GUJARAT UNIVERSITY
B. Sc. SEMESTER III
CHEMISTRY
ACCORDING TO NEP - 2020

Course Structure with respect to credit, hours and marks

Course Type	Course	Credit	Work Hours/ week	Exam hours	Marks		Total Mark
					Internal	External	
Discipline specific Courses – Core (Major)	DSC-C-CHE 231T Inorganic Chemistry	4	4	2.0	50	50	100

DSC – C – CHE 231T
INORGANIC CHEMISTRY

Learning Objectives:

- To study basic principles and application of valence bond theory and molecular orbital theory.
- To develop the basic knowledge and conceptual ideas regarding the formation of bonding and antibonding molecular orbitals.
- To understand energy level diagram of molecular orbitals.
- To study coordination compounds and types of coordination compounds.
- To understand bonding in complexes, splitting in complexes.
- To know application of complexes and hybridization in complexes.
- To study acceptable wave function, Physical interpretation of ψ, ψ^2 and $\psi\,\psi^*$.
- To understand Operators, Operator algebra.
- To know Eigen value, Eigenvalue function and Eigen value equation.
- To study principle involved in particle in one dimensional box.
- To study different types of non-aqueous solvents.
- To understand reactions involved in non-aqueous solvents.
- To know the different concepts of acids and bases.
- To study principles and reactions regarding HSAB Principle

Learning outcomes:

By the end of the course, the students will be able to:

- Draw molecular orbital diagram of different molecules.
- Find bond order, bong length and bond strength of different molecules.
- Learn basic difference between bonding and antibonding molecular orbitals.
- Give shape and hybridization of complexes.
- Calculate CFSE in weak and strong ligand field.
- Learn application of complexes in research.
- Use Normalization and orthogonality condition in quantum chemistry.
- Determine Eigen value and Normalized wave function.
- To find application of particle in one dimensional box.
- Learn application of commutators.
- Use non-aqueous solvents in different reactions.
- Learn physical and chemical properties of non-aqueous solvents.
- Learn different concepts regarding acids, bases, hard and soft acids and bases.
- Study importance of HSAB Principle.

B. Sc. SEMESTER - III
DSC – C – CHE 231T
INORGANIC CHEMISTRY

Unit – I: Chemical Bonding **[25 Marks]**
[15 Hours]

Valence bond theory of bond formation and its limitations (Heitler and London approach), Formation of H_2 molecule by valence bond theory, Molecular orbital Theory, LCAO Method, conditions for the combination of atomic orbitals to form molecular orbitals, bonding and antibonding molecular orbitals, σ and π molecular orbitals, mixing of orbitals, energy level diagram for molecular orbitals, rules for filling up of molecular orbitals, Bond order and its calculation, stability of molecules in terms of bonding and antibonding electrons, relation between bond order, bond strength and bond energy, Molecular orbital diagrams of heteronuclear diatomic molecules (CO, NO, NO^+, CN^-, HF, HCl), Molecular orbital diagrams of heteronuclear polyatomic molecules (BeH_2, NH_3), Molecular orbital diagrams of $[CoF_6]^{-3}$ and $[Co(NH3)_6]^{+3}$, Band Theory for metals.

Unit – II: Coordination Compounds **[25 Marks]**
[15 Hours]

Valence bond theory of complexes, examples of ML_4 and ML_6 type complexes, Drawbacks of Valence bond theory, Crystal Field Theory, Crystal Field Splitting in octahedral, tetrahedral, and square Planar complexes, Crystal Field Stabilization Energy (CFSE) with examples, Calculation of CFSE in octahedral and tetrahedral complexes in weak ligand field (high spin) and strong ligand field (low spin), factors affecting the magnitude of crystal field Splitting (Δ), Application of crystal field theory (colour of transition metal complexes, magnetic property of complexes), Jahn- Teller Effect.

Unit – III: Wave Mechanics **[25 Marks]**
[15 Hours]

Derivation of time independent Schrodinger's Wave Equation, Conditions for acceptable wave function, Physical interpretation of ψ , ψ^2 and $\psi\,\psi^*$, Condition of Normalisation of wave function, condition of Orthogonality, Degeneracy, Orthonormal set of wave function, Operators, Operator algebra, Addition, Subtraction and multiplication of operators, commuting operators, commutators, Linear operator, Vector operator, Laplacian operator, Eigenvalue, Eigenvalue function and Eigen value equation, Postulates of quantum mechanics, time dependent Schrodinger's Wave Equation, Particle in one dimensional box, Zero point energy.

Unit – IV: (a) Non Aqueous solvents **[13 Marks]**
[8 Hours]

Introduction: Classification of Solvents; General Properties of Ionising Solvents.

Liquid Ammonia (NH3): Physical Properties, Auto-ionization, Acid-Base reactions, Ammonia as a proton – acceptor, Precipitation reactions, Complex formation reaction, Ammonolysis reactions, Reactions of Metal-Ammonia solution, Reduction – Oxidation (Redox) reactions, Advantages and disadvantages of using liquid Ammonia as a solvent.

Liquid SO_2: Physical Properties, solubility of Inorganic materials and Organic Compounds, Electrolytic conductance behaviour of solutions, Acid-Base reactions, Solvolysis, Precipitation reactions, Complex formation reactions, Reduction –Oxidation (Redox) reactions.

Liquid HF: Physical Properties, Solvent effect, Amphoteric behaviour, Precipitation reactions, Reduction –Oxidation (Redox) reactions, Solutions of Compounds of Biological Interest.

(b) Acids – bases **[12 Marks]**
[7 Hours]

Bronsted-Lowry concept of acid-base, Relative strength of acids and bases, Lewis concept, Hard and soft acids and bases, Introduction and their

classification, Characteristics of hard and soft acids and bases, Pearson's HSAB principle, Applications of HSAB principle, Limitations of HSAB principle.

REFERENCE BOOKS

1. '**Concise Inorganic Chemistry**' by J. D. Lee, 5th Ed., 2013, Wiley India.

2. '**Basic Inorganic Chemistry'** by F. A. Cotton, Geoffrey Wilkinson, Carlos A Murilloand Manfred Bochmann, 6th Ed., Wiley publication.

3. '**Inorganic Chemistry'** by Shriver & Atkins, 5th Ed., 2013, Oxford University Press.

4. **'Modern Inorganic Chemistry'** by Dr. R. D. Madan, 1987, S. Chand, New Delhi.

5. **'Principles of Inorganic Chemistry'** by Puri, Sharma and Kalia, 2018, Vishal Publishing Co., Jallandhar – Delhi.

6.'**Introductory Quantum Chemistry'** by A. K. Chandra, 4th Ed., 2017, Tata Mc Graw Hill PublishingCompany Limited, New Delhi.

7.'**Quantum chemistry'** by R. K. Prasad, 2nd Ed.,1996, New Age International publishers.

8.'**Elements of Quantum Mechanics**' by Michael D. Fayer, Indian Ed., 2001, Oxford University Press.

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Discipline specific Courses – Core (Major)	DSC-C-CHE 232T Physical Chemistry	4	4	2.0	50	50	100

DSC – C – CHE 232T
PHYSICAL CHEMISTRY

Learning Objectives:

- To understand the fundamental concepts of thermodynamics, Energy, work and enthalpy.
- To study zeroth and first law of thermodynamics and its application.
- To understand reaction rate, molecularity and order of reaction.
- To study the derivation of integrated expression of zero, first and second order kinetic equation.
- To know the concepts of colloids and classification of colloids.
- To understand the fundamental concepts of miscelles and dialysis.
- To study the basic concepts of adsorption and catalysis
- To understand fundamentals of transport numbers and Conductometric titration.

Learning outcomes:

By the end of the course, the students will be able to:

- Solve the problems of Heat, energy, work, enthalpy and bond energy.
- Derive different equations for zeroth and first law of thermodynamics.
- Solve the problems regarding rate and order of reaction.
- Understand different types of complex reaction in chemical kinetics.
- Learn properties and application of colloids.
- Know dialysis, electro dialysis and tyndall effect
- Understand the mechanisms of adsorption and catalysis.
- Study activity and activity co-efficient.

B. Sc. SEMESTER III
DSC – C – CHE 232T
PHYSICAL CHEMISTRY

Unit – I: Thermodynamics **[25 Marks]**
[15 Hours]

Thermodynamics terms, Intensive and extensive properties, state and path functions, isolated, closed and open systems, 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, 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.

Heats of reactions: standard states, enthalpy of formation of molecules and ions and enthalpy of combustion and its applications, calculation of bond energy, bond dissociation energy and resonance energy from thermochemical data, effect of temperature (Kirchhoff's equations) and pressure on enthalpy of reactions. Adiabatic flame temperature, explosion temperature.

Unit – II: Chemical Kinetics **[25 Marks]**
[15 Hours]

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

Unit – III: Colloidal state **[25 Marks]**
[15 Hours]

Difference between true solution, Colloidal solution and suspension, Phase of colloidal solution, Classification of colloids, Difference between lyophilic and lyophobic colloids, miscelles, preparation of colloids, dialysis, properties of colloidal solution, Tyndall effect, sedimentation, electrophoresis, origin of charge, double layer theory, protective colloids, gold number, emulsions, gels, determination of molecular mass of colloids of colloidal particles, application of colloids.

Unit – IV: (A) Adsorption and catalysis **[13 Marks]**
[8 Hours]

Adsorption and its terms, Factor affecting the adsorption of gases by solids, Factor affecting the adsorption of solids from solution, Types of adsorption, Adsorption isotherms, Freundlich adsorption isotherm, application of adsorption. Catalysis: Catalyst, types of catalysis, positive and negative catalysis, homogeneous and heterogeneous catalysis, properties of catalytic surface active centers.

(**B) Electro chemistry:** **[12 Marks]**
[7 Hours]

Transference numbers, Determination of transport number, moving boundary method, result of transport number measurements, Determination of solubility by conductance measurement, Conductometric titrations, activity, activity co-efficient and ionic strength.

REFERENCE BOOKS

1. '**Elements of Physical Chemistry**' by Peter Atkins & Julio De Paula, 5/E, Indian Edition, OxfordUniversity Press.

2. '**Physical Chemistry**' by P. W. Atkins, 7/E, 2002, IndianEdition Oxford University Press.

3. '**Physical Chemistry**' by W. J. Moore, 6/E, 1996, MacGraw Hill Publication.

4. '**Principle of Physical Chemistry'** by Puri, Sharma & Pathania, 41/E, Vishal Publishers.

5. '**Essentials of Physical Chemistry'** by Bahl & Tuli, 22/E, S. Chand publication, New Delhi.

6. '**Advanced Physical Chemistry**' by Gurdeep Raj, 19/E, Goel Publishing House Meerut

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Discipline specific Courses – Core (Major)	DSC-C-CHE 233P	4	8	6	50	50	100

*** Practical Exam (3 Hour + 3 Hour = 6 Hour)**

*** DSC-C- CHE 233P = CHEMISTRY PRACTICAL**

N.B.: Each practical batch should have 10 students

No. of students per batch during practical exam = 10

B. Sc. SEMESTER III
CHEMISTRY
DSC – C – CHE-233P

Learning Objectives:

- To study the principles of inorganic qualitative analysis of inorganic mixtures.
- To know how to perform dry test and wet test for inorganic radicals.
- To understand the detection of positive and negative ions present in the inorganic mixtures.
- To study the group separation of positive radical.
- To know the different factors affecting the rate of reaction.
- To understand rate of reaction, order of reaction.
- To study the different types of adsorptions.
- To know the principles involved in different types of Conductometric titrations and calibration of conductometer.
- To understand basics of specific refraction, molar refraction, and viscosityof different liquids.

