 1991.
2. Douglas, B.E; McDaniel, D.H. & Alexander, J.J. *Concepts & Models of Inorganic Chemistry 3rd Ed.* John Wiley Sons, N.Y. 1994.
3. Greenwood, N.N., Earnshaw. *Chemistry of the Elements*, Butterworth - Heinemann. 1997.
4. Cotton, F.A. &Wilkinson,G. *Advanced InorganicChemistry*,Wiley,VCH,1999.
5. Rodger, G. E. *Inorganic and Solid State Chemistry*, Cengage Learning India Edition, 2002.
6. Miessler,G. L. & Donald, A.Tarr. *Inorganic Chemistry* Fourth Ed., Pearson, 2010
7. Atkins, P. W and Shriver D. N. *Atkins' Inorganic Chemistry* 5th Ed. Oxford University Press (2010).
8. Purcell K.F & Kotz, J.C. *Inorganic Chemistry* W.B. Saunders Co, 1977. Huheey, J.E., *Inorganic Chemistry*, Prentice Hall, 1993.
9. Lippard, S.J. & Berg, J.M. *Principles of Bioinorganic Chemistry* Panima Publishing Company1994.
10. Basolo, F and Pearson, R.C. *Mechanisms of Inorganic Chemistry*, John Wiley & Sons, NY, 1967.

CHEMISTRY PRACTICAL- MJ 12 LAB (Credit: Practical-01)
(Inorganic Chemistry)

Practical (ESE: 2Hrs) =25 Marks	**Pass Marks: Practical (ESE) = 10**
Internal Examination=0 Marks	

Instruction to Question Setter for
End Semester Examination (ESE):
There will be one Practical Examination of 2Hrs duration. Evaluation of Practical Examination may be as per the following guidelines:

Experiment	*= 15 marks*
Practical record notebook	*= 05 marks*
Viva-voce	*= 05 marks*

PRACTICALS: **Hours: 30**

(A) Study of 200-500 nm absorbance spectra of $KMnO_4$ and $K_2Cr_2O_7$ (in 0.1M H_2SO_4) and determine the λ_{max} value. Calculate the energy of the two transitions in different units (kj/mole,per cm, eV)
(B) Study of pH dependence of UV-Vis spectrum (200-500nm) of $K_2Cr_2O_7$
(C) Analysis of the given vibrational-rotational spectrum of HCl(g)
(D) Estimation of Ni using DMG
(E) Estimation of Co using α-Nitroso-β-Napthol
(F) Estimation of Cu using CuSCN
(G) Estimation of Hardness of water using EDTA.

Reference Books:

1. Mendham, J., *A I.Vogel's Quantitative Chemical Analysis* Sixth Edition Pearson, 2009.
2. Vogel' *Qualitative Inorganic Analysis,* Revised by G. Svehla. Pearson Education, 2002.
3. Marr & Rockett, *PracticaI Inorganic Chemistry*.JohnWile & Sons1972.

13.MAJOR COURSE- MJ 13: (Credits: Theory-03, Practicals-01)

Marks: 15 (5 Attd. + 10 SIE: 1Hr) + 60 (ESE: 3Hrs) = 75	**Pass Marks: Th (MSE + ESE) = 30**

Instruction to Question Setter for

Semester Internal Examination (SIE10+5=15marks):

The Semester Internal Examination shall have two components.

(a)One Semester Internal Examination Written Test (SIE) of 10 Mark.

(b)Class Attendance Score (CAS) including the behaviour of the student towards teachers and other students of the College of 5 marks .End Semester Examination (ESE 60 marks):

There will be two groups of questions **A** and **B**. **Group A is compulsory** which will contain three questions. **Question No.1 will be very short answer type** consisting of five questions of 1 mark each. **Question No. 2 & 3 will be short answer type** of 5 marks. Group B will contain descriptive type five questions of fifteen marks each, out of which any three are to be answered.

note: *There may be subdivisions in each questions asked in theory examination.*

ORGANICCHEMISTRY-III Theory: 45 Lectures

Course Objectives:

After completion of the course, the learners shall be able to understand:

1. Nitrogen containing functional groups and their reactions.
2. Familiarization with polynuclear hydrocarbons and their reactions.
3. Heterocyclic compounds and their reactions.
4. Alkaloids and Terpenoides.
5. Reactions and reaction mechanism of nitrogen containing functional groups.
6. The reactions and mechanisms of diazonium compounds.
7. The structure and their mechanism of reactions of selected polynuclear hydrocarbons.
8. The structure, mechanism of reactions of selected heterocyclic compounds.
9. Classification, structure, mechanism of reactions of few selected alkaloids and terpenoides.

Course Learning Outcomes:

On successful completion of this course the students should be able to know:

1. Use of benzene diazonium salt in organic synthesis.
2. Applications of heterocyclic compounds in pharmaceutics/drugs and the mechanism of actions.
3. Pharmaceutics/Biomedical applications of alkaloids and terpenoides.
4. Nitrogen containing organic compounds/heterocyclic compounds in synthetic chemistry.

Course Outlines:

Nitro compounds, Nitriles and isonitriles, amines, diazonium salt and its synthetic applications.

Course Content:

Unit-1 Nitrogen Containing Functional Groups

(10 classes of 60 minutes duration each).

Preparation and important reactions of nitro compounds, nitriles and isonitriles Amines: Effect of substituent and solvent on basicity; Preparation and properties: Gabriel phthalimide synthesis, Carbylamine reaction, Mannich reaction, Hoffmann's exhaustive methylation, Hofmann-elimination reaction; Distinction between 1°, 2° and 3° amines with Hinsberg reagent and nitrous acid. Diazonium salts: Preparation and synthetic applications.

Unit-2 Polynuclear Hydrocarbons (5 classes of 60 minutes duration each)

Structure, Preparation, structural elucidation and reactions of naphthalene, phenanthrene and anthracene.

Unit-3 Heterocyclic Compounds: (15 classes of 60 minutes duration each)

Classification and nomenclature, Structure, aromaticity in 5-membered and 6-membered rings containing one heteroatom; Synthesis, reactions and mechanism of substitution reactions of Furan, Pyrrole (Paal-Knorr synthesis, Knorr pyrrole synthesis), Thiophene, Pyridine (Hantzsch synthesis),

Structural elucidation of indole, Fischer indole synthesis and Madelung synthesis, Structural elucidation of quinoline and isoquinoline, Skraup synthesis, Friedlander's synthesis, Bischler-Napieralski reaction.

Unit-4 Alkaloids & Terpenoids: (15 classes of 60 minutes duration each)

Natural occurrence, General structural features, Isolation and their physiological action Hoffmann's exhaustive methylation, Emde's modification, Structural elucidation and synthesis of Nicotine, Atropine and Papavarine: occurrence, classification, isoprene rule, special isoprene rule and exception.

Elucidation of structure, synthesis and industrial applications of Citral, ά-terpineol and Camphor.

ReferenceBooks:

1. PSykes, A Guide Book to Mechanism in Organic Chemistry, 6th Edition (1997), Orient Longman, New Delhi.
2. Morrison, R.T., Boyd, R. N., Bhatterjee, S.K., Organic Chemistry, 7th Edn., Pearson.
3. Acheson, R.M. *Introduction to the Chemistry of Heterocyclic compounds,* John Welly & Sons (1976).
4. Solomons, T.W., Fryhle Craig, *Organic Chemistry,* John Wiley & Sons, Inc (2009).
5. McMurry, J.E. *Fundamentals of Organic Chemistry*, 7th Ed. Cengage Learning India Edition,2013.
6. Kalsi, P.S. *Organic reacations and their mechanisms*, New Age Science (2010).
7. Clayden, J.; Greeves, N.; Warren, S.; Wothers, P.; *Organic Chemistry,* Oxford University Press Inc., New York (2001).
8. Singh, J.; Ali, S. M. & Singh, J. *Natural Product Chemistry*, Pragati Prakashan (2010).
9. Bansal R. K. *Heterocyclic Chemistry: Syntheses, Reactions and Mechanisms*, New Age, Third Edition (1999).

CHEMISTRY PRACTICAL- MJ 13 LAB (Credit: Practical-01)
(Organic Chemistry)

Practical (ESE: 2Hrs) =25 Marks	**Pass Marks: Practical (ESE) = 10**
Internal Examination=0 Marks	

Instruction to Question Setter for
End Semester Examination (ESE):
There will be one Practical Examination of 2Hrs duration. Evaluation of Practical Examination may be as per the following guidelines:

Experiment	*= 15 marks*
Practical record notebook	*= 05 marks*
Viva-voce	*= 05 marks*

PRACTICALS: **Hours: 30**

1. Preparation of methyl orange.
2. Extraction of caffeine from tea leaves.
3. Analysis of Carbohydrate: aldoses and ketoses, reducing and non-reducing sugars using simple lab procedures.
4. Preparation of acetanilide from aniline.

Reference Books

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)
3. Ahluwalia, V.K. & Aggarwal, R. Comprehensive Practical Organic Chemistry: Preparation and Quantitative Analysis, University Press (2000)
4. Ahluwalia, V.K. & Dhingra, S. Comprehensive Practical Organic Chemistry: Qualitative Analysis, University Press (2000).
5. Vogel, A.I. *Quantitative Organic Analysis,* Part 3, Pearson (2012).
6. Mann, F.G. & Saunders, B.C. *Practical Organic Chemistry*, Pearson Education (2009)
7. Furniss, B.S.; Hannaford, A.J.; Smith, P.W.G.; Tatchell, A.R. *Practical Organic Chemistry,5th Ed.*, Pearson (2012)
8. Ahluwalia, V.K. & Aggarwal, R. *Comprehensive Practical Organic Chemistry: Preparation and Quantitative Analysis*, University Press (2000).
9. Ahluwalia, V.K. & Dhingra, S. Comprehensive Practical Organic Chemistry: Qualitative Analysis, University Press (2000).

14. MAJOR COURSE- MJ 14: (Credits: Theory-03, Practicals-01)

Marks: 15 (5 Attd. + 10 SIE: 1Hr) + 60 (ESE: 3Hrs) = 75	**Pass Marks: Th (MSE + ESE) = 30**

Instruction to Question Setter for

Semester Internal Examination (SIE10+5=15marks):

The Semester Internal Examination shall have two components.

(a)One Semester Internal Examination Written Test (SIE) of 10 Mark.

(b)Class Attendance Score (CAS) including the behaviour of the student towards teachers and other students of the College of 5 marks .End Semester Examination (ESE 60 marks):

There will be two groups of questions **A** and **B**. **Group A is compulsory** which will contain three questions. **Question No.1 will be very short answer type** consisting of five questions of 1 mark each. **Question No. 2 & 3 will be short answer type** of 5 marks. Group B will contain descriptive type five questions of fifteen marks each, out of which any three are to be answered.

note: *There may be subdivisions in each questions asked in theory examination.*
in theory examination

PHYSICALCHEMISTRY-IV Theory: 45 Lectures

CourseObjectives:

On completion of this course, the students will be able to understand:

1. Phases, components, Gibbs phase rule, Phase diagrams and applications.
2. Chemical kinetics: type of reactions, determination of rate, theories of reaction rate, steady state approximation.
3. Catalyst–mechanism, acid base catalysis, enzyme catalysis.
4. Adsorption, Chemisorption, Adsorption isotherms.
5. Phases, components, Gibb's phase rule and its applications, construction of phase diagram of different systems, the application of phase diagram.
6. The basics of chemical kinetics: determination of order, molecularity, and understanding theories of reaction rates, determination of rate of opposing / parallel / chain reactions with suitable examples, application of steady state kinetics, Steady-state approximation.
7. Catalyst – mechanism of catalytic action, enzyme catalysis.
8. Langmuir, Freundlich – adsorption isotherms, significance, multilayer adsorption – theory and significance.

Course Learning Outcomes :

On successful completion of this course the students should be able to know:

1. Application of phase diagram.
2. Study of reaction kinetics.
3. Heterogeneous catalysis used in industry and its mechanism of action.
4. Application of adsorption isotherms in metal adsorption, significance.

Course Outlines:

Phase Equilibria, Chemical Kinetics, Catalysis, Surface chemistry.

Course Content:

Unit-1 PhaseEquilibria: (10 classes of 60 minutes duration each)

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, (water, sulphur and carbon dioxide) with applications. Phase diagrams for systems of solid-liquid equilibria involving eutectic, congruent and incongruent melting points, solid solutions. Nernst distribution law, its derivations and applications.

Unit-2 Chemical Kinetics: (15 classes of 60 minutes duration each)

Rate of reactions, factors affecting rate of reaction, Temperature dependence of reaction rates; Arrhenius equation; activation energy Order and molecularity of a reaction, rate **laws in terms of the advancement of a reaction, differential and integral rate laws for zero,** first, second and fractional order reactions, pseudounimolecular reactions, determination of the order of reaction, kinetics of complex reactions (limited to first order): (i) Opposing reactions (ii) parallel reactions and (iii) consecutivereactions. Collision theory of reaction rates, Lindemann mechanism, qualitative treatment of the theory of absolute reaction rates.

Unit-3 Surface chemistry and Catalysis: (15 classes of 60 minute duration each)

Physical adsorption, chemisorption, adsorption isotherms (Freundlich, Temkin, Derivation of Langumuir adsorption isotherms, surface area determination), BET theory of multilayer adsorption (no derivation), Adsorption in solution. Types of catalyst, specificity and selectivity, mechanisms of catalyzed reactions at solid surfaces; effect of particle size and efficiency of nanoparticles as catalysts. Homogeneous and Heterogeneous catalysis, Enzyme catalysis, Michaelis-Menten mechanism, acid-base catalysis.

Unit-4 Photochemistry : (05 classes of 60 minutes duration each)

Laws of photochemistry, quantum yield. Jablonski diagrams: Franck-Condon principle, Law of photochemical equivalence, quantum efficiency, low and high quantum yield. kinetics of photochemical reactions (H_2+ Br_2= HBr, 2HI = H_2+ I_2), energy transfer in photochemical reactions (photosensitization and quenching), fluorescence, phosphorescence, chemiluminescence, Discussion of Electronic spectra and photochemistry (Lambert-Beer law and its applications).

