Semester	2
Paper Code	B1CH230212T; B1CH230212P
Paper Title	MINOR COURSE : GENERAL CHEMISTRY 2
No. of Credits	Theory – 3 Practical – 1
Theory/Composite	Composite
No. of periods assigned	Th: 3 Pr: 2
Name of Faculty member(s)	Dr. Sanjib Ganguly, Dr. Rahul Sharma, Dr. Koushik Sarkar
Course description/objective	Theory: 1. To enable students to develop a distinction between the macroscopic and microscopic viewpoints of matter. 2. They will develop the concepts of classical thermodynamics at the macroscopic level and learn through problem solving at different levels of complexity, after having a knowledge of the first law of thermodynamics and upto the second law of thermodynamics. 3. To get a basic idea about chemical equilibrium from the thermodynamic viewpoint. 4. To have basic knowledge about the wave mechanical model of an atom, the concept of Atomic Orbital and ground state terms. 5. To develop concepts on electrophilic addition and aromatic substitution reactions of organic compounds. Practical: 1. To develop skills and to understand the underlying principles in acid-base titrimetric analysis. 2. To develop skills and to understand the underlying principles in redox titrimetric analysis. 3. To develop skills and to understand the underlying principles in complexometric titrimetric analysis.
Syllabus	Annexure Minor Course 2
Learning outcomes	After completing this course, student will be able to 1. The relationship between microscopic properties of molecules with macroscopic thermodynamic observables 2. Solve conceptual questions using the knowledge gained by studying the quantum mechanical model of the atom, quantum numbers, electronic configuration, radial and angular distribution curves, shapes of s, p, and d orbitals. 3. To learn about various reactions on electrophilic addition and aromatic substitution reactions of organic compounds and solve the respective problems. 4. Explain the theory and application of acid-base, redox, complexometric titrimetric analysis. 5. prepare standard solutions for titration
Reading/Reference Lists	Theory: 1. Castellan, G. W. Physical Chemistry, Narosa.

	2. McQuarrie, D. A. & Simons, J. D. Physical Chemistry: A Molecular Approach, Viva. 3. Douglas, B.E. and McDaniel, D.H. Concepts & Models of Inorganic Chemistry Oxford, 1970. 4. Atkin, P. Shriver & Atkins' Inorganic Chemistry, 5th Ed., Oxford University Press (2010). 5. Winter, M. J., The Orbitron, http://winter.group.shef.ac.uk/orbitron/ (2002). An illustrated gallery of atomic and molecular orbitals. 6. Pfennig, B. W. (2015), Principles of Inorganic Chemistry. John Wiley & Sons. 7. Sykes, P. *A guidebook to Mechanism in Organic Chemistry,* Pearson Education, 2003. 8. Morrison, R. N. & Boyd, R. N. *Organic Chemistry*, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education). Practical: 1. Mendham, J., A. I. Vogel's Quantitative Chemical Analysis 6th Ed., Pearson, 2009. 2. Harris, D. C.; Lucy,C. A.(2016), Quantitative Chemical Analysis, 9th Edition, Freeman and Company	
Evaluation	Theory: 60 Internal: 15 (CIA: 10; Other form of Assessment: 2; Attendance: 3) Semester Exam:45 (Gr. A: 15; Gr. B:30)	Practical: 40 CA:38; Attendance: 2
Paper Structure for Theory Semester Exam	Gr. A: Attempt ONE out of TWO questions of 15 Marks each Gr. B: Attempt TWO out of THREE questions of 15 marks each.	

Chemical Thermodynamics 2 (12 Lectures)

1. Statement of Second law of Thermodynamics and their equivalence.
2. Carnot's cycle and Carnot's theorem.
3. Entropy revisited, Absolute scale of temperature.
4. Clausius inequality, condition of reversibility and irreversibility of a process.
5. Auxiliary state functions: Helmholtz free energy and Gibbs free energy and their simple applications.
6. Laws of Thermochemistry and their applications, Born Haber Cycle, Standard Enthalpy changes in various transformations, Kirchoff relation.
7. Maxwell's relation, $C_p - C_v$ relation, Joule-Thompson coefficient for van der Waals gases
8. Thermodynamic Equation of state.
9. Gibbs- Helmholtz relation and its application
10. Chemical Equilibrium: State of equilibrium and thermodynamic condition of equilibrium

11. Condition of Minimum Gibbs' potential,
12. van't Hoff reaction isotherm (deduction using chemical potential).
13. Temperature dependence of Equilibrium constant.
14. Homogeneous equilibrium: Use of different standard states to define K_p, K_x, and K_c and their interrelations
15. Examples of homogenous equilibrium in gas phase.

Extra nuclear Structure of atom (12 Lectures)

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de Broglie equation, Heisenberg's Uncertainty Principle and its significance, Schrödinger's wave equation, significance of ψ and ψ2. Quantum numbers and their significance. Radial and angular wave functions for hydrogen atom. Radial and angular distribution curves. Shapes of s, p, d and f orbitals. Pauli's Exclusion Principle, Hund's rules and multiplicity, Exchange energy, Aufbau principle and its limitations.

Electrophilