S. S. Jain Subodh P.G. College, Jaipur

(Autonomous)

Bachelor of Science (Chemistry)

B.Sc. Chemistry

(Three/Four Year Under Graduate Programme)

Syllabus & Examination Scheme (NEP 2020)

I Semester

2025-26

S. S. Jain Subodh P.G. College, Jaipur

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BACHELOR OF SCIENCE (Chemistry)

Semester I

EXAMINATION SCHEME

Paper code	Paper Title	Maximum Marks	Credit	EoSE* in Hrs.	
				Theory	Practical
BCHEH101	Chemical Bonding and Chemistry of Representative and Transition Elements	100	4	3	-
BCHEH102	States of Matter, Chemical Kinetics and Thermodynamics ¤	100	4	3	-
BCHEHP 151	Chemistry Lab I	50	2	-	4
BCHEHP 151	Chemistry Lab II	50	2	-	4
Total		300	12	-	-

* **EoSE = End of Semester Examination**

S. No.	PAPER	EoSE	CIA	TOTAL
1.	Theory	70%	30%	100
2.	Practical	60%	40%	100

Note:

- It will be necessary for a candidate to pass in theory part as well as practical part of a subject separately.

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B.Sc.(Chemistry) Semester I

1 credit- 25 marks
4 credit- 100 marks
External Assessment: 70 marks
Internal Assessment: 30 marks

Objectives:

The aim of this course is to provide students with a theoretical understanding of the basic constituents of matter, atoms, ions and molecules in terms of their electronic structure and chemical bonding of these are to be explained by applying basic quantum chemistry, and to explain periodicity in the physical and chemical properties of s, p and d block elements and also to explain chemistry of their compounds. The objective of this course is also to explain the basic concepts of thermodynamics in addition to heat capacity, Joule's law, different types of enthalpies and bond enthalpies and their applications, and to explain the structural differences and transformations between states of matter and structural determination of solids. In addition, the laboratory courses are designed to provide students with practical experience in basic qualitative analytical techniques related to radicals, quantitative analytical techniques related to volumetric analysis, and the determination of physical properties of matter, pKa of an acid and kinetic parameter for various reactions.

Course Outcomes :

By the end of this course, students will have a clear understanding of various concepts related to atomic and molecular structure, chemical bonding, periodicity in the physical and chemical properties of s, p and d block elements and chemistry of their compounds. Students will also have practical experience in calibration of glassware, qualitative analysis of radicals, quantitative analytical techniques including volumetric analysis, determination of various physical properties of substances, crystallization and preparation of standard solutions of different concentrations and determination of order and rate constant of various reactions.

Marks distribution in question paper:

The question paper (EoSE – End of Semester Examination) will consist of two parts A and B

Part-A- 14 marks

Part-A will be compulsory having 10 very short answer type questions(with a limit of 20 words) of two marks each and candidate can attempt any 7 questions.

Part-B- 56 marks

Part-B of the question paper shall be divided into 4 units comprising question no 2-5.

There will be one question from each unit with internal choice. Each question will carry 14 marks.

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Paper I: Chemical Bonding and Chemistry of Representative and Transition Elements

Unit-I

Ionic Bond: General characteristics, type of ions, size effects, radius ratio and coordination number, Madelung-constant, Born-Haber cycle, applications of lattice energy, polarizing power, polarizability, Fajan's rules, hydration energy, solubility of ionic-compounds, defects in structures, Frankel and Schottky defects, non-stoichiometric compounds.

Solids: Metallic bond: Qualitative idea of free electron, valence bond and band theories, semiconductors and insulators, conduction in ionic solids, electrical and magnetic properties of solids, introduction to superconductors and super-conductivity.

Unit-II

Covalent bond: General characteristics, Valence bond theory and its limitations. Directional characteristics of covalent bond, Resonance and resonance energy, Hybridization involving s, p and d-orbitals.

Valence Shell Electron Pair Repulsion (VSEPR) Theory to NH_3, H_20, H_30^p, SF_4, CIF_3, $IC1_2$, shapes of simple inorganic molecules and ions. Dipole moment, percentage ionic-character from dipole moment and electronegativity difference.

Molecular Orbital Theory: Detailed description of linear combination of atomic orbital (LCAO), Homonuclear (H_2, He_2, B_2, C_2, N_2, O_2, F_2) and heteronuclear diatomic molecules (CO, NO) and their ions, comparison of valence bond and molecular orbital theories, multicenter bonding in electron deficient molecules, bond strength and bond energy.

Weak Interactions: Hydrogen bond, theories of hydrogen bonding. Weak intermolecular forces of attraction, Vander Waals forces

Unit-III

s-Block Elements: Comparative study, diagonal relationship, salient features of hydrides, solvation and complexation tendencies including their functions in biosystems, an introduction to alkyls and aryls.

p-Block Elements: Comparative study of the p-block elements and group trends, electronic configuration, physical and chemical properties, diagonal relationship, atomic and ionic radii, ionization potentials, electron affinity, electronegativity and oxidation states, oxidation state diagrams on the basis of redox potentials, inert pair effect, catenation.

Compounds of p-Block Elements: Hydrides of boron, diborane and higher boranes, borazine, borohydrides, fullerenes, carbides, fluorocarbons, silicates (structural principle), silicones, oxygen fluorides, peracids of sulphur, tetrasulphur tetranitride, basic properties of halogens, interhalogen compounds and polyhalides.

Unit-IV

d-Block elements:

Chemistry of the elements of first transition series: Electronic configuration and comparative study with respect to atomic and ionic radii, oxidation states and ionization potentials. Redox potentials, oxidation state diagrams on the basis of redox potentials, binary compounds and complexes illustrating relative stability of their oxidation states, coordination number and geometry, metallic nature, magnetic properties, catalytic activity, colour and spectral properties of transition metal ions.

Chemistry of the elements of second and third transition series: Electronic configuration, general characteristics, comparative treatment with their 3d-analogues in respect of ionic radii, oxidation states, magnetic behaviour, spectral properties and stereochemistry.

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References:

1. Lee, J.D. Concise Inorganic Chemistry Wiley, India.
2. Housecroft, Catherine E. & Sharpe, Alan G. Inorganic Chemistry, Pearson Education Ltd.
3. Tuli, G.D. Advanced Inorganic Chemistry, S. Chand, New Delhi.
4. Satya Prakash Advanced Inorganic Chemistry, S. Chand, New Delhi.
5. Adams, D. M. Inorganic Solids - Introduction to Concepts in Solid-state Structural Chemistry, John Wiley, London.
6. Puri, Sharma & Kalia, Principles of lnorganic Chemistry, S. Chand, New Delhi.
7. Cotton, F.A., Wilkinson, G. & Gaus, P.L. Basic Inorganic Chemistry, Wiley.
8. Douglas, B.E., McDaniel, D.H. & Alexander, J.J. Concepts and Models in Inorganic Chemistry, John Wiley & Sons.
9. Sharpe G., Inorganic Chemistry, Pearson Education Ltd.
10. Pfennig Brian W. Principles of Inorganic Chemistry, John Wiley & Sons.

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Paper II: States of Matter, Chemical Kinetics and Thermodynamics

Unit I

Gaseous State : Ideal gases: Kinetic Theory of Gases, Concept of molar mass and molar volume. Determination of molar mass of a gas and volatile substances. The barometric distribution laws. Maxwell distribution law of molecular velocities. The Maxwell energy distribution. The Maxwell Boltzmann distribution law and its experimental verification, Derivation of average, root mean square velocities and most probable velocities. Collision properties: Collision cross section, collision number, collision frequency, collision diameter and mean free path of molecules.

Real gases: Deviations of real gases from ideal behavior, compressibility factor, causes of deviation. Van der Waal's equations and its implications. Isotherms of van der Waals gas. Critical phenomenon and critical constants. Reduced equation of state and law of corresponding states.

Unit II

Mathematical Concepts: Logarithmic relations, curve sketching, linear graphs and calculations of slopes, differentiation of functions like kx, ex, xn, sinx and log x; maxima and minima, partial differentiation and reciprocity relations, integration of some useful/relevant functions; permutations and combinations, factorials, probability. Matrices and Determinant.

Liquid State: Thermal expansion and compressibility, Heat of vaporization. Determination of vapour pressure and heat of vaporization. Disorder in liquid state and structure of liquid water. Intermolecular forces. Cohesion of liquids. Eyring theory of liquids. Liquid crystals and its applications.

Solid state: Crystalline and amorphous states. Isotropy and anisotropy. Elements of symmetry. Law of rational indices. Weiss and miller indices and equation of plane in intercept form. Law of constancy of interfacial angles. Unit cell and lattice, Symmetry elements in crystals. Basic concept of X-ray diffraction by crystals. Derivation of Bragg's equation. Determination of crystal structure of NaCl and CsCl (Laue's method and powder method.). Defects in solids.