Reference Books :

1) Atkins P. and De Paula, J. *Physical Chemistry* Tenth Ed., OUP, 2014.
2) Castellan, G.W. *Physical Chemistry* 4th Ed., Narosa, 2004.
3) Engel, T. and Reid, P. *Physical Chemistry* 3rd Ed., Prentice Hall, 2012.
4) McQuarrie, D.A. and Simon, J.D. *Molecular Thermodynamics* Viva Books, 2004.
5) Roy, B.N. *Fundamentals of Classical and Statistical Thermodynamics* Wiley, 2001
6) *Commonly Asked Questions in Thermodynamics*.CRC Press, 2011.
7) Levine, I.N. *Physical Chemistry* 6th Ed., Tata McGraw Hill, 2010.
8) Metz, C.R. *2000 Solved Problems in Chemistry*, Schaum Series, 2006.
9) Zundhal, S. S. *Chemistry concepts and applications*
   Cengage India, 2016 Ball, D. W. *Physical Chemistry*
10) Mortimer, R.G. *Physical Chemistry 3rd Ed.,* Elsevier: NOIDA, UP, 2009.
11) Levine, I.N. *Physical Chemistry 6th Ed.,* Tata McGraw-Hill,2011

CHEMISTRY PRACTICAL- MJ 14 LAB (Credit: Practical-01)
(Physical Chemistry)

Practical (ESE: 2Hrs) =25 Marks	**Pass Marks: Practical (ESE) = 10**
Internal Examination=0 Marks	

Instruction to Question Setter for
End Semester Examination (ESE):
There will be one Practical Examination of 2Hrs duration. Evaluation of Practical Examination may be as per the following guidelines:

Experiment	*= 15 marks*
Practical record notebook	*= 05 marks*
Viva-voce	*= 05 marks*

PRACTICALS: **Hours: 30**

1. Determation of rate constant of first order reaction of acid hydrolysis of ester by HCl
2. To study the kinetics Iodide-perthiosulphate reaction by initial rate method.
3. Saponification of ethyl acetate.
4. Determination of specific rotation by polarimetry.

Reference Books

1, Khosla, B. D.; Garg, V. C. & Gulati, A. *Senior Practical Physical Chemistry*, R. Chand, New Delhi, 2011.
2. Garland, C.W.; Nibler, J.W. & Shoemaker, D. P. *Experiments in Physical Chemistry*, Eighth Edition, McGraw-Hill (2003).
3. Halpern, A.M. and McBane, G.C. *Experimental Physical Chemistry*,Third Edition, W, H. Freeman (2003)

15. MAJOR COURSE- MJ 15: (Credits: Theory-03, Practicals-01)

Marks: 15 (5 Attd. + 10 SIE: 1Hr) + 60 (ESE: 3Hrs) = 75	**Pass Marks: Th (MSE + ESE) = 30**

Instruction to Question Setter for

Semester Internal Examination (SIE10+5=15marks):

The Semester Internal Examination shall have two components.

(a)One Semester Internal Examination Written Test (SIE) of 10 Mark.

(b)Class Attendance Score (CAS) including the behaviour of the student towards teachers and other students of the College of 5 marks .End Semester Examination (ESE 60 marks):

There will be two groups of questions **A** and **B**. **Group A is compulsory** which will contain three questions. **Question No.1 will be very short answer type** consisting of five questions of 1 mark each. **Question No. 2 & 3 will be short answer type** of 5 marks. Group B will contain descriptive type five questions of fifteen marks each, out of which any three are to be answered.

note: *There may be subdivisions in each questions asked in theory examination.*
in theory examination

BIO-ORGANIC AND BIO-INORGANIC CHEMISTRY Theory:45 Lectures

Course Objectives:

On completion of this course, the students will be able to understand:

1. Bio-inorganic chemistry–metal ions in biological system, its toxicity; hemoglobin.
2. Hemoglobin and its importance in biological systems.
3. Structure, function and biological importance of carbohydrates, amino acids, peptides and portions.

Course Learning Outcomes:

On successful completion of this course the students should be able to know:

1. How the processes are going on in living systems.
2. How the chemicals as drugs/medicine can be used in our daily life.

CourseOutlines:

Bio-organic chemistry, Bio-inorganic chemistry.

Course Content:

Unit-1 Bio-inorganic Chemistry: (10 classes of 60 minutes duration each)

A brief introduction to bioinorganic chemistry, Metal ions present in biological systems, classification of elements according to their action in biological system. Geochemical effect on distribution of metals. Role of metal ions present in biological systems with special reference to Na^+, K^+ and Mg^{2+} ions: Na/K pump; Role of Mg^{2+} ions in energy production and in chlorophyll. Role of Ca^{2+} in blood clotting, stabilization of protein structures and structural role (bones). carbonic anhydrase and carboxypeptidase. Excess and deficiency of some trace metals. Toxicity of metal ions (Hg, Pb, Cd and As), toxicity, chelating agents in medicine. Iron and its application in bio- systems, Haemoglobin; Storage and transfer of iron.

Unit-2 Carbohydrates: (15 classes of 60 minutes duration each)

Classification and their biological importance Monosachharides: Constitution and absolute configuration of glucose and fructose, epimers and anomers, mutarotation, mechanism of osazone formation, determination of ring size of glucose and fructose, Haworth projections, Inter conversions of aldoses and Ketoses, Killani- Fischer synthesis and Ruff degradation.

Unit-3 Amino Acids, Peptides and Proteins:
(10 classes of 60 minutes duration each)

Amino Acids, Peptides and their classification.Amino Acids synthesis, ionic properties and their reactions. Zwitterions, pk_a values, isoelectric point and electrophoresis; Study of peptides: determination of their primary structures-end group analysis, methods of peptide synthesis, Synthesis of peptides using N-protecting, C-protecting and C-activating groups-solid-phase synthesis, primary, secondary, tertiary and quaternary structure and denaturation of protein.

Unit-4 Nucleic acid: (05 classes of 60 minutes duration each)

Structure and component of nucleic acid, nucleotides, nucleoside, nomenclature of nucleotides and nucleoside, structure of polynucleotides (DNA and RNA), concepts of DNA duplex formation and its characterization, biological roles of DNA and RNA, concepts of heredity, genetic code, replication, transcription and translation.

Unit-5 Co-Enzyme Chemistry: (05 classes of 60 minutes duration each)

Co-Enzyme, Co-factors, Prosthetic group, Biological functions of some important Co-Enzyme like Co-Enzyme A, Co-carboxylase, NAD^+, $NADP^+$, FMN, FAD.

Immobilization: meaning of Immobilization, Immobilization techniques, effect and application of Immobilization.

Reference Books:

1. Lee, J.D. *Concise Inorganic Chemistry*, ELBS,1991.
2. Douglas, B.E; McDaniel, D.H. & Alexander, J.J. *Concepts & Models of Inorganic Chemistry3rd Ed.*John Wiley Sons, N.Y. 1994.
3. Greenwood, N.N., Earnshaw. *Chemistry of the Elements*, Butterworth- Heinemann. 1997.
4. Miessler, G.L. & Donald, A.Tarr. *Inorganic Chemistry* Fourth Ed., Pearson, 2010.
5. Atkins, P. W and Shriver D. N. *Atkins' Inorganic Chemistry* 5th Ed. Oxford University Press (2010).
6. Purcell, K. F & Kotz, J.C. *Inorganic Chemistry* W.B. Saunders Co, 1977. Huheey, J.E., *Inorganic Chemistry*, Prentice Hall, 1993.
7. Lippard, S.J. & Berg, J.M. *Principles of Bioinorganic Chemistry* Panima Publishing Company1994.

CHEMISTRY PRACTICAL- MJ 15 LAB (Credit: Practical-01)
(Bioorganic and Bioinorganic Chemistry)

Practical (ESE: 2Hrs) =25 Marks	**Pass Marks: Practical (ESE) = 10**
Internal Examination=0 Marks	

Instruction to Question Setter for
End Semester Examination (ESE):
There will be one Practical Examination of 2Hrs duration. Evaluation of Practical Examination may be as per the following guidelines:

Experiment	*= 15 marks*
Practical record notebook	*= 05 marks*
Viva-voce	*= 05 marks*

PRACTICALS: **Hours: 30**

1. Ninhydrin Test - Detection of α-amino acids
2. Biuret Test - Detection of Peptide bond.
3. Xanthoproteic Test - Detection of amino acids containing benzene ring.
4. Millon's Test - Detection of amino acids with phenolic hydroxyl group.
5. Sakaguchi test - Detection of Arginine.
6. Hopkins-cole Test - Detection of Tryptophan in protein.
7. Nitroprusside Test - Detection of amino acids with -SH group.
8. Osazone formation test - Detection of different carbohydrates.

Reference Books:

1. R.C. Gupta &S. Bhargava, Prithvi Books, CBS Publication.
2. Practical Biochemistry-Dr. Vidyottma & Dr. S. K. Kataria.Vayu Education of India, Delhi.
3. Practical Biochemistry-Shuchi Goyal-Pragati BookCentre.

16. MAJOR COURSE- MJ 16: (Credits: Theory-04, Practicals-0)

Marks: 25 (05 Attd. + 20 SIE: 1.5Hr) + 75 (ESE: 3Hrs) = 100	**Pass Marks: Th (MSE + ESE) = 40**

InstructiontoQuestionSetterfor

SemesterInternalExamination(SIE20+5=25marks):

TheSemesterInternalExaminationshallhavetwocomponents.

(a)OneSemester InternalExaminationWrittenTest(SIE)of20Mark

(b)ClassAttendanceScore(CAS)including the behaviour of the student towards teachers and other students of the College of 5 marks.End Semester Examination (ESE 75 marks):

There will be two group of questions **A** and **B**. **Group A is compulsory** which will contain threequestions.**QuestionNo.1willbeveryshortanswertype**consistingoffivequestions of 1 mark each. **Question No. 2 & 3 will be short answer type** of 5 marks. Group B will contain descriptive type seven questions of fifteen marks each out of which any four are to be answered.

Note: *There may be subdivisions in each questions asked in theory examination.*

Research Methodology Theory: 60 Lectures

CourseObjectives:

After completion of the course, the learner should be able to understand:

1. To make the students aware of fundamental but mandatory ethical practices in chemistry.
2. To make the students aware of data analysis.
3. To make the students aware of literature survey in different nodes.
4. To make the students aware of safety handling and safe storage of chemicals.
5. To learn different e-resources.

This paper will help students to learn to avoid plagiarism.

Course Learning Outcomes :

On successful completion of this course, the students should be able to know:

1. Understand ethical practices in chemistry.
2. Carry out Data analysis.
3. Carry out literature survey in different modes.
4. Use e-resources for research.
5. Understand plagiarism, consequences and how to avoid.

Course Outlines :

Research methodology, Research methods, Research Problems, Research Hypothesis, Ethical Aspects of research process, Research methodology in Chemistry

Unit 1: Scope of Research **Lectures: 06**

Introduction, overview of research process: define research problem, review literature, formulate hypothesis, design research/experiment collect and analyse data, interpret and report, scope and importance.

Unit 2: Literature Survey, databases and Research metrics **Lectures: 12**

Print: Sources of information: Primary, Secondary, tertiary sources:
Journals: journal abbreviations,
Digital: database and their responsible use: Google Scholar, Scopus SciFinder,
Search techniques: Phrase, Field, Boolean, Proximity, Concept, limiting/Refining Search Results.
Research metrics: Impact factor of journal, h-index, i10 index, Altmetrics, Citation index.

Unit: 3 Communication in Science **Lectures: 12**

Types of technical documents: Full length research paper, book chapters, reviews, short communication, project proposal, Letters to editor and thesis.

Thesis writing- different steps and software tools (World processing, Chem draw etc) in the design and preparation of thesis, layout, structure (chapter plan) and language of typical reports, Illustrations and tables, bibliography, referencing: Styles (APA. Oxford etc). annotated bibliography, Citation management Tools: mendeley, Oral presentation/papers-planning, software tools, creating and making effective presentation, use of visual aids, electronic management submission.

Unit 4: Research and Publication ethics **Lectures: 10**

Publication Ethics: Introduction, COPE (Committee on Publication Ethics) guidelines: Conflicts of interest, Publication misconduct: problems that to unethical behaviour and vice versa, violation of publication ethics, authorship and contributorship, software tools for finding plagiarism (Turnitin, Urkund etc), redundan publication.

IPR: Intellectual property right and patent law, commercialization, copy right, royalty, trade related aspects of intellectual property right (TRIPS)

Unit 5: Statistical analysis for chemists **Lectures: 10**

Types of Data, Data collection-Methods and tools, data processing, hypothesis testing, Normal and Binormal distribution, tests of signification: t-test, F-test, chi-square test, ANOVA multiple range test, regression and correlation. Features of data analysis with computers and software-Microsoft Excel, Origin, SPSS.

Activity: **Lectures: 10**

1. Collection of journal articles on a particular topic using Google and creating a database.
2. Collection of journal articles on a particular topic using Science Direct and creating a database.
3. Collection of journal articles on a particular topic using Scopus and creating a database.
4. Collection of chemical structure using ChemSpider and database.
5. Collection of chemical structure using SciFinder and creating a database.
6. Curve fitting using freely available software/apps (any one)
7. Making of power point presentation.
8. poster presentation on defined topics
9. Technical writing on topics assigned
10. Demonstration for checking of plagiarism using recommended software.

Reference Books:

1. Dean, J.R. Nones, A.M. Holmes, D., Read R., Weyers, J. & Jones, A. (2011) Practical skills in chemistry, 2nd Ed. Prentice-Hill, Harlow.
2. Hibbert, D. B. & Gooding, J. J. (2006) Data analysis for chemistry, Oxford University Press.
3. Topping, J. (1984) Error of observation and their treatment. Fourth Ed., Chapman Hall, London.
4. Harris, D. C. Quantitative chemical analysis. 6th Ed., Freeman (2007) Chapters 3-5

SEMESTER VII

17. MAJOR COURSE- MJ 17: (Credits: Theory-03, Practicals-01)

Marks: 15 (5 Attd. + 10 SIE: 1Hr) + 60 (ESE: 3Hrs) = 75	Pass Marks: Th (MSE + ESE) = 30

Instruction to Question Setter for

Semester Internal Examination (SIE10+5=15marks):

The Semester Internal Examination shall have two components.

(a)One Semester Internal Examination Written Test (SIE) of 10 Mark.

(b)Class Attendance Score (CAS) including the behaviour of the student towards teachers and other students of the College of 5 marks .End Semester Examination (ESE 60 marks):

There will be two groups of questions **A** and **B**. **Group A is compulsory** which will contain three questions. **Question No.1 will be very short answer type** consisting of five questions of 1 mark each. **Question No. 2 & 3 will be short answer type** of 5 marks. Group B will contain descriptive type five questions of fifteen marks each, out of which any three are to be answered.

note: *There may be subdivisions in each questions asked in theory examination in theory examination*

GREEN CHEMISTRY Theory: 45 Lectures

Course Objectives:

After completion of the course, the learners shall be able to understand:

1. 1. Green chemistry and its principles.
2. Green synthesis and reactions.
3. Green chemistry for sustainable solutions.
4. Principles of green chemistry.
5. Design of chemical reactions /chemical synthesis using green chemistry principles.
6. Atom economy and design of chemical reactions using the principle.
7. The use of green chemistry principle and processes in laboratory reactions.
8. About elementary quantum mechanics.

Course Learning Outcomes:

On successful completion of this course the students should be able to know:

1. Use of green chemistry in designing new laboratory experiments.
2. Use of principle of atom economy and design experiments using the principle.
3. Use of green chemistry in combinatorial chemistry and biomimetic catalyst.
4. Basic principles of quantum mechanics.

Course Outlines:

1.Principles of Green Chemistry,

2.Green Synthesis / Reactions,

3.Future Trends in Green Chemistry.

Course Content:

Unit-1 Introduction and principle of Green Chemistry:

(15 classes of 60 minutes duration each)

What is green chemistry, need for green chemistry, goals of green chemistry, limitations in the pursuit of green chemistry, green chemistry in India, real world cases of green chemistry. Twelve principles of green chemistry with their explanation and examples.Need of green metrics, percentage yield, atom economy, reaction mass efficiency, effective mass yield. Role of solvent, solvent free processes, water as a solvent, ionic liquid, Bio solvent.

Unit-2 Catalysis and Synthetic Methodologies: (10 classes of 60 minutes duration each)

Introduction of traditional method and new green method of catalysis, Catalysis by solid acids and solid bases. Phase transfer Catalysis, application of enzymes in organic synthesis. Non-traditional Synthetic Methodologies**,** Microwave synthesis, Sonochemistry, Photochemistry and green chemistry, Oxidation reaction, Combinatorial chemistry, multi-component reaction.

Unit-3 Green synthesis: (05 classes of 60 minutes duration each)

Designing of green synthesis, Green nano-science, bio-synthesis of nano-particle.

Unit-4 Elementary Quantum Mechanics : (15 classes of 60 minutes duration each)

Postulate of Quantum Mechanics, Quantum Mechanical operators, properties of operators, Hermitian operator, Derivation of Schrondiger's wave equation and its applications for particle in one dimensional box and particle in three dimensional box, concept of degeneracy and zero point energy. Schrondiger's wave equation for H-atom, separation of variables, hydrogen like wave functions.

Reference Books:

1. V. K. Ahluwalia & M.R. Kidwai, New trends in green chemistry, Anamalaya publishers.
2. P. T. Anastas and J. K. Warnar, Oxford Green Chemistry-Theory and Practical, University Press.
3. A. S. Matlack: Introduction to green chemistry, Marcel Dekker.
4. R. K. Prasad, Quantum mechanics, Wiley Eastern Limited.
5. A. K. Chandra, Quantum mechanics, Tata Mac Graw Hills.

CHEMISTRY PRACTICAL- MJ 17 LAB **(Credit: Practical-01)**
(Green Chemistry)

Practical (ESE: 2Hrs) =25 Marks	**Pass Marks: Practical (ESE) = 10**
Internal Examination=0 Marks	

Instruction to Question Setter for
End Semester Examination (ESE):
There will be one Practical Examination of 2Hrs duration. Evaluation of Practical Examination may be as per the following guidelines:

Experiment	*= 15 marks*
Practical record notebook	*= 05 marks*
Viva-voce	*= 05 marks*

PRACTICALS: **Hours: 30**

1. Preparation of acetanilide by green method.
2. Preparation of adipic acids green method.
3. Base catalysed aldol condensation-synthesis of dibenzalpropanone.
4. Solventless aldol condensation.
5. diels-Alder reaction-[4+2] cycloaddition by green method.
6. Preparation of benzopinacol by green method.
7. Solvent-free Knoevenagel reaction (Microwave assisted).
8. Green synthesis method of nitration of phenol, Bromination of acetanilide, preparation of green benzilic acid.

Reference Books:

1. V. K. Ahluwalia & M.R. Kidwai, New trends in green chemistry, Anamalaya publishers.
2. Kirchoff, M. & Riyan, M.A., Greener Approaches to undergraduate chemistry experiments, American Chemical Society, Washington D. C.

18. MAJOR COURSE- MJ 18: **(Credits: Theory-03, Practicals-01)**

Marks: 15 (5 Attd. + 10 SIE: 1Hr) + 60 (ESE: 3Hrs) = 75	**Pass Marks: Th (MSE + ESE) = 30**

Instruction to Question Setter for

Semester Internal Examination (SIE10+5=15marks):

The Semester Internal Examination shall have two components.

(a)One Semester Internal Examination Written Test (SIE) of 10 Mark.

(b)Class Attendance Score (CAS) including the behaviour of the student towards teachers and other students of the College of 5 marks .End Semester Examination (ESE 60 marks):

There will be two groups of questions **A** and **B**. **Group A is compulsory** which will contain three questions. **Question No.1 will be very short answer type** consisting of five questions of 1 mark each. **Question No. 2 & 3 will be short answer type** of 5 marks. Group B will contain descriptive type five questions of fifteen marks each, out of which any three are to be answered.

note: *There may be subdivisions in each questions asked in theory examination in theory examination*

POLYMER CHEMISTRY **Theory: 45 Lectures**

Course Objectives:

After completion of the course, the learners shall be able to understand:

1. The mechanism of polymer material formation.
2. Molecular weight and structure property relationship
3. Polymerization procedure and Zigler-Natta catalysis.
4. Characterization of polymers

Course Learning Outcomes:

On successful completion of this course the students should be able to know:

1. Different types of polymers and their uses.
2. Industrial Methods of Polymerization.
3. Methods of characterization of polymers.
4. Conducting polymers, Biodegradable polymers.
5. PVC, Rubber, polyamides, Biomedical polymers.

Course Outlines:

1. Classification of Polymerization.
2. Polymeric structures and properties.
3. Characterization of polymers.
4. Synthesis of different types of polymers.

Course Content:

Unit-1 Introduction of Polymers, Polymeric Structure and Properties

(15 classes of 60 minutes duration each)

Polymer, monomer, examples of polymers, biopolymers, classification, polymerization process, degree of polymerization, condensation, addition polymers, kinetics of addition polymerization process.

Structure of polymers - Linear, branched, cross linked and network polymers, molecular weight (number average, weight average, viscosity average) and distribution of molecular weight,

polydispersity index, crystallinity in polymer, melting temperature and glass transition temperature, Volumetric properties - molar volume, density, Van der Waals volume – Coefficient of linear thermal expansion and volumetric thermal expansion- Pressure volume temperature (PVT) relationship.

Unit-2 Polymerization Chemistry (10 classes of 60 minutes duration each)

Industrial methods of polymerization such as a bulk, solution, emulsion, suspension. Stereochemistry of polymers and stereo-specific polymerization, Catalysts-their utility in polymers and stereo-specific polymerizations, Catalysts their utility in polymer manufacture, Zieglar-Natta, Metallocene and others.

Unit-3 Characterization of Polymers (05 classes of 60 minutes duration each)

Molecular Weight Determination by Light Scattering, Osmometry, End-Group Analysis, Viscosity, Gel Permeation Chromatography; Application, of FTIR, UV-visible, NMR, and Mass Spectroscopy for Identification of polymers.

Unit-4 Frontier areas of polymer science and technology
(15 classes of 60 minutes duration each)

Conducting polymers: basic principles of conducting polymers, delocalized electronic states of conjugated polymers, polyanilines, polyacetylenes, polythiophene, applications of conducting polymers. Biodegradable polymers: Definition classification of natural biodegradable polymers, cellulose, cellulose acetate, cellophane, soy protein, corn: zein protein, wheat gluten protein, synthetic biodegradable polymers, polyhydroxy alkanoates, polycarpolactone, polyvinyl alcohol, polyacetic acid, application of biodegradable and biomedical polymers, contact lens, dental polymers, artificial heart, kidney, skin, and blood cells.Fibers: natural fibers, cotton, wool, silk, rayon, artificial fibers, polyamides, acrylic acid, PVC, PVA. Rubber: Compounding and elastomeric properties, vulcanization, reinforcement.

Reference Books:

1. D.W. Van Krevelen and P.J. Hoftyzen, "Properties Of Polymer, 3rd Edition Elsevier Scientific,Publishing Company Amsterdam - Oxford - Newyork. 1990.
2. J.E. Mark Ed.AIP, Physical Properties Of Polymers Hand Book, Williston, Vt, 1996.
3. Reaction Engineering of Step Growth Polymerization, S K Gupta and Anil Kumar, PlenumPress, 1987
4. Odian; George, Principles of Polymerization, McGraw-Hill Book Co., New York (1970).
5. W. Billmeyer, Text book of polymer science, 3rdEdn., 2007, Wiley.
6. J.R.Fried, Polymer Science and Technology, (2005), PHI publication.
7. Billmeyer Jr.; Fred W., Textbook of Polymer Science, Wiley- Interscience Publishers, NewYork (1962).
8. Physical methods for chemistry: R. S. Drago, 1992, Saunders college publication.
9. Polymer science, V. R. Gowariker, N. V. Viswanathan, J. Sreedhar, New Age International (P)Ltd., 2015.
10. P. J. Flory, Principle of polymer chemistry, Cornell University Press.
11. Polymer Science and technology, Plastics, Rubber and composites, P. Ghosh, Tata McGraw Hill.
12. V. Gowriker, N. V. Viswanathan, J. Sreedhar, Polymer Science, New Age Int. Publication.

CHEMISTRY PRACTICAL- MJ 18 LAB (Credit: Practical-01)
(POLYMER CHEMISTRY)

Practical (ESE: 2Hrs) =25 Marks Pass Marks: Practical (ESE) = 10
Internal Examination=0 Marks

Instruction to Question Setter for
End Semester Examination (ESE):
There will be one Practical Examination of 2Hrs duration. Evaluation of Practical Examination may be as per the following guidelines:

Experiment	*= 15 marks*
Practical record notebook	*= 05 marks*
Viva-voce	*= 05 marks*

PRACTICALS: **Hours: 30**

1. Free radical solution polymerization of any one: Styrene, methylmethacrylate, methyl acrylate, methacrylic acid (using free radical initiators). (purification of monomer should be taught).
2. Preparation of phenol-formaldehyde resins.

3. Emulsion polymerization of polymethylmethacrylate. Use of viscometer for molecular weight determination–(any known polymer, example: polyvinyl pyrrolidone in water/polyacrylamide in $NaNO_2$ solution) by viscometry. (students should be explained regarding principles and use of ubbelohde /ostwald viscometer).

4. Estimation of amount of HCHO in a given solution by sodium bisulphite method.

5. Use of FTIR/TGA/DSC – for polymer characterization (may be demonstrated to students).

6.Determination of exchange capacity of cation exchange resins and anion exchange resins.

7. Interfacial polymerization, preparation of polyester from isophthaloyl chloride (IPC) and phenolphthalein.

8.Determination of composition of dolomite (by complexometric titration).

9 Analysis of XRD pattern of few selected crystals like $NaNO_3$, $CaCl_2$, etc.; Indexing of a given powder diffraction pattern of a cubic crystalline system.

10. Interpretation of FTIR, NMR and UV-Vis data of given material.

Reference Books:

1. P. Munk & T.M. Aminabhavi, *Introduction to Macromolecular Science*, 2nd ed. John Wiley &Sons (2002).
2. 2.M.P. Stevens, *Polymer Chemistry: An Introduction* 3rd ed. Oxford University Press (2005).
3. L. H. Sperling, *Introduction to Physical Polymer Science*, 4th ed. John Wiley & Sons (2005)

SEMESTER VIII

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19. MAJOR COURSE- MJ 19: (Credits: Theory-03, Practicals-01)

Marks: 15 (5 Attd. + 10 SIE: 1Hr) + 60 (ESE: 3Hrs) = 75	**Pass Marks: Th (MSE + ESE) = 30**

Instruction to Question Setter for

Semester Internal Examination (SIE10+5=15marks):

The Semester Internal Examination shall have two components.

(a)One Semester Internal Examination Written Test (SIE) of 10 Mark.

