Curriculum Framework and Credit System for the Four Year Undergraduate Programme (FYUGP)

CHEMISTRY

Academic Session:

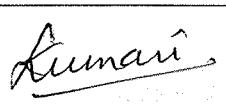
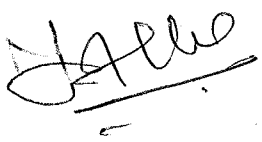
w.e.f. 2022

for

All Constituent/Affiliated Colleges Under

Binod Bihari Mahto Koyalanchal University, Dhanbad

Members of Board of Studies for Under Graduate Syllabus of the Department of Chemistry of Binod Bihari Mahto Koyalanchal University, Dhanbad, Jharkhand.

1	Dr. Leelawati Kumari, Head, University Department of Chemistry, BBMKU	CHAIRPERSON	
2	Dr. Y. JHA, Retired Head, Department of Chemistry, P.K.R.M. College, Dhanbad	EXTERNAL EXPERT	
3	Sri Rajendra Prasad Singh, UNIVERSITY DEPARTMENT of CHEMISTRY, BBMKU	MEMBER	
4	Dr. Dharmendra Kumar Singh, University Department of Chemistry, BBMKU	MEMBER	
5	Dr. Rajeev Pradhan, Head Department of Chemistry, P.K.R.M. College, Dhanbad	MEMBER	

SEM-I

INTRODUCTORY REGULAR COURSE (IRC)-01

CHEMISTRY

LECTURE -45 **CREDIT -03**

FULL MARKS- 100 **PASS MARKS- 40**

UNIT: 1 Atomic Structure — 07 Lectures

Bohr's theory, its limitations and atomic spectrum of hydrogen atom. Wave mechanics: de Broglie equation, Heisenberg's Uncertainty Principle and its significance, Quantum numbers and their significance. Pauli's Exclusion Principle, Hund's rule of maximum multiplicity, Aufbau's principle and its limitations, Variation of orbital energy with atomic number.

UNIT 2: Periodicity of Elements: — 07 Lectures

Basic ideas of the following periodic properties-

(a) Effective nuclear charge, shielding or screening effect, Slater rules,

(b) Atomic radii

(c) Ionic and crystal radii.

(d) Covalent radii

(e) Ionization enthalpy.

(f) Electron gain enthalpy

(g) Electronegativity, Pauling's/ Mulliken's/ Allred Rachow's/ and Mulliken-Jaffé's electronegativity scales.

UNIT 3: Chemical Bonding: — 12 Lectures

Ionic bond: Defination, General characteristics, Factors favouring formation of ionic bond.

Covalent bond: Lewis structure, Valence Bond theory (Heitler-London approach). Energetics of hybridization, equivalent and non-equivalent hybrid orbitals. Bent's rule, Resonance and resonance energy, Molecular orbital theory. Molecular orbital diagrams of diatomic and simple polyatomic molecules N2, O2, C2, B2, F2, Valence shell electron pair repulsion theory (VSEPR), shapes of simple molecules and ions containing lone pairs and bond pairs of electrons, multiple bonding (σ and π bond approach) and bond lengths.

Covalent character in ionic compounds, polarizing power and polarizability. Fajan's rules and consequences of polarization.

Ionic character in covalent compounds: Bond moment and dipole moment. Percentage ionic character from dipole moment and electronegativity difference.

Weak Chemical Forces: Hydrogen bonding: definition, types of hydrogen bond, Effect of hydrogen bonding on physical and chemical properties.

UNIT 4: Basics of Organic Chemistry-I — 05 Lectures

Organic Compounds: Classification and Nomenclature.

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

UNIT 5: Basics of Organic Chemistry-II — 05 Lectures

Reaction mechanism, Homolytic and Heterolytic fission with suitable examples. Curly arrow rules, formal charges;

Electrophiles and Nucleophiles; Nucleophlicity and basicity; Types, shape and their relative stability of Carbocations, Carbanions, Free radicals and Carbenes.

Introduction to types of organic reactions and their mechanism: Addition, Elimination and Substitution reactions.

UNIT 6: Ionic equilibria — 09 Lectures

Strong, moderate and weak electrolytes, degree of ionization, factors affecting degree of ionization, ionization constant and ionic product of water. Ionization of weak acids and bases, pH scale, common ion effect; dissociation constants of mono-, di-and triprotic acids (exact treatment).

Buffer solutions; derivation of Henderson equation and its applications; buffer capacity, buffer range, buffer action and applications of buffers in analytical chemistry and biochemical processes in the human body.

Solubility and solubility product of sparingly soluble salts –applications of solubility product principle.

References Books-

1. Inorganic Chemistry by J. D. Lee
2. Inorganic Chemistry by Puri Sharma Kalia
3. Organic Chemistry by A Bahl and B. S. Bahl
4. Organic Chemistry Volume-1 by I. L. FINAR
5. Physical Chemistry by Puri Sharma Pathania

SEM-01

CHEMISTRY MAJOR - 0I

INORGANIC CHEMISTRY – I

Theory - 60 Lectures **Credit - 04**

Full Mark - 75 **Pass Mark - 30**

Atomic Structure (14 Lectures)

Bohr's theory, its limitations and atomic spectrum of hydrogen atom. Wave mechanics: de Broglie equation, Heisenberg's Uncertainity Principleand its significance, Schrodinger's wave equation, significance of Ψ and Ψ^2. Quantum numbers and their significance. Normalized and orthogonal wave functions. Sign of wave functions. Radial and angular wave functions for hydrogen atom. Radial and angular distribution curves. Shapes of s,p,d and f orbitals. Contour boundary and probability diagram.

Pauli's Exclusion Principle, Hund's rule of maximum multiplicity, aufbau's principle and its limitations, Variation of orbital energy with atomic number.

Periodicity of Elements (16 Lectures)

s,p,d and f block elements, the long form of periodic table. 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 radii (van der Waals)
c) Ionic and crystal radii
d) Covalent radii (octahedral and tetrahedral)
e) Ionization enthalpy, Succesive ionization enthalpies and factors affecting ionization energy. Applications of ionization enthalpy.
f) Electron gain enthalpy, trends of electron gain enthalpy.
g) Electronegativity, Pauling's/Mulliken's/ Allred Rachow's/ and Mulliken- Jaffee's electronegativity scales. Variation of electronegativity with bond order, partial charge, hybridization, group electronegativity. Sanderson's electron density ratio.

Chemical Bonding (30 Lectures)

Chemical Bonding: Section A

i. Ionic bond : General characteristics, types of ions, size effects, radius ration rule and its limitations. Packing of ions in crytals. Born-Lande equations with derivation and importance of Kaustinskii expression for lattice energy. Madelung constant, Born-Haber cycle and its applications, Solvation energy.

ii. Covalent bond : Lewis structure, Valence Bond theory (Heitler –London approach). Energetics of hybridization, equivalent and non-equivalent hybrid orbitals. Bent's rule, Resonance and resonance energy, Molecular orbital theory. Molecular orbital diagrams of diatomic and simple polyatomic molecules N_2 , O_2 , C_2 , B_2 , F_2 , CO, NO and their ions; HCl, BeF_2,CO_2 (idea of s-p mixing and orbital interaction to be given). Formal charge, Valence shell electron pair repulsion theory (VSEPR), shapes osf simple molecules and ions containing lone pairs and σ bond and π approach) irsf electrons and multiple bonding lengths.

Chemical Bonding: Section – B

Covalent character in ionic compounds, polarizing power and polarizability. Fajan's rule and consequences of polarization.

Ionic character in covalent compounds: Bond moment and dipole moment. Percentage ionic character from dipole moment and electronegativity difference.

Weak Chemical Forces: van der Waals forces, ion-dipole forces, dipole-dipole interactions, induced dipole interactions, instantaneous dipole-induced dipole interactions. Hydrogen bonding (theories of hydrogen bonding, valence bond treatment)

Reference Books:

- Lee, J.D. Concise Inorganic Chemistry, ELBS, 1991.
- Douglas, B.E. and Mc Daniel, D.H., Concepts & Models of Inorganic Chemistry, Oxford, 1970.
- Atkins, P.W. & Paula, J. Physical Chemistry, Oxford Press, 2006.
- Day,M.C. and Selbin, J. Theoritical Inorganic Chemistry, ACS Publications 1962.

(Chemistry Practical)

PAPER: MJ-01

Credits: 02 **60 Lectures**

Marks: 25 **Pass Marks: 10**

GROUP- A

30 LECTURES

(A) Titrimetric Analysis

(i) Calibration and use of apparatus

(ii) Preparation of solutions of different Molarity/Normality of titrants

(B) Acid-Base Titrations

(i) Estimation of carbonate and hydroxide present together in mixture.

(ii) Estimation of carbonate and bicarbonate present together in a mixture.

(iii) Estimation of free alkali present in different soaps/detergents.

(C) Oxidation-Reduction Titrimetry

(i) Estimation of Fe(II) and oxalic acid using standardized KMnO4 solution.

(ii) Estimation of oxalic acid and sodium oxalate in a given mixture.

(iii) Estimation of Fe(II) with K2Cr2O7 using internal (diphenylamine, anthranilic acid) and external indicator.

GROUP-B

30 LECTUTRES

1. Surface tension measurements.

a. Determine the surface tension by (i) drop number (ii) drop weight method.

b. Study the variation of surface tension of detergent solutions with concentration.

2. Viscosity measurement using Ostwald's viscometer.

a. Determination of viscosity of aqueous solutions of (i) polymer (ii) ethanol and (iii) Sugar at room temperature.

b. Study the variation of viscosity of sucrose solution with the concentration of solute.

Reference Books-

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

2. Khosla, B. D.; Garg, V. C. & Gulati, A. Senior Practical Physical Chemistry, R. Chand & Co.:

N.Delhi (2011).

3. Garland, C. W.; Nibler, J. W. & Shoemaker, D. P. Experiments in Physical Chemistry 8

th Ed.;

McGraw-Hill: New York (2003).

4. Halpern, A. M. & McBane, G. C. Experimental Physical Chemistry 3rd Ed.; W.H. Freeman & Co.: New York (2003)

SEM-II

(Physical Chemistry)

PAPER: MJ-02

Credits: Theory-04 **Theory: 60 Lectures**

Marks: 15 (MSE) + 60 (ESE) =75 **Pass Marks: (MSE: 06 +ESE: 24) = 30**

Instruction to Question Setter for

Mid Semester Examination (MSE): 1 Hrs.

The Mid Semester Examination shall have two components. (a) One Semester Internal Assessment Test (SIA) of 10 Marks. There will be three questions of 5 marks each, out of which two are to be answered. Each question may be subdividedinto two or more parts (b) Class Attendance Score (CAS) & Day to day activities (DDA) of 5 marks.

(Attendance: Upto75% = 1 mark; 75-80% = 2 marks; 80.-85% = 3 marks; 85-90% = 4 marks; >90% = 5 marks)

End Semester Examination (ESE): 3 Hrs.

*There will be **two** groups of questions. **Group A is compulsory** and will contain two questions. Q. No. 1(A) will be multiple type six questions of 1 mark each. Q. No. 1(B) will contain two short answer type questions (max. 50 words) each of 3 marks. **Group B will contain descriptive type eight** questions of twelve marks each, out of which any four are to be answered.*

UNIT 1: Gaseous state 20 Lectures

Kinetic molecular model of a gas: postulates and derivation of the kinetic gas equation; collision frequency; collision diameter; mean free path and viscosity of gases, including their temperature and pressure dependence, relation between mean free path and coefficient of viscosity. Maxwell distribution and its use in evaluating molecular velocities (average, root mean square and most probable) and average kinetic energy, law of equipartition of energy, degrees of freedom and molecular basis of heat capacities. Behaviour of real gases: Deviations from ideal gas behaviour, compressibility factor, Z, and its variation with pressure for different gases. Causes of deviation from ideal behavior. Vander Waals equation of state, its derivation and application in explaining real gas behaviour. Isotherms of real gases and their comparison with van der Waals isotherms, continuity of states, critical state, relation between critical constants and van der Waals constants, law of corresponding states.

UNIT 2: Ionic equilibria 24
Lectures

Strong, moderate and weak electrolytes, degree of ionization, factors affecting degree of ionization, ionization constant and ionic product of water. Ionization of weak acids and bases, Ph scale, common ion effect; dissociation constants of mono-, di-and triprotic acids (exact treatment). Salt hydrolysis-calculation of hydrolysis constant, degree of hydrolysis and Ph for different salts. Buffer solutions; derivation of Henderson equation and its applications; buffer capacity, buffer range, buffer action and applications of buffers in analytical chemistry and biochemical processes in the human body. Solubility and solubility product of sparingly soluble salts – applications of solubility product principle. Qualitative treatment of acid – base titration curves (calculation of P^H at various stages). Theory of acid–base indicators; selection of indicators and their limitations.

UNIT 3: Chemical Equilibria 16
Lectures

Criteria of thermodynamic equilibrium, degree of advancement of reaction, chemical equilibria in ideal gases, concept of fugacity. Thermodynamic derivation of relation between Gibbs free energy of reaction and reaction quotient. Equilibrium constants and their quantitative dependence on temperature, pressure and concentration. Free energy of mixing and spontaneity; thermodynamic derivation of relations between the various equilibrium constants Kp, *Kc* and *Kx*. Le Chatelier principle (quantitative treatment); equilibrium between ideal gases and a purecondensed phase.

Reference Books:

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

SEM-II

(Chemistry Practical)

PAPER: MJ-02

Credits: 02 **60 Lectures**

Marks: 25 **Pass Marks: 10**

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1. Surface tension measurements.

a. Determine the surface tension by (i) drop number (ii) drop weight method.

b. Study the variation of surface tension of detergent solutions with concentration.

2. Viscosity measurement using Ostwald's viscometer.

c. Determination of viscosity of aqueous solutions of (i) polymer (ii) ethanol and (iii) Sugar at room temperature.

d. Study the variation of viscosity of sucrose solution with the concentration of solute.

3. Thermochemistry

a) Determination of heat capacity of a calorimeter for different volumes using change of enthalpy data of a known system (method of back calculation of heat capacity of calorimeter from known enthalpy of solution or enthalpy of neutralization).

b) Determination of heat capacity of the calorimeter and enthalpy of neutralization of hydrochloric acid with sodium hydroxide.

c) Calculation of the enthalpy of ionization of ethanoic acid.

d) Determination of heat capacity of the calorimeter and integral enthalpy (endothermic and exothermic) solution of salts.

References Books:

1. Vogel, A.I. A Textbook of Quantitative Inorganic Analysis, ELBS.
2. Khosla, B. D.; Garg, V. C. & Gulati, A. *Senior Practical Physical Chemistry,* R. Chand & Co.: N.Delhi (2011).
3. Garland, C. W.; Nibler, J. W. & Shoemaker, D. P. *Experiments in Physical Chemistry 8th Ed.*; McGraw-Hill: New York (2003).
4. Halpern, A. M. & McBane, G. C. *Experimental Physical Chemistry 3rd Ed.;* W.H. Freeman & Co.: New York(2003).
5. Mann, F.G. & Saunders, B.C. Practical Organic Chemistry, Pearson Education (2009)
6. 6.Furniss, B.S.; Hannaford, A.J.; Smith, P.W.G.; Tatchell, A.R. Practical Organic Chemistry, 5th Ed., Pearson (2012)