Learning outcomes:

By the end of the course, the students will be able to:

- Know the preparation of water extract and original solution of inorganic mixture.
- Identify positive and negative ion present in the inorganic mixture.
- Understand how to perform group separation of inorganic qualitative

analysis.

- Determine relative strength of acids and temperature coefficient.
- Operate and calibrate conductometer.
- Observe different types of conductance.
- Understand the theory and applications of different types of Conductometric titrations.
- Know how to use refractometer and viscometer.
- Find density, specific refraction, molar refraction and viscosity of different liquids.

DSC – C – CHE-233P
CHEMISTRY LAB – V

[50 marks]
[60 Hours]

Inorganic qualitative analysis for inorganic Mixture

Semi micro method of analysis of inorganic mixture containing four radicals (excluding phosphate, arsenite, arsenate, and borate (Pb^{+2}, Hg^{+2}, Cd^{+2}, Cr^{+3} only demonstrated, do not given as practical)

A minimum of twelve mixtures should be performed.

Inorganic Preparations

(1) Tetrammine cupric sulphate $[Cu(NH_3)_4SO_4]$. H2O

(2) Ferrous ammonium sulphate (Mohr's salt) $FeSO_4(NH_4)_2SO_4$. $6H_2O$

(3) Hexa-ammine nickel(II) chloride $[Ni(NH_3)_6]$ Cl_2

(4) Potash Alum $K_2SO_4.Al_2(SO_4)_3$. $24H_2O$

(5) Sodium cobaltinitrite $Na_3[Co(NO_2)_6]$

Viva-Voce questions.

CHEMISTRY LAB – VI

[50 marks]
[60 Hours]

PHYSICAL CHEMISTRY PRACTICAL

(1) To determine the relative strength between HCl and H_2SO_4 by studying hydrolysis of methyl acetate.

(2) To determine the temperature coefficient of hydrolysis of methyl acetate catalyzed by acid.

(3) Study the kinetics of saponification of ethyl acetate.

(4) To study the adsorption of an organic acid by animal charcoal (Acetic acid/Oxalic acid).

(5) To study the partition coefficient of benzoic acid in kerosene.

(6) To determine water equivalent of thermos flask and heat of weak acid using strong acid and base.

(7) To determine cell constant of conductometer by using KCl solution.

(8) Conductometric titration of strong acid → strong base (HCl → NaOH)

(9) Conductometric titration of weak acid → strong base

(10) Conductometric titration of mixture of acids→ strong base (HCl + CH_3COOH) → NaOH)

(11) Determine the concentration of given X N $BaCl_2$ solution using 0.1 N K_2CrO_4 solution conductometrically.

(12) To determine specific refraction and molar refraction of liquid A, B and its mixture.

(13) PH Metric titration of X N HCL → 0.1 N NaOH

(14) To determine absolute viscosities of liquid A, B and its mixture.

(15) To determine the surface tensions of liquids by using stalagmometer.

Viva-Voce questions.

REFERENCE BOOKS

1. '**Vogel's Qualitative analysis' by G. Svehla,** Pearson Education Ltd., Seventh Edition,2009

2.'**Vogel's Textbook of Quantitative Chemical analysis'** Revised by G. H. Jeffery, J. Bassett, J. Mendham & R. C. Denney, ELBS (English Language Book Society) Longman. 5th Ed., New York.

3.**'Analytical Chemistry'** by Dhruba Charan Dash, 2011, 2th Ed., PHI Learning Private Ltd, New Delhi.

4.**'Analytical Chemistry' by Gary D. Christian,** 1986**,** 4th Ed., John Wiley & Sons.

5.'**Advanced Practical Inorganic Chemistry'** by Gurdeep Raj, 9th Ed., Goel Publishing House, Meerut.

6. **'Advanced University Practical Chemistry'** by P. C. Kamboj, Vishal Publishing Co., Jallandhar – Delhi.

7.'**Advance Physical Practical Chemistry'** by J. B. Yadav, Goel Publishing House, Meerut.

8. **'Advances Physical Chemistry Experiments'** by Gurtu – Gurtu, Pragati Prakashan, Meerut.