(b)Class Attendance Score (CAS) including the behaviour of the student towards teachers and other students of the College of 5 marks .End Semester Examination (ESE 60 marks):

There will be two groups of questions **A** and **B**. **Group A is compulsory** which will contain three questions. **Question No.1 will be very short answer type** consisting of five questions of 1 mark each. **Question No. 2 & 3 will be short answer type** of 5 marks. Group B will contain descriptive type five questions of fifteen marks each, out of which any three are to be answered.

note: *There may be subdivisions in each questions asked in theory examination in theory examination*

ANALYTICALCHEMISTRY Theory: 45 Lectures

Course Objectives:

After completion of the course, the learners shall be able to understand:

1. Fundamentals of analytical chemistry.
2. Basics of spectroscopic, thermal, electrochemical techniques
3. Basics of separation techniques and its applications.
4. Analytical tools, statistical methods applied to analytical chemistry.
5. Principle of UV-Vis spectroscopy and its applications.
6. Principles of thermo-gravimetric analysis and study of thermal decomposition of materials/characterization of materials.
7. Basics of electro-analytical techniques and its applications.
8. Principles of separation technology and its use in advanced instrumentations.

Course Learning Outcomes:

On successful completion of this course the students should be able know:

1. Thermo-gravimetric Analysis of different compounds and application of mathematical models.
2. Study of different kinds of chromatograms; calculation of R_f,
3. Analysis of GC/HPLC data for known materials / compounds.

CourseOutlines:

1. Statistical Test data.
2. Vibrational and UV-Visiblespectroscopy
3. TGA
4. Separation Technique.

Course Content:

Unit-1 Qualitative and quantitative aspects of analysis:

(05 classes of 60 minutes duration each)

Tools in analytical chemistry and their applications, Sampling, evaluation of analytical data, errors, accuracy and precision, statistical test of data; F, Q and t-test, rejection of data, and confidence intervals.

Unit-2 Spectroscopy: (15 classes of 60 minutes duration each)

Origin of spectra, interaction of radiation with matter, fundamental laws of spectroscopy and selection rules, validity of Beer-Lambert's law.

Vibrational spectroscopy: Basic principles of instrumentation, sampling techniques. Application of IR spectroscopy for characterization through interpretation of data, Effect and importance of isotope substitution. Introduction to Raman spectra.

UV-Visible Spectrometry: Basic principles of instrumentation, principles of quantitative analysis using estimation of metal ions from aqueous solution, Determination of composition of metal complexes using Job's method of continuous variation and mole ratio method.

Unit-3 Thermalanalysis and Electro analytical methods:

(10 classes of 60 minutes duration each)

Theory of thermogravimetry (TG and DTG), instrumentation, estimation of Ca and Mg from their mixture. Classification of electroanalytical methods, basic principle of pH metric, potentiometric and conductometric titrations. Techniques used for the determination of equivalence points. determination of pKa values.

Unit-4 Separation techniques: (15 classes of 60 minutes duration each)

Solvent extraction:Classification, principleand efficiency of the technique.Mechanism of extraction: extraction by solvation and chelation. Technique of extraction: 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 non- aqueous media.

Chromatographic techniques: Classification, principle and efficiency of the technique. Mechanism of separation: adsorption, partition & ion exchange. Development of chromatograms: frontal, elution and displacement methods. Qualitative and quantitative aspects of chromatographic methods of analysis using LC, GLC, TLC and HPLC.

Reference Books:

1. Mendham, J., A. I. *Vogel's Quantitative Chemical Analysis* 6th Ed., Pearson, 2009.
2. Willard, H.H. et al.: *Instrumental Methods of Analysis*, 7th Ed. Wardsworth Publishing California, USA, 1988.
3. Christian, G.D, *Analytical Chemistry*, 6th Ed. John Wiley & Sons, New York, 2004.
4. Harris, D.C.: *Exploring Chemical Analysis*, 9th Ed. New York, W.H. Freeman, 2016.
5. Skoog, D.A. Holler F.J. & Nieman, T.A. *Principles of Instrumental Analysis*, Saunder College Publications, (1998).
6. Mikes, O. *Laboratory Hand Book of Chromatographic & Allied Methods*, Elles Harwood John Wiley 1979.
7. Ditts, R.V. *Analytical Chemistry*; Methods of separation, van Nostrand, 1974.
8. Khopkar, S. M., *Basic Concepts of Analytical Chemistry*, New Age (Second edition)1998
9. Skoog D.A., Holler F.J., Nieman T.A., *Principles of instrumental analysis*, 5th Edn., Brooks & Cole (1997).

CHEMISTRY PRACTICAL- MJ 19 LAB (Credit: Practical-01)
(ANALYTICAL CHEMISTRY)

Practical (ESE: 2Hrs) =25 Marks	**Pass Marks: Practical (ESE) = 10**
Internal Examination=0 Marks	

Instruction to Question Setter for
End Semester Examination (ESE):
There will be one Practical Examination of 2Hrs duration. Evaluation of Practical Examination may be as per the following guidelines:

Experiment	*= 15 marks*
Practical record notebook	*= 05 marks*
Viva-voce	*= 05 marks*

PRACTICALS: **Hours: 30**

I. Chromatography:

(i) Paper chromatographic separation of Fe^{3+}, Al^{3+}, and Cr^{3+}.
(ii) Separation and identification of the monosaccharides present in the given mixture (glucose & fructose) by paper chromatography. Reporting the R_f values.
(iii). Separate a mixture of Sudan yellow and Sudan Red by TLC technique and identify them onthe basis of their Rfvalues.
(iv) Chromatographic separation of the active ingredients of plants, flowers and juices by TLC

II. SolventExtractions:

(i) To separate a mixture of Ni^{2+} & Fe^{2+} by complexation with DMG and extracting the Ni^{2+}-DMG complex in chloroform, and determine its concentration by spectrophotometry.
ii. Determine the pH of the given aerated drinks fruit juices, shampoos and soaps.
iii. Determination of Na, Ca, Li, in cola drinks and fruit juices using flame Photometric techniques.

III. Analysis of soil:

(i) Determination of pH of soil.
(ii) Total soluble salt
(iii) Estimation of calcium, magnesium, phosphate, nitrate

IV. Ion exchange:

(i) Determination of exchange capacity of cation exchange resins and anion exchange resins.
(ii) Separation of metal ions from their binary mixture.
(iii) Separation of amino acids from organic acids by ion exchange chromatography.

V. Spectrophotometry

(i) Determination of pKa values of indicator using spectrophotometry.
(ii) Structural characterization of compounds by infrared spectroscopy.
(iii) Determination of dissolved oxygen in water.
(iv) Determination of chemical oxygen demand (COD).
(v) Determination of Biological oxygen demand (BOD).
(vi) Determine the composition of the Ferric-salicylate/ferric-thiocyanate Complex by Job's method.

Reference Books:

1. Mendham, J, *A.I.Vogel's Quantitative Chemical Analysis 6th Ed.*, Pearson, 2009.
2. Willard, H.H. *et al*,: *Instrumental Methods of Analysis*,7th Ed. Wards worth Publishing Company, Belmont, California, USA, 1988.
3. Christian, G. D. *Analytical Chemistry*, 6th Ed. John Wiley & Sons, New York, 2004.
4. Harris, D.C. *Exploring Chemical Analysis*, 9th Ed. New York, W. H. Freeman, 2016.
5. Khopkar, S. M. *Basic Concepts of Analytical Chemistry*. New Age International Publisher, 2009.
6. Skoog, D. A. HollerF. J. and Nieman, T. A. *Principles of Instrumental Analysis*, Cengage Learning India Edition.
7. Mikes, O. & Chalmes, R. A. *Laboratory Handbook of Chromatographic & Allied Methods*, Elles Harwood Ltd. London.
8. Ditts, R.V. *Analytical Chemistry: Methods of separation.* Van Nostrand, New York,1974

20. MAJOR COURSE- MJ 20: (Credits: Theory-03, Practicals-01)

Marks: 15 (5 Attd. + 10 SIE: 1Hr) + 60 (ESE: 3Hrs) = 75	Pass Marks: Th (MSE + ESE) = 30

Instruction to Question Setter for

Semester Internal Examination (SIE10+5=15marks):

The Semester Internal Examination shall have two components.

(a)One Semester Internal Examination Written Test (SIE) of 10 Mark.

(b)Class Attendance Score (CAS) including the behaviour of the student towards teachers and other students of the College of 5 marks .End Semester Examination (ESE 60 marks):

There will be two groups of questions **A** and **B**. **Group A is compulsory** which will contain three questions. **Question No.1 will be very short answer type** consisting of five questions of 1 mark each. **Question No. 2 & 3 will be short answer type** of 5 marks. Group B will contain descriptive type five questions of fifteen marks each, out of which any three are to be answered.

note: *There may be subdivisions in each questions asked in theory examination in theory examination*

NANOCHEMISTRY Theory: 45 Lectures

CourseObjectives:

On successful completion of this course the students should know:

1. Nano-technology and Nanomaterials.
2. The scope of Nanoscience.
3. Properties and characterization of Nanomaterials.

Course LearningOutcomes:

On successful completion of this course the students should be able to know:

1. Nano technology in our day to day life.
2. Modern techniques of characterization like electron microscopic technique, diffraction technique, photoelectron spectroscopy.
3. Nanomaterials in environmental remediation.

CourseOutlines:

1. Nanoscience, Nanomaterial.
2. Carbon nanotubes, wire, rod.
3. Quantum dot.
4. Quantum confinement.
5. Gold and silver nanoparticles.

Course Content:

Unit-1 Introduction to nanoscience: (10 classes of 60 minutes duration each)

nanostructure and nanotechnology (basic idea), Overview of nanostructures and nano-materials, classification, (cluster, colloid, nanoparticles, and nanostructures - thin films, Wires, Rod, Tube, and Quantum Dots); Calculation of percentage of surface atom and

surface to volume ratio of spherical, wire, rod, and disc shapes nanoparticles.

Unit 2 Introduction of nanomaterials: (10 classes of 60 minutes duration each)

Overview of nanostructures and nano-materials: classification. Preparation of gold and silver metallic nanoparticles, Carbon nanotubes and inorganic nanowires nanocompsites.

Unit 3 Some properties of nanomaterials: (5 classes of 60 minutes duration each)

Size dependent properties of nanomaterials (basic idea with few examples only): Quantum confinement, Electronic and optical properties of nanomaterials, variation in colors (Blue shift & Red shift), Magnetic, thermal and catalytic properties.

Unit 4 Synthesis of Nanomaterials: (10 classes of 60 minutes duration each)

Brief introduction about Top-down and Bottom-up approaches & self-assembly techniques of nanoparticles synthesis, Solvothermal process, Examples of preparation of gold and silver metallic nanoparticles, self-assembled nanostructures – control of nano architecture-one dimensional control. Carbon nanotubes and inorganic nanowires.

Unit 5: Material characterization techniques: (10 classes of 60 minutes duration each)

(basic idea of use of following instruments in nanomaterial characterization need to be emphasized): Electron microscopic technique (SEM, TEM), diffraction technique, photoelectron spectroscopy, zeta-potential measurement; Examples of use of nanomaterials in environmental remediation and biology (few practical examples of use of materials can be discussed).

ReferenceBooks:

1. Atkins, P.W & Paula, J. D. *Physical Chemistry*, 10th Ed., Oxford University Press (2014).
2. Castellan, G.W. *Physical Chemistry* 4th Ed., Narosa (2004).
3. Mortimer, R.G. *Physical Chemistry* 3rd Ed., Elsevier: NOIDA, UP (2009).
4. Barrow, G. M., *Physical Chemistry* 5th Ed., Tata McGraw Hill: New Delhi (2006).
5. Engel, T. & Reid, P. *Physical Chemistry* 3rd Ed., Prentice-Hall (2012).
6. Rogers, D.W. *Concise Physical Chemistry* Wiley (2010).
7. Silbey, R. J.; Alberty, R. A. & Bawendi, M. G. *Physical Chemistry* 4th Ed., John Wiley & Sons, Inc. (2005).
8. Zhen Guoand Li Tan, *Fundamentals and Applications of Nanomaterials*. 2009, Artech House, London Publication.
9. C.N. R. Rao, A. Muller, A. K. Cheetam, The Chemistry of Nanomaterials: Synthesis, Properties and Applications, Willey-VCH Verlag, Germany, 2005.
10. G. Cao, Nanostructures and Nanomaterials: Synthesis, Properties and Appications, Imperial College Press, London, 2004
11. R.W. Kelsall, I. W.Hameley, M. Geoghegan, Nanoscale Science and Technology, John Wiley & Sons, England, 2005
12. Charles P. Poole and Frank J Owens, *Introduction to nanotechnology*, Wiley Inter science, 2003.
13. Pradeep, T., A text of book of nanoscience and nanotechnology, Tata McGraw Hill Education Pvt. Ltd., New Delhi, 2012

CHEMISTRY PRACTICAL- MJ 20 LAB (Credit: Practical-01)
(ANALYTICAL CHEMISTRY)

Practical (ESE: 2Hrs) =25 Marks	**Pass Marks: Practical (ESE) = 10**
Internal Examination=0 Marks	

Instruction to Question Setter for
End Semester Examination (ESE):
There will be one Practical Examination of 2Hrs duration. Evaluation of Practical Examination may be as per the following guidelines:

Experiment	*= 15 marks*
Practical record notebook	*= 05 marks*
Viva-voce	*= 05 marks*

PRACTICALS: **Hours: 30**

1. Preparation of gold and silver nano-particles.
2. Synthesis of ZnO nanoparticles.
3. Preparation of Silver nanoparticles.
4. Diverse nanoparticles can be prepared by various routes.
5. Depending upon the availability of infrastructure facilities, instructor may encourage the students to prepare bimetallic nano-particles, etc. and characterized them, study their various properties like magnetism, adsorption, etc.

Reference Books:

1. Khosla, B. D.; Garg, V. C. & Gulati, A. *Senior Practical Physical Chemistry,* R. Chand & Co. : New Delhi (2011).
2. Ahluwalia, V. K. & Aggarwal, R. *Comprehensive Practical Organic Chemistry,* Universities Press.
3. Garland, C. W.; Nibler, J.W. & Shoemaker, D. P. *Experiments in Physical Chemistry 8th Ed.;*
4. *Sulabha K Kulkarni, Nanptechnology : Principles and practices Textbook, Springer, 2015.*
5. Fahlman, B. D. *Materials Chemistry,* Springer, 2004.

SEMESTER VII

FOR RESEARCH COURSE (FOR HONS. WITH RESEARCH)-RC 1:

(Credits: Theory-04, Practical-0)

Marks: 25 (5 Attd. + 20 SIE: 1:30 Hr) + 50 (ESE: 3Hrs)
Term Paper: 25 Marks = 100

Pass Marks: Th (MSE + ESE) = 40

RESEARCH PROPOSAL -PLANNING & TECHNIQUES Theory: 60Lectures

Course Objectives:

On successful completion of this course the students should know:

1. What is research proposal?
2. How planning is done?
3. What techniques are used?

Course Learning Outcomes:

On successful completion of this course the students should be able to know:

1. Justification of a proposal.
2. Significance of meaningful research.
3. Ethical aspects of research.

Course Outlines:

1. Introduction.
2. Purpose of research.
3. Use of appropriate techniques.
4. Time and budget planning.

Course Content:

TOPIC

Suggestion – Please write the title of the work entirely in **CAPITAL** letters without marking inverted commas ('---'), question mark (?), or full stop (.).

UNIT 1 Introduction: (10 classes of 60 minutes duration each)

Research proposal is a formal text document that gives a clear cut idea of planned research project which includes Background/ Origin of the problem/Backdrop of the study, the knowledge gap.

Suggestion–Usually, It should be of the length of 2 and a half pages, i.e., in approx 250 words.

a. **Existing Knowledge** – The researcher should begin with the sentence –
" After an extensive and intensive review work, it was found that so and so----------have studied/conducted/undertaken/completed/invented/explored/investigated/researched.

Suggestions–

1. Here in the synopsis, the research scholar should write the researcher name, the topic of the research in short and the year of the research.

2. It must contain as many researches the researcher had reviewed before preparing the synopsis. If the researcher has considered many types of research, then the researcher must write in three to four paragraphs if not more than one or two section should be sufficient.
3. The sole purpose of developing this portion is to have a comprehensive knowledge of existing knowledge in the area/problem being chosen in this study.
4. The researcher should develop the critical ability to pin point the knowledge gap related to his/her research problem.

1.2The knowledge gap

A half sentence is/are sufficient.

UNIT 2 Key features of research proposal: (40 classes of 60 minutes duration each)

research question, the need of study, the statement of the problem, definition of terms used in the title, objective of a study hypothesis, methodology, method to be used, simple and sampling technique, tools to be used, collection of data, preparation of the master chart, tabulation, classification and analysis of a data, statistics to be used, De-limitation of the study.

2.1 The research question

The researcher should write clear cut some questions (preferably 3-5) centrally related to the quest of finding the answer to the research problem.
Suggestion – The researcher should write in form 1.3.1, 1.3.2, 1.3.3 .....

2.2 The need of the study

Suggestion – One sentence as - "To preserve the knowledge gap and find the answer to the research question the need of the present study seems relevant."

Or

"This study has been undertaken to preserve the existing knowledge gap and answer the research question."

2.3 The statement of the problem

Suggestion – The researcher should write only one sentence as - " The formal title of this study is as below (or studied below)"

In the above line, the exact title of the research problem as written on the top of the synopsis should be written in CAPITAL letters with similar precautions as suggested earlier.

2.4 Definition of terms used in the Title

The researcher should begin with the sentence - " It is imperative to define each term which has

come in the title of the study literally and functionally (operationally).
The researcher should write the term to be defined in the same sequence as the term has appeared in the title in the following manner -

2.4.1.– (term-1)
2.4.2 – (term-2)
Suggestions – The researcher should write the literal definition of the term from dictionary/ encyclopedia/thesis/research abstract/ reference book etc. (literary sources). At the end of each term, the researcher must write the annotation of the definition/meaning which (s)he has conceptualized to use throughout the body of the thesis.

2.5 Objective of the study
The primary objective of the study are as follows : -
Suggestions – The researcher should begin each objective of the study in the following manner -

2.5.1 To find out . . . . . .
2.5.2 To survey . . . . . .
2.5.3 To collect . . . . . .
2.5.4 To explore . . . . . .
2.5.5 To know/ To identify . . . .

Usually, the researcher should prefer to write as many objective as is the number of research question.

2.6 The Hypothesis
The researcher should formulate the hypothesis in correspondance with the research questions and objectives in a convincing manner. The hypothesis must be arranged as below -
2.6.1 . . .
2.6.2 . . .

2.7 Methodology of the study in brief
The researcher should write the first sentence - “This study will be completed on the following methods/ procedure/steps/- ”
2.7.1 The researcher should write very clearly whether the study will be conducted in the form of a survey or experimental or historical or any other approach/method.
2.7.2 The method to be used
The population (universe) – Here the scholar should mention the brief information about the definiteness or indefiniteness of population/ universe including the area (region).
2.7.3 The sample and sampling technique
The researcher should write clearly the nature of the sampling technique (s) to be deployed for selecting the sample of this study. Here the researcher should indicate the size and nature of the sample to be chosen for this study.
2.7.4 Tools to be used
Here the scholar should mention the name of research tools/setting/apparatus/contents.
2.7.5 Administration of the tool/ Collection of data

The researcher should write in categorical term about the approach of researching group or individual, generally in social sciences and about the apparatus and setting and experimentation in sciences.

2.7.6 Preparation of the Master Chart
The researcher should enter all the relevant information (data) in the master chart.
2.7..7Tabulation, Classification, and Analysis of Data
Here the researcher should write about the tabulation, classification, and analysis of the data entered in the master chart about the objectives of the study.
2.7.8 Statistics to be used
The researcher should write the names of suitable description and inferential statistics.

2.8 The De-limitation of the study
The researcher should write in the beginning here under the delimitation as the sentence - " Due to lack of time and resources the researcher has delimited this study on the following points -
2.8.1 The languages to be used.
2.8.2 About sample size/ gender/strata / qualitative or quantitative or either of the two.

UNIT 3 Tentative schemes of Chapters: (10 classes of 60 minutes duration each)

This research in the form of a thesis/ dissertation will be organized and reported in the following chapters-

3.1 Chapter -1 - The introduction of the study.
3.2 Chapter -2 - Review of related literature.
3.3 Chapter -3 - Methodology of the study and data collection.
3.4 Chapter -4 - Tabulation / Classification/ Analysis and Interpretation of data.
3.5 Chapter -5 - Findings (Results, Conclusion, Limitations, Implications) and suggestion for further research.

Appendices

Bibliography

References:
All references should come in the body of the synopsis must be cited with the sequence – "Authors name, place of publication, year of publication, the title of article/ book, year of edition, page number."

SEMESTER VIII

FOR RESEARCH COURSE (FOR HONS. WITH RESEARCH)- RC 2:

(Credits: Theory-08)

Full Marks: 200	**Pass Marks: Th (MSE + ESE) = 80**

RESEARCH INTERNSHIP / FIELDWORK /PROJECT / DISSERTATION /THESIS

GUIDELINE TO BE FRAMED

1. Research Internship.
2. Preparation of dissertation/Thesis.
   Important features of dissertation:
   - Extensive literature review, experimental work and data analysis.
   - New findings in the field of Chemistry.
   - Use of well defined methodology.
   - Result, Discussion and Conclusion.
   - Future scope.
   - References.

Marks distribution may be as follows adjusted as appropriate:

a) Assessment of Project Synopsis :50 marks
b) Assessment of Project Thesis :100 marks
c) Viva-voce :50marks

SEMESTER VII

ADVANCED MAJOR PAPER 1- AMJ 1: (Credits: Theory-04, Practical-0)

Marks: 25 (5 Attd. + 20 SIE: 1:30 Hr) + 75 (ESE: 3 Hrs) = 100	Pass Marks: Th (MSE + ESE) = 40

Instruction to Question Setter for

Semester Internal Examination (SIE20+5=25marks):

The Semester Internal Examination shall have two components:

(a)OneSemester Internal Examination Written Test (SIE) of 20 Mark

(b) Class Attendance Score (CAS) including the behaviour of the student towards teachers and other students of the College of 5 marks.

End Semester Examination (ESE 75 marks):

There will be two group of questions **A** and **B**. **Group A is compulsory** which will contain three questions. **Question No.1 will be very short answer type** consisting of five questions of 1 mark each. **Question No. 2 & 3 will be short answer type** of 5 marks. Group B will contain descriptive type seven questions of fifteen marks each, out of which any four are to be answered.

Note:*There may be subdivisions in each questions asked in theory examination*

ADVANCED INORGANIC CHEMISTRY Theory: 60 Lectures

Course Objectives:

On successful completion of this course the students should know:

1. Structure and stability of nucleus.
2. Use of nuclear energy.
3. Metal-ligand co-existence.
4. Bonding in metal pi-complexes

CourseLearningOutcomes:

On successful completion of this course the students should be able to know:

1. Stability of nucleus.
2. Crystal field theory.
3. Metal carbonyl and nitrosyl.

CourseOutlines:

Nuclear chemistry, Metal-ligand equilibria and bonding, Metal π-complexes, Zeise salt, Ferrocene and Metal Alkyls.

Course Content:

UNIT 1 Nuclear Chemistry: (20 classes of 60 minutes duration each)

i. Nuclear stability: Mass defect, nuclear binding energy, binding energy per nucleon, N/P ratio, exchange energy, liquid drop model and shell model of nucleus, Decay laws
ii. Nuclear reactions: Nuclear reaction cross section, nuclear fission and nuclear fusion and their applications in making nuclear weapons.
iii. Tracer technique and its applications in the determination of structure of molecules/ions and mechanism of reactions, medical science, agriculture and industries.
iv. Counting techniques: Radioactivity and its various units, Geiger-Muller counter and Scintillation counter.
v. Nuclear pollution and safety management: Radiation protection standards, basics of radiation hazards, international guidelines on radiation protection, disposal of nuclear waste, nuclear disaster and its management, effect of radiation on health – biological effects of radiation, radiation monitors, dose limits for worker and public.

UNIT 2 Metal-Ligand Equilibria in Solution: (15 classes of 60 minutes duration each)

Stability of complexes, Stepwise and overall formation constants and their relationship, kinetic versus thermodynamic stability, trends in stepwise constants, factors affecting the stability of metal complexes, chelate effect and its thermodynamic origin, macrocyclic effect, experimental methods for the determination of stability constant and composition of complexes by Spectrophotometric method, Job's method and Bjerrum method.

UNIT 3 Metal π-Complexes: (10 classes of 60 minutes duration each)

Metal carbonyls, metal nitrosyls, structure and bonding, Vibrational spectra of metal carbonyls for bonding and structural elucidation & important reactions of metal carbonyls; preparation, bonding structure and important reactions of transition metal nitrosyl; dinitrogen and dioxygen complexes; tertiary phosphine as ligand, metal olefin complexes – structure and bonding.

UNIT 4 Organo metallic : (15 classes of 60 minutes duration each)

Zeise's salt: Preparation and structure, evidences of synergic effect and comparison of synergic effect with that in carbonyls.

Metal Alkyls: Important structural features of methyl lithium (tetramer) and trialkyl aluminium (dimer), concept of multicentre bonding in these compounds. Role of triethylaluminium in polymerisation of ethene (Ziegler – Natta Catalyst). Species present in ether solution of Grignard reagent and their structures, Schlenk equilibrium.

Ferrocene: Preparation and reactions (acetylation, alkylation, metallation, Mannich Condensation).
Structure and aromaticity. Comparison of aromaticity and reactivity with that of benzene.

Reference Books:

1. Inorganic Chemistry -Shriver and Atkins
2. Advanced Inorganic Chemistry, F.A. Cotton and Wilkinson, John Wiley.
3. Inorganic Chemistry, J.E. Huhey, Harpes & Row.
4. Essential Trends in Inorganic Chemistry, D.M.P. Mingos, Oxford Univ. Press, N. Delhi 1995.
5. Structural Inorganic Chemistry, A.F. Wells, ELBS
6. Coordination Chemistry, D.Banerjee, TMH,N.Delhi,1995
7. Principles of Bioinorganic Chemistry, S.J. Lippard and J.M. Berg. University Science Books
8. Bioinorganic Chemistry, I Bertomo, H.B. Gray, S.J. Lippard and J.S. Valentine, University Science Books
9. Inorganic Biochemistry vols I and II ed. G.L. Eichhorn, Elsevier.
10. Inorganic Reactions Mechanism, Indrajit Kumar, Vishal Publication, Jalandhar

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SEMESTER VIII

ADVANCED MAJOR PAPER 2- AMJ 2: (Credits: Theory-04, Practical-0)

Marks: 25 (5 Attd. + 20 SIE: 1:30 Hr) + 75 (ESE: 3 Hrs) = 100	Pass Marks: Th (MSE + ESE) = 40

Instruction to Question Setter for

Semester Internal Examination (SIE20+5=25marks):

The Semester Internal Examination shall have two components:

(a)OneSemester Internal Examination Written Test (SIE) of 20 Mark

(b) Class Attendance Score (CAS) including the behaviour of the student towards teachers and other students of the College of 5 marks.

End Semester Examination (ESE 75 marks):

There will be two group of questions **A** and **B**. **Group A is compulsory** which will contain three questions. **Question No.1 will be very short answer type** consisting of five questions of 1 mark each. **Question No. 2 & 3 will be short answer type** of 5 marks. Group B will contain descriptive type seven questions of fifteen marks each, out of which any four are to be answered.

Note:*There may be subdivisions in each questions asked in theory examination*

ADVANCED ORGANIC CHEMISTRY Theory: 60 Lectures

Course Objectives:

On successful completion of this course the students should know:

1. Enzyme and enzyme mechanism.
2. Energy changes in biosynthesis.
3. Reagents used in organic synthesis.
4. Supramolecular Chemistry.

Course Learning Outcomes:

On successful completion of this course the students should be able to know:

1. Classification, nomenclature and action of enzyme.
2. Metabolism and its path way.
3. Suitable use of organic reagents.
4. Classification and chemistry of supramolecules.

Course Outlines:

Enzyme mechanism, ATP, glycolysis, Kreb's cycle, PIDA, DMDO,DMSO, host-guest compounds.

Course Content:

UNIT 1 Enzymes: (15 classes of 60 minutes duration each)

Introduction, Classification, nomenclature and characteristics of enzyme, mechanism of action of enzyme (taking trypsin as example), factors affecting enzyme action, specificity of enzyme action, enzyme inhibition and their importance, phenomenon of inhibition (competitive, uncompetitive and non- competitive).

UNIT 2 Concept of energy in bio-synthesis : **(15 classes of 60 minutes duration each)**

Calorific value of food, standard calorie content of carbohydrates, proteins and fats, oxidation of food stuff (organic molecules) as a source of energy of cells.
Introduction to metabolism (catabolism and anabolism), ATP: The universal currency of cellular energy, ATP hydrolysis and free energy change. Conversion of food into energy,
Outline of catabolic path way of carbohydrates – glycolysis, fermentation and Krebs cycle.
Overview of catabolic path way of fats and proteins. Inter-relationship of metabolic path ways of proteins, fats and carbohydrates.

UNIT 3 Reagents in organic synthesis: (15 classes of 60 minutes duration each)

Triacetoxyborohydride, Lead acetate, Phenyliodine(III)diacetate (PIDA), DCC, Dimethyldioxirane (DMDO) oxidation, DMSO (Barton modification and Swern oxidation), Oxidation of organic compounds using thallium nitrate, selenium dioxide, $KMnO_4$, PCC, OsO_4, CrO_3, $K_2Cr_2O_7$.
Synthesis and applications of BuLi, Grignard, organoaluminium and organozinc reagents.
Applications of hydroboration (reductions, oxidations and carboxylation), Diborane, 9-BBN.

UNIT 4 Supramolecular Chemistry: (15 classes of 60 minutes duration each)

Definition and development of supramolecular chemistry, Classification of **s**upramolecular host-guest compounds, Receptors, Co-ordination and the lock and key analogy, Binding constants, Co-operativity and the chelate effect,Preorganisation and complementarity, Thermodynamic and kinetic selectivity and discrimination, nature of supramolecular interactions, salvation and hydrophobic effect, supramolecular chemistry of life.

Reference Books:

1. Advanced Organic Chemistry-Reactions. Jerry March, John Wiley
2. Advanced Organic Chemistry, F.A. Carey and n J. Sundberg, Plenum
3. A Guide Book to Mechanism in Organic Chemistry, Peter Sykes, Longman.
4. Structure and Mechanism in Organic Chemistry, C.K.Ingold, Cornell UniversityPress.
5. Organic Chemistry, R.T. Morrison and R.N.Byd. Prentice Hall.
6. Modern Organic reactions, H.O. House, Benjamin.
7. Principles of Organic Synthesis, R.O.C. Norman and J.M.Coxon, Blackie Academic& Professional
8. Reaction Mechanism in Organic Chemistry, S.M. Mukherji and S.P.Singh,Macmillan.
9. Stereochemistry of Organic Compounds D. Nasipuri, New Age International
10.Setereochemistry of Organic Compounds, P.S.Kalsi, New Age International
11.Basic Stereochemistry of Organic Molecules, S.Sengupta, Book, SyndicatePvt.Ltd. Kolkata, 1987.
13. Organic Chemistry, Clayden, et.al ,oxford university press.

SEMESTER VIII

ADVANCED MAJOR PAPER 3- AMJ 3: (Credits: Theory-04, Practical-0)

Marks: 25 (5 Attd. + 20 SIE: 1:30 Hr) + 75 (ESE: 3 Hrs) = 100	Pass Marks: Th (MSE + ESE) = 40

Instruction to Question Setter for

Semester Internal Examination (SIE20+5=25marks):

The Semester Internal Examination shall have two components:

(a)OneSemester Internal Examination Written Test (SIE) of 20 Mark

(b) Class Attendance Score (CAS) including the behaviour of the student towards teachers and other students of the College of 5 marks.

End Semester Examination (ESE 75 marks):

There will be two group of questions **A** and **B**. **Group A is compulsory** which will contain three questions. **Question No.1 will be very short answer type** consisting of five questions of 1 mark each. **Question No. 2 & 3 will be short answer type** of 5 marks. Group B will contain descriptive type seven questions of fifteen marks each, out of which any four are to be answered.

Note: *There may be subdivisions in each questions asked in theory examination*

ADVANCED PHYSICAL CHEMISTRY Theory: 60 Lectures

CourseObjectives:

On successful completion of this course the students should know:

1. Vectors 2. Operators 3. Matrix Algebra and Group theory.4. Statistical Thermodynamics

5. Fugacity, Activity and Dipole moment

CourseLearningOutcomes:

On successful completion of this course the students should be able to know:

1. Types of Vectors, Operators and Matrices.
2. Use of Group theory in chemistry.
3. M-B, B-E & F-D Statistics.
4. Dipole moment and polarisation.

CourseOutlines:

Vector, Operator, Matrix algebra, Group theory, Fugacity, Activity, Statistical Thermodynamics, Dipole moment

Course Content:

UNIT 1 VECTOR : (15 classes of 60 minutes duration each)

Introduction, Addition and subtraction of vectors, unit vector, Multiplication of vectors, Scalar and vector products, Simple applications of vector products.

OPERATOR : Introduction, Algebra of operators: Addition, subtraction & multiplication,

commutative operator, unit operator, Linear operator, vector operator, eigen function and eign value, Hermitian operator & its properties, Setting up quantum mechanical operators : Linear momentum, operator for total energy, Angular momentum operator, Ladder operator and different relations

UNIT 2 MATRIX ALGEBRA : (20 classes of 60 minutes duration each)

Introduction, Types of matrices, Rectangular matrix, Square matrix, Singular matrix, Non -singular matrix, Diagonal matrix, Scalar matrix, Unit matrix, Trace or character of a matrix, Row and column matrix, Symmetric matrix, Determinant of a matrix, Algebra of a matrix : Addition and Subtraction of matrix, Multiplication of matrices. Transpose of a matrix, Adjoint of matrix, Unitary matrix, Orthogonal matrix, Inverse of a matrix, Skew- symmetric matrix, Hermitian matrix, Skew-Hermitian matrix, Simultaneous Linear equation in matrix form,

Similarity Transformation, Diagonalisation of a matrix. Introduction of Group Theory and Symmetry, Simple problems related to point Group of molecules.

UNIT 3 FUGACITY AND ACTIVITY : (05 classes of 60 minutes duration each)

Fugacity, Fugacity co-efficient and its determination,Activity,Activity co-efficient and its determination.

UNIT 4: **STASTICAL THERMODYNAMICS** : **(10 classes of 60 minutes duration each)**

Probability Theorem and Statistical Thermodynamics, Thermodynamic Probability, Maxwell-Boltzman, Bose-Einstein and Fermi-Dirac Statistics, Bose-Einstein condensation, comparsion among M-B, B-E and F-D Statistics.

UNIT 5 DIPOLE MOMENT : (10 classes of 60 minutes duration each)

Dipole moment, Induced Dipole moment, Polarization, Dielectric constant, Mosotti-Clausius equation, Determination and application of Dipole moment.

Magnetism: Diamagnetism, Para-magnetism , Ferromagnetism & Anti-ferromagnetism

ReferenceBooks:

1. AtkinsP.andDe Paula,J.*Physical Chemistry* TenthEd.,OUP, 2014.
2. Castellan,G.W. *Physical Chemistry* 4thEd.,Narosa,2004.
3. Engel,T.andReid,P. *Physical Chemistry* 3rdEd.,PrenticeHall,2012.
4. McQuarrie,D.A.and Simon,J.D. *Molecular Thermodynamics*VivaBooks, 2004.
5. Roy,B.N. *Fundamentals of Classical and Statistical Thermodynamics*Wiley,2001
6. *CommonlyAskedQuestions in Thermodynamics*.CRCPress,2011.
7. Levine,I.N. *Physical Chemistry* 6thEd.,TataMcGrawHill,2010.
8. Metz,C.R.*2000 Solved Problems in Chemistry*, SchaumSeries,2006.
9. Zundhal,S.S.*Chemistry concepts and applications*Cengage India, 20116 Ball, D. W. *Physical Chemistry* Cengage India, 2012.
10. Mortimer,R.G. *Physical Chemistry 3rdEd.,* Elsevier: NOIDA,
11. Levine,I.N. *Physical Chemistry 6thEd.,*TataMcGraw-Hill,2011.

COURSES OF STUDY FOR

ASSOCIATED

AND

ELECTIVE (MINOR) FYUGP IN "CHEMISTRY"

from

Academic Year 2025-26

Vinoba Bhave University, Hazaribag

SEMESTER I OR II

ASSOCIATED CORE COURSE PAPER AC - I Credits: Theory-03, Practical-01)

Marks: 15 (5 Attd. + 10 SIE: 1:30 Hr) + 60 (ESE: 3 Hrs) = 75 **Pass Marks: Th (MSE + ESE) = 30**

Instruction to Question Setter for

Semester Internal Examination (SIE10+5 =15marks):

The Semester Internal Examination shall have two components.

(a) One Semester Internal Examination Written Test (SIE) of 10 Mark

(b) Class Attendance Score (CAS) including the behaviour of the student towards teachers and other students of the College of 5 marks.

End Semester Examination (ESE =60 marks):

There will be two group of questions **A** and **B**. **Group A is compulsory** which will contain three questions. **Question No.1 will be very short answer type** consisting of five questions of 1 mark each. **Question No. 2 & 3 will be short answer type** of 5 marks. Group B will contain descriptive type five questions of fifteen marks each, out of which any three are to be answered.

Note: *There may be subdivisions in the questions of group B.*

ASSOCIATED CORE COURSE AC-I **Theory: 45 Lectures**

Course Objectives :

On completion of this course the students should know the basics of chemistry:

This course is designed :

- To expose the students to the basic principles of chemistry
- To introduce the first course

Course Learning Outcomes :

On successful completion of this course the students should be able to understand other subjects such as Botany, Zoology, Geology, etc.

Course Outlines :

Atomic Structure, Periodicity, Chemical Bonding and Molecular Structure, Gaseous state, Solutions, Introduction to Organic Chemistry, Organic reaction mechanism.

Unit-I Atomic structure: (8 Lectures)

Bohr's atomic theory, Calculation of radius of orbits of atom and calculation of energy of electron in hydrogen-like atoms, Electromagnetic radiation and electromagnetic spectrum, hydrogen spectrum and its origin, Limitations of Bohr's atomic theory, de-Broglie theory, Heisenberg's uncertainty principle, quantum numbers, Aufbau principle, Hund's rule, Pauli's exclusion principle, electronic configuration of atoms and ions.

Unit-II Periodicity: (6 Lectures**)**

Modern periodic law and modern periodic table, Classification of elements into blocks, atomic radius, Ionisation energy, Electron affinity, Electronegativity and their variation in the periodic table, Diagonal relationship.

Unit-III Chemical bonding: (6 Lectures)

General idea about chemical bonds and their types- ionic bond, covalent bond and coordinate bond, Valence bond theory of covalent bond, Explanation of shapes of molecules/ions VSPER theory and hybridisation, Covalent character in ionic bond, Ionic character in covalent bond, Intermolecular forces.

Unit-IV Gaseous state: (6 Lectures)

Ideal gas and ideal gas equation, Kinetic theory of gases, Real gases and their deviation from ideal gas behaviour, van der Waals equation and its derivation, Significance and units of terms involved in van der Waals equation.

Unit-V Solutions: (6 Lectures)

Solutions and their classifications, Concentration of solution and various terms used to express the strength of solution, Calculations related to strength of solution, Ideacolligative properties and vapour pressure of solution of solution, Ideal and non-ideal solutions,

Unit-VI Introduction to organic chemistry: (8 Lectures)

Organic compounds and their classification, Functional group, Homologous series, Types of carbon chains, carbon atoms & hydrogen atoms, IUPAC nomenclature of organic compounds, Hybridisation and shapes of organic molecules, General idea about structural isomerism and stereoisomerism in organic compounds, Aromaticity and its implications.

Unit-VII Organic reaction mechanism: (5 Lectures)

Fission of covalent bonds, Electrophiles and nucleophiles, Electronic displacements in organic molecules-Inductive effect, electromeric effect & Mesomeric effect, Resonance, Basic ideas of organic reaction intermediates - carbocation, carbanion, free radicals and Types of organic reactions.

Reference Books:

1. J. D. Lee : A new Concise Inorganic chemistry, E.L.B.S.
2. F.A. Cotton & G.Wilknson : Basic Inorganic Chemistry, John Wiley.
3. Douglas, McDaniel and Alexader : Concepts and Models in Inorganic Chemistry, john Wiley.
4. James E. Huheey, Ellen Keiter and Richard Keiter : Inorganic Chemistry: Principles of Structure and Reactivity, Pearson Publication.
5. T.W. Graham Solomon : Organic Chemistry, John Wiely and Sons.
6. Peter Sykes : A Guide Book to Mechanism in Organic Chemistry, Orient Longman.
7. E. L. Eliel : Stereochemistry of Carbon Compounds, Tata McGraw Hill.
8. I. L. Finar : Organic Chemistry (Vol. I & II), E.L.B.S.
9. R. T. Morrison & R. N. Boyd : Organic Chemistry. Prentice Hall.
10. Arun Bahl and B. S. Bahl : *Advanced Organic Chemistry*, S. Chand.