Unit III

Chemical Kinetics: Rate, Initial rate, specific rate, rate constant and units. Method of determination of initial rate. Order, molecularity and stoichiometry of reaction. Methods of determination of order of reaction. Derivation of integrated rate equations- zero order, first order, second order and third order. Graphical applications of these equations for the determinations of rate constant. Effect of temperature on rate constant, Arrhenius equation, energy of activation and its determination. Complex reactions and their nature. Derivation of rate equation for the opposing or reversible reactions ($A + B \rightleftharpoons C$), parallel reactions and consecutive reactions ($A \rightarrow B \rightarrow C$), characteristics of consecutive reactions.

Unit IV

Thermodynamics: Definitions of thermodynamic terms: system, surroundings, thermodynamic process. Concept of work and heat, Internal energy, Enthalpy. State and path functions and their exact and inexact differential, Work of expansion and compression under isothermal and adiabatic conditions. Zeroth law of thermodynamics, first law of thermodynamics. Changes in enthalpy at constant temperature and pressure. Concept of heat capacity (Cp and Cv) and their thermodynamic relationship. Application of first law of thermodynamics. The heat of reaction and heat of formation. bond energies. Hesse's Law. Heat of reaction at constant Pressure and volume. Variation of heat of reaction with temperature. Bond enthalpies and bond energies.

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References:

1. Puri, B. R., Sharma, L. R. & Pathania, M. S. Principles of Physical Chemistry, Vishal Publishing Co.
2. Gurdeep Raj, Advanced Physical Chemistry, Goel Publishing House.
3. Atkins, W. Physical Chemistry, Oxford University Press.
4. Silby, R. J. & Alberty, R. A. Physical Chemistry, John Wiley & Sons.
5. Barrow, G.M. Physical Chemistry, Tata McGraw-Hill.
6. Kapoor, K. L. A Textbook of Physical Chemistry, (Volume I) Macmillan India Ltd.
7. Kapoor, K. L. A Textbook of Physical Chemistry, (Volume II) Macmillan India Ltd.

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B.Sc.(Chemistry) Semester I

Chemistry Lab I

1 credit- 25 marks
2 credit- 50 marks
External Assessment: 30 marks
Internal Assessment: 20 marks

Inorganic Chemistry

A. Qualitative analysis: **10 marks**

Analysis of the given inorganic mixture containing six radicals (three acidic and three basic) including interfering acid radicals - fluoride, borate, oxalate, phosphate and excluding insoluble.

B. Quantitative analysis: Volumetric analysis **10 marks**

1. Estimation of Ca^{2+} & Mg^{2+} using EDTA solution.
2. Estimation of Cu (II) ions iodometrically, using sodium thiosulphate solution
3. Determination of total hardness of water.
4. Determination of number of molecules of water of crystallization in oxalic acid crystals.
5. Estimation of sodium carbonate and bicarbonate in mixed solution.
6. Estimation of sodium carbonate and sodium hydroxide in a mixed solution.
7. Estimation of Ferrous and Ferric sulphates in a mixed solution.

Viva voce **5 marks**

Practical Record **5 marks**

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Chemistry Lab II

1 credit- 25 marks
2 credit- 50 marks
External Assessment: 30 marks
Internal Assessment: 20 marks

Physical Chemistry:

10 marks

1. To study the solubility curve of salts such as potassium nitrate, etc.
2. To Study the solubility curve of phenol in water and hence study the effect of separate addition of substances such as naphthalene, potassium chloride and acetic acid.
3. Determination of pH of different buffer solutions and e valuate the pKa of an acid by Handerson equation.

Viscosity and Surface Tension: **10 marks**

1. To determine the viscosity/surface tension of a ·pure liquid (alcohol etc.)at room temperature. (Using the Ostwald viscometer/stalagmometer).
2. To determine the percentage composition of a given binary mixture (Acetone and Ethyl Methyl ketone) by surface tension method.
3. To determine the percentage composition of a given mixture (non- interacting systems) by viscosity method.
4. To determine the viscosity of amyl alcohol in water at different concentration and calculate the excess viscosity of these solutions.

Viva voce **5 marks**

Practical Record **5 marks**

References:

l. Vogel, A. I. Vogel's Qualitative Inorganic Analysis, Prentice Hall.
2. Vogel, A. I. Vogel's Quantitative Inorganic Analysis Including Elementary
3. Instrumental Analysis, ELBS. Gurdeep Raj, Advance Practical Inorganic Chemistry, Goel Publishing

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