CHEMISTRY PRACTICAL- AC I LAB (Credit: Practical-01)
(INORGANIC, ORGANIC AND PHYSICAL CHEMISTRY)

Practical (ESE: 2Hrs) =25 Marks	**Pass Marks: Practical (ESE) = 10**
Internal Examination=0 Marks	

Instruction to Question Setter for
End Semester Examination (ESE):
There will be one Practical Examination of 2Hrs duration. Evaluation of Practical Examination may be as per the following guidelines:

Experiment	*= 15 marks*
Practical record notebook	*= 05 marks*
Viva-voce	*= 05 marks*

PRACTICALS: **Hours : 30**

Section A: Inorganic Chemistry

Semi-micro qualitative analysis using H_2S of mixtures-not more than four ionic species (two anions and two cations and excluding insoluble salts) out of the following:

a) Cations : NH_4^+,Pb^{2+},Ag^+,Bi^{3+},Cu^{2+},Cd^{2+},Sn^{2+},Fe^{3+},Al^{3+},Co^{2+},Cr^{3+},Ni^{2+},Mn^{2+},Zn^{2+},Ba^{2+}, Sr^{2+}, Ca^{2+}, K^+.
b) Anions : CO_3^{2-},S^{2-},SO_3^{2-},$S_2O_3^{2-}$,NO_3^-,CH_3COO^-,Cl^-,Br^-,I^-,NO_3^-,SO_4^{2-},PO_4^{3-},BO_3^{3-},$C_2O_4^{2-}$,F^-.

(Spot tests should be carried out wherever feasible)

Section B :Physical Chemistry

1. Surface tension measurement (use of organic solvents excluded)
   Determination of the surface tension of a liquid or a dilute solution using a stalagmometer.

2. Viscosity measurement (use of organic solvents excluded).
   Determination of the relative and absolute viscosity of a liquid or dilute solution using an Ostwald's viscometer.

Reference Books:

1. A. I. Vogel : Qualitative Inorganic Analysis, Prentice Hall, 7th Ed.
2. A. I. Vogel : Quantitative Chemical Analysis, Prentice Hall, 6th Ed.
3. B. D. Khosla, Senior Practical Physical Chemistry, R. Chand & CO.

SEMESTER III OR IV

ELECTIVE COURSE I PAPER ELC - I (Credits: Theory-03, Practical-01)

Marks: 15 (5 Attd. + 10 SIE: 1:30 Hr) + 60 (ESE: 3 Hrs) = 75	**Pass Marks: Th (MSE + ESE) = 30**

Instruction to Question Setter for

Semester Internal Examination (SIE10+5 =15marks):

The Semester Internal Examination shall have two components.

(a) One Semester Internal Examination Written Test (SIE) of 10 Mark

(b) Class Attendance Score (CAS) including the behaviour of the student towards teachers and other students of the College of 5 marks.

End Semester Examination (ESE =60 marks):

There will be two group of questions **A** and **B**. **Group A is compulsory** which will contain three questions. **Question No.1 will be very short answer type** consisting of five questions of 1 mark each. **Question No. 2 & 3 will be short answer type** of 5 marks. Group B will contain descriptive type five questions of fifteen marks each, out of which any three are to be answered.

Note: *There may be subdivisions in the questions of group B.*

Course Objectives :

On completion of this course the students will know:

1. Atomic structure.
2. Chemical bonding.
3. Kinetic theory of gases.
4. Electron displacement.
5. Stereochemistry.
6. Aliphatic hydrocarbon.

Course Learning Outcomes :

On successful completion of this course the students should be able to know:

1. About various principles and about structure of atom.
2. Different types of bonding and structure of molecules.
3. Kinetic theory and behaviour of gases.
4. Various types of displacement phenomena.
5. Reaction intermediate.
6. Aliphatic hydrocarbons containing single, double and triple bonds.

Course Outlines:

Bohr's theory, de-Broglie's relation, Heisenberg Uncertainty principle, quantum number, electronic configuration, bonding, Lattice energy, Born-Haber cycle, VSEPR theory, Hybridization, Ideal gas, real gas, van der Waals equations, Inductive effect, Resonance, Aromaticity, Conformation, Optical and Geometrical Isomerism, Alkane, Alkene, Alkyne.

Section A : Inorganic Chemistry - 1

Unit-I Atomic Structure: (10 Lectures)

Review of Bohr's theory and its limitations, dual behaviour of matter and radiation, de-Broglie's relation, Heisenberg Uncertainty principle, Hydrogen atom structure, Need of a new approach to Atomic structure. Significance of quantum numbers: Orbital angular momentum quantum numbers m_l, Shapes of s, p and d atomic orbitals, nodal planes. Discovery of spin, spin quantum number (s) and magnetic spin quantum number (m_s). Rules for filling electrons in various orbitals, Electronic, configurations of the atoms, stability of half-filled and completely filled orbitals, concept of exchange energy. Relative energies of atomic orbitals, Anomalous electronic configurations.

Unit-II Chemical Bonding and Molecular Structure: (10Lectures)

Ionic Bounding: General characteristics of ionic bonding. Energy considerations in ionic bonding, lattice energy and solvation energy and their importance in the context of stability and solubility of ionic compounds. Statement of Born-Lande equation for calculation of lattice energy, Born-Haber cycle and its applications, polarizing power and polarizability, Fajan's rules, ionic character in covalent compounds, bond moment, dipole moment and percentage ionic-character.

Covalent bonding: VB Approach Shapes of some inorganic molecules and ions on the basis of VSEPR and hybridization with suitable examples of linear, trigonal planar, square planar, tetrahedral, trigonal bipyramidal and octahedral arrangements.

Concept of resonance and resonating structures in various inorganic and inorganic and organic molecules/ions.

Unit-III Kinetic Theory of Gases: (05Lectures)

Postulates of kinetic theory of Gases and derivation of the kinetic gas equation. Deviation of real gases from ideal behaviour, compressibility factor, causes of deviation.van der Waals equation of state for real gases. Boyle temperature (derivation not required). Critical phenomena, critical constants and their calculation from van der Waals equation. Andrew's isotherms of CO_2.

Section B : Organic Chemistry - 1

Unit-IV Fundamentals of Organic Chemistry: (05 Lectures)

a) **Electronic Displacements:** Inductive Effect, electronic Effect, Resonance and Hyperconjugation, Cleavage of Bonds: Homolysis and Heterolysis. Structure, Shape and reactivity of organic molecules, Nucleophiles and electrophiles.
b) **Reactive intermediates :** Carbocations, Carbanions and free radicals.
c) **Strength of organic acids and bases:** Comparative study with emphasis on factors affecting pK values. Aromaticity: Benzenoids and Huckel's rule.

Unit-V Stereochemistry : (05 Lectures)

Conformations with respect to ethane, butane and cyclohexane, Interconversion of Wedge Formula, Newmann, Sawhorse and Fischer representation, Concept of chirality (upto two carbon atoms). Configuration : Geometrical and Optical isomerism; Enantiomers, Diastereomers and Meso compounds. Threo- and erythro-, D and L, cis – trans nomenclature;

CIP Rules; R/S (for up to 2 chiral carbon atoms) and E/Z Nomenclature (for up to two C=C systems).

Unit-VI Aliphatic hydrocarbons : (10Lectures)

Fundamental group approach for the following reactions (preparations & reactions) to be studied in context to their structure.

a) Alkanes : (upto 5 Carbons). *Preparation :* Catalytic hydrogenation,Wurtz reaction, Kolbe's synthesis, from Grignard reagent. *Reactions:* Free radical Substitution: halogenation.

b) Alkenes: (up to 5 Carbons) *Preparation:* Elimination reactions: Dehydration of alkenes and dehydrohalogenation of alkyl halides (Saytzeff's rule); cis alkenes (Partial catalytic hydrogenation) and trans alkenes (Birch reduction). *Reactions:* cis-addition (alk. $KMnO_4$) and trans-addition (bromine), Addition of HX (Markownikoff's and anti-Markownikoff's addition), hydration, Ozonolysis, oxymercuration-demercuration, hydroboration-oxidation.

c) Alkynes:(upto5Carbons) *Preparation :* Acetylene from CaC_2 and conversion into higher alkynes; by dehalogenation of tetra halides and dehydrohalogenation of vicinal-dihalides. *Reactions:* formation of metal acetylides, addition of bromine and alkaline $KMnO_4$. Ozonolysis and oxidation with hot alkaline $KMnO_4$.

Reference Books:

1. J. D. Lee : A new Concise Inorganic chemistry,E.L.B.S.
2. F. A. Cotton & G.Wilknson : Basic Inorganic Chemistry, John Wiley.
3. Douglas, McDaniel and Alexader: Concepts and Models in Inorganic Chemistry, john Wiley.
4. James E. Huheey, Ellen Keiter and Richard Keiter: Inorganic Chemistry: Principles of Structure and Reactivity, Pearson Publication.
5. T. W. Graham Solomon : Organic Chemistry, John Wiley and Sons.
6. Peter Sykes : A Guide Book to Mechanism in Organic Chemistry, Orient Longman.
7. E. L. Eliel : Stereochemistry of Carbon Compounds, Tata McGraw Hill.
8. I. L. Finar : Organic Chemistry (Vol. I & II), E.L.B.S.
9. R. T. Morrison & R. N. Boyd : Organic Chemistry. Prentice Hall.
10. Arun Bahl and B. S. Bahl : *Advanced Organic Chemistry*, S. Chand.

CHEMISTRY PRACTICAL - ELC I LAB (Credit: Practical-01)
(INORGANIC AND ORGANIC CHEMISTRY)

Practical (ESE: 2Hrs) =25 Marks	**Pass Marks: Practical (ESE) = 10**
Internal Examination=0 Marks	

Instruction to Question Setter for
End Semester Examination (ESE):
There will be one Practical Examination of 2Hrs duration. Evaluation of Practical Examination may be as per the following guidelines:

Experiment	*= 15 marks*
Practical record notebook	*= 05 marks*
Viva-voce	*= 05 marks*

PRACTICALS: **Hours : 30**

SectionA:Inorganic Chemistry – volumetric Analysis

1. Estimation of sodium carbonate and sodium hydrogen carbonate present in a mixture.
2. Estimation of oxalic acid by titrating it with $KMnO_4$.
3. Estimation of Water of crystallization in Mohr's salt by titrating with $KMnO_4$.
4. Estimation of Fe (II) ions by titrating it with $K_2Cr_2O_7$ using internal indicator.
5. Estimation of Cu (II) ions iodometrically using $Na_2S_2O_3$.

Section B : Organic Chemistry

1. Detection of extra elements (N, S, Cl, Br, I) inorganic compounds (containing upto two extra elements).

Reference Books :

1. Vogel's Qualitative Inorganic Analysis, A. I. Vogel, Prentice Hall, 7th Edition.
2. Vogel's Qualitative Chemical Analysis, A. I. Vogel, Prentice Hall, 6th edition.
3. Text book of Practical Organic Chemistry, A. I. Vogel, Prentice Hall, 5th Edition.
4. Practical Organic Chemistry, F. G. Mann. & B. C. Saunders, Orient Longman.

SEMESTER V OR VI

ELECTIVE COURSE II PAPER ELC-II (Credits: Theory-03, Practical-01)

Marks: 15 (5 Attd. + 10 SIE: 1:30 Hr) + 60 (ESE: 3 Hrs) = 75	**Pass Marks: Th (MSE + ESE) = 30**

ELC-II PHYSICAL AND ORGANIC CHEMISTRY Theory : 45 Lectures

Instruction to Question Setter for

Semester Internal Examination (SIE10+5 =15marks):

The Semester Internal Examination shall have two components.

(a) One Semester Internal Examination Written Test (SIE) of 10 Mark

(b) Class Attendance Score (CAS) including the behaviour of the student towards teachers and other students of the College of 5 marks.

End Semester Examination (ESE =60 marks):

There will be two group of questions **A** and **B**. **Group A is compulsory** which will contain three questions. **Question No.1 will be very short answer type** consisting of five questions of 1 mark each. **Question No. 2 & 3 will be short answer type** of 5 marks. Group B will contain descriptive type five questions of fifteen marks each, out of which any three are to be answered.

Note: *There may be subdivisions in the questions of group B.*

Course Objectives :

On completion of this course the students will know:

1. Chemicals Energetics.
2. Chemical Equilibrium and ionic Equilibria .
3. Chemical kinetics.
4. Aromatic hydrocarbons.
5. Alcohol and Phenol.

Course Learning Outcomes :

On successful completion of this course the students will be able to know:

1. Laws of Thermodynamics.
2. Le Chatelier's Principle.
3. Ionization of electrolytes.
4. Buffer solutions.
5. Order and molecularity of a reaction.
6. Arrhenius equations.
7. Collision theory.
8. Activated complex theory.
9. Reactions of benzene and its derivatives.

Course Outlines :

First, second and third Laws of thermodynamics, bond energy, K_p, K_c and K_x, solubility and solubility product, its applications, rate equation of zero, first and second order reactions, Friedel-Craft's reactions, Sandmeyer and Gattermann reactions, Benzyne mechanism, Reimer-Tiemann Reaction, Gattermann-Koch Reaction, Houben-Hoesch Condensation, Schotten-Baumann Reaction.

Section A : Physical Chemistry – 1

Unit-I Chemical Energetics : (4 LECTURES)

Review of thermodynamics and the Laws of Thermodynamics, Important principles and limitations of thermochemistry. Concept of standard state and standard enthalpies of formations, integral and differential enthalpies of solution and dilution. Calculation of bond energy, bond dissociation energy and resonance energy from thermochemical data.Variation of enthalpy of a reaction with temperature-Kirchhoff's equation.

Unit-II Chemical Equilibrium: (3 LECTURES)

Free energy change in a chemical reaction. Thermodynamic derivation of the law of chemical equilibrium. Distinction between G and G^0, Le Chatelier's principle. Relationships between K_p, K_C and K_x for reactions involving ideal gases.

Unit-II IonicEquilibria: (5 LECTURES)

Strong, moderate and weak electrolytes, degree of ionization, factors affecting degree of ionization, ionization constant ionic product to water, ionization of weak acids and bases, $_P$H for different types of salts solutions and buffer solutions. Solubility and solubility product of sparingly soluble salts – applications of solubility product principle.

Unit-IV Chemical Kinetics : (8 LECTURES)

The concept of reaction rates. Effect of temperature, pressure, catalyst and other factors on reaction rates. Order and molecularity of a reaction. Derivation of integrated rate equations for zero, first and second order reactions (both for equal and unequal concentrations of reactants). Half-life of a reaction. General methods for determination of order of are action. Concepts of activation energy and its calculation from Arrhenius equations.
Theories of Reactions Rates: Collision theory and activated complex theory of bimolecular reactions. Comparison of the two theories (qualitative treatment only).

Section B : Organic Chemistry - 2

Functional group approach for the following reactions (preparations & reactions) to be studied in context to their structure.

Unit-V Aromatic hydrocarbons : (8 LECTURES)

Preparation (case benzene): from phenol, by decarboxylation, from acetylene, from benzene sulphonic acid.
Reactions: (Case benzene): electrophilic substitution: nitration, halogenation and sulphonation. Friedel-Craft's reaction (alkylation and acylation) (up to 4 carbons on benzene). Side chain oxidation of alkyl benzene (up to 4 carbons on benzene).

Unit-VI Alkyl and Aryl Halides : (8 LECTURES)

a) **Alkyl Halides** (upto5Carbons) Types of nucleophilic Substitution (S_N1, S_N2 and S_Ni) reactions. *Preparation:* from alkenes and alcohols. *Reactions:* hydrolysis, nitrite & nitro formation, nitrile & isonitrile formation. Williamson's ether synthesis: Elimination vs substitution.
b) **Aryl Halides:** *Preparation*: (Chloro**,** bromo and iodo-benzene case): from phenol, Sandmeyer & Gattermann reactions.

Reactions: (Chlorobenzene): Aromatic nucleophilic substitution (replacement by–OH group) and effect of nitro substituent. Benzyne Mechanism : KNH_2/NH_3 (or $NaNH_2$ / NH_3).

Unit-VII Alcohols and Phenols (upto5 Carbons): **(9 LECTURES)**

a) **Alcohols:** *Preparation :* Preparation of 1^0, 2^0,and 3^0 alcohols: using Grignard reagent, Ester hydrolysis, Reduction of aldehydes, ketones, carboxylic acid and esters.
Reactions: with sodium, HX (Lucas test), esterification, oxidation (with PCC, alk. $KMnO_4$, acidic dichromate, conc. HNO_3). Oppeneauer oxidation, oxidation of diols (up to 6 Carbons), Pinacol-Pinacolone rearrangement.
b) **Phenols :** Preparation, Cumene hydroperoxide method, from diazonium salts.
Reactions: Electrophilic substitution: Nitration, halogenation and sulphonation.
Reimer - Tiemann Reaction, Gattermann - Koch Reaction, Houben - Hoesch Condensation, Schotten - Baumann Reaction.

Reference Books:

1. T.W. Graham Solomons : Organic Chemistry, John Wiley and Sons.
2. Peetr Sykes : A Guide Book to Mechanism in Organic Chemistry, Orient Longman.
3. I. L. Finar : Organic Chemistry (Vol. I & II), E.L.B.S.
4. R.T. Morrison & R. N. Boyd : Organic Chemistry, Prentice Hall.
5. Arun Bahl and B.S.Bahl : Advanced Organic Chemistry, S. Chand.
6. G.W. Castellan : Physical Chemistry 4th Ed. Narosa (2004).
7. J. C. Kotz, P. M. Treichel & J. R. Townsend: General Chemistry Cengage Lening India Pvt. Ltd., New Delhi (2009).
8. B. H. Mahan : University Chemistry 3rd Ed. Narosa (1998).
9. R. H. Petrucci : General Chemistry 5th Ed. Macmillan Publishing Co. :New York (1985).

CHEMISTRY PRACTICAL- ELC II LAB (Credit: Practical-01)
(PHYSICAL AND ORGANIC CHEMISTRY)

Practical (ESE: 2Hrs) =25 Marks	**Pass Marks: Practical (ESE) = 10**
Internal Examination=0 Marks	

Instruction to Question Setter for
End Semester Examination (ESE):
There will be one Practical Examination of 2Hrs duration. Evaluation of Practical Examination may be as per the following guidelines:

Experiment	*= 15 marks*
Practical record notebook	*= 05 marks*
Viva-voce	*= 05 marks*

PRACTICALS: **Hours :30**

Section A: Physical Chemistry

Thermochemistry

1. Determination of heat capacity of calorimeter for different volumes.
2. Determination of enthalpy of neutralization of hydrochloric acid with sodium hydroxide.

Ionic equilibria

a) Measurement of pH of different solutions like aerated drinks, fruit juices, shampoos and soaps (use dilute solutions of soaps and shampoos to prevent damage to the glass electrode) using pH-meter.
b) Preparation of buffer solutions:
   I. Sodium acetate-acetic acid
   II. Ammonium chloride – ammonium hydroxide.

Measurement of the pH of buffer solutions and comparison of the values with theoretical values.

SectionB : Organic Chemistry

1. Purification of organic compounds by crystallization (from water and alcohol) and distillation.
2. Criteria of purity : Determination of melting and boiling points.
3. Preparation:
   Recrystallisation, determination of melting point and calculation of quantitative yields to be done.
   a) Bromination of Phenol/Aniline.
   b) Benzoylation of amines/phenols.
   c) Oxime and 2,4-dinitrophenylhydrazone of aldehyde/ketone.

Reference Books:

1. I. Vogel : Text book of Practical Organic Chemistry, 5th edition, Prentice Hall.
2. F. G. Mann & B. C. Saunders, Practical Organic Chemistry, Orient Longman (1960).
3. B. D. Khosla, Senior Practical Physical Chemistry, R. Chand & Co.

SEMESTER VII OR VIII

ELECTIVECOURSE III PAPER ELC-III (Credits: Theory-03, Practical-01)

Marks: 15 (5 Attd. + 10 SIE: 1:30 Hr) + 60 (ESE: 3 Hrs) = 75	**Pass Marks: Th (MSE + ESE) = 30**

ELC-III PHYSICAL AND ORGANIC CHEMISTRY Theory : 45 Lectures

Instruction to Question Setter for

Semester Internal Examination (SIE10+5 =15marks):

The Semester Internal Examination shall have two components.

(a) One Semester Internal Examination Written Test (SIE) of 10 Mark

(b) Class Attendance Score (CAS) including the behaviour of the student towards teachers and other students of the College of 5 marks.

End Semester Examination (ESE =60 marks):

There will be two group of questions **A** and **B**. **Group A is compulsory** which will contain three questions. **Question No.1 will be very short answer type** consisting of five questions of 1 mark each. **Question No. 2 & 3 will be short answer type** of 5 marks. Group B will contain descriptive type five questions of fifteen marks each, out of which any three are to be answered.

Note: *There may be subdivisions in the questions of group B.*

Course Objectives :

On completion of this course the students will know:

1. Ideal and non-ideal Solution.
2. Phase Equilibrium.
3. Conductance and cell.
4. Carboxylic acids and their derivatives.
5. Amines and their derivatives.
6. Amino Acids and proteins.
7. Carbohydrate.

Course Learning Outcomes :

On successful completion of this course the students will be able to know:

1. Raoult's law.
2. Lever rule.
3. Nernst distribution law and its applications.
4. Phase rule.
5. Clausius- Clapeyron equation.
6. Kohlrausch law.
7. EMF of a cell.
8. Nitration, halogenation and sulphonation.
9. Different types of carbohydrates and their properties.

CourseOutlines:

Thermodynamics of ideal solutions, partial miscibility of liquids, phase, components and degrees of freedom, conductivity and conductometric titrations, electrode potentials, electro chemical cell, Hell-Vohlard- Zelinsky, Reformatsky Reaction, Perkin condensation, Gabriel's Phthalimide synthesis, Hofmann Bromamide reaction, Zwitterion, Isoelectric point and electrophoresis, Glucose and Fructose, Hofmann vs Saytzeff's elimination, Carbylamine test, Hinsberg's test, with HNO_2. Schotten – Baumann Reaction.

Section A : Physical Chemistry - 2

Unit-I Solutions : (05 Lectures)

Thermodynamics of ideal solutions: Ideal solutions and Raoult's law, deviations from Raoult's law, non-ideal solutions. Vapour pressure-composition and temperature-composition curves and non-ideal solutions. Distillation of solutions. Lever rule. Azeotropes.

Partial miscibility of Iiquids: Critical solution temperature; effect of impurity on partial miscibility of liquids. Immiscibility of liquids – Principle of steam distillation. Nernst distribution law and its applications, solvent extraction.

Unit-II Phase Equilibrium : (05 Lectures)

Phase, components and degree of freedom of a system, criteria of phase equilibrium.Gibbs Phase Rule and its thermodynamic derivation. Derivation of Clausius – Clapeyron equation and its importance in phase equilibria. Phase diagram of one-component system (water and sulphur).

Unit-III Conductance: (05 Lectures)

Conductivity, equivalent and molar conductivity and their variation with dilution for weak and strong electrolytes. Kohlrausch law of independent migration of ions. Conductometric titrations (only acid-base).

Unit-IV Electrochemistry: (05 Lectures)

Reversible and irreversible cells. Concept of EMF of a cell. Measurement of EMF of a cell. Nernst equation and its importance. Types of electrodes. Standard electrode potential. Electrochemical series. Thermodynamics of a reversible cell, calculation of thermodynamics properties: G, H and S from EMF data.

Section B : Organic Chemistry - 3

Functional group approach for the following reactions (preparations & reactions) to be studied in context to their structure.

Unit-V Carboxylic acids and their derivatives : (06 Lectures)

Carboxylic acids (aliphatic and aromatic). *Preparation* : Acidic and Alkaline hydrolysis esters. *Reactions:* Hell –Vohlard - Zelinsky Reaction.

Carboxylic acid derivatives (aliphatic) :(upto5carbons): *Preparation*: Acid chlorides, Anhydrides, Esters and Amides from acids and their interconversion.

Reactions: Comparative study of nucleophilicity of acyl derivatives. Reformatsky Reaction, Perkin condensation.

Unit-VI Amines and Diazonium Salts : (12 Lectures)

Amines (AliphaticAromatic) : (upto5carbons)

***Preparation*:** From alkyl halides, Gabriel's Phthalimide synthesis, Hofmann Bromamide reaction.

Hofmann vs Saytzeff's elimination, Carbylamine test, Hinsberg's test, with HNO_2. Schotten – Baumann Reaction, Electrophilic substitution (case aniline): nitration, bromination, sulphonation.

Diazonium salts: Preparation: from aromatic amines. *Reactions : Conversion to benzene, phenol, dyes.*

AminoAcids, Peptides and Proteins:

Preparation of amino acids : Strecker synthesis using Gabriel's Phthalimide synthesis. Zwitterion, Isoelectric point and electrophoresis.

Reactions of amino Acids : ester of –COOH group, acetylation of $–NH_2$ group, complexation with Cu^{2+} ions, ninhydrin test.

Overview of Primary, Secondary, Tertiary and Quaternary structure of proteins.

Unit-VII Carbohydrates: (07 Lectures)

Classification**,** General properties, Glucose and fructose (open chain and cyclic structure), Determination of configuration of monosaccharides, absolute configuration of Glucose and fructose, mutarotation, ascending and descending in monosaccharides, Structure of disaccharides (sucrose, cellobiose, maltose, lactose).

Reference Books :

1. G.W.Castellan : Physical Chemistry 4th Ed. Narosa (2004).
2. J. C. Kotz, P. M. Treichel, J.R. Townsend, General Chemistry, Cengage Learning India Pvt. Ltd. New Delhi (2009).
3. B.H. Mahan : University Chemistry, 3rd Ed. Narosa (1988).
4. R.H. Petrucci, General Chemistry, 5th Ed., Macmillan Publishing Co. New York (1985).
5. Morrisin, R.T. & Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson education).
6. Finar, I. L. Organic Chemistry (Volume1), Dorling Kindersley (India) Pvt. Ltd. (Pearson education).
7. Nelson, D. L. & Cox, M. M. Lehninger's Principles of Biochemistry 7th Ed., W. H. Freeman.
8. Berg, J.M.Tymoczko, J.L.&Stryer,L.Biochemistry7th Ed.,W.H. Freeman.

CHEMISTRY PRACTICAL- ELC III LAB (Credit: Practical-01)
(PHYSICAL AND ORGANIC CHEMISTRY)

Practical (ESE: 2Hrs) =25 Marks	**Pass Marks: Practical (ESE) = 10**
Internal Examination=0 Marks	

Instruction to Question Setter for
End Semester Examination (ESE):
There will be one Practical Examination of 2Hrs duration. Evaluation of Practical Examination may be as per the following guidelines:

Experiment	*= 15 marks*
Practical record notebook	*= 05 marks*
Viva-voce	*= 05 marks*

PRACTICALS: **Hours :30**

Section A: Physical Chemistry

DistributionLaw

Studyoftheequilibriumofoneofthefollowingreactionsbythedistribution method:

a) $I_2(aq)+I^-(aq) \rightleftharpoons I_3^-(aq)$
b) $Cu^{2+}(aq)+xNH_3 \rightleftharpoons [Cu(NH_3)_x]^{2+}$

Conductance

a) Determination of Cell constant.
b) Determination of equivalent conductance, degree of dissociation and dissociation constant of a weak acid.
c) Perform the following conductometric titrations :
   I. Strong acid vs. Strong base
   II. Weak acid vs. Strong base
   III. Weak acid vs. Strong base

Section B : Organic Chemistry

Systematic Qualitative organic analysis of organic compounds possessing mono-functional groups (-COOH, phenolic, aldehydic, ketonic, amide, nitro, amines) and preparation of one derivative.

ReferenceBooks:

1. I.Vogel : Text book of Practical Organic Chemistry, Prentice Hall, 5th Ed.
1. F.G. Mann & B.C.Saunders, Practical Organic Chemistry, Orient Longman (1960).
2. B.D. Khosla, Senior Practical Physical Chemistry, R. Chand &Co.
3. Ahluwalia, V. K. & Aggarwal, R. Comprehensive Practical Organic Chemistry, Universities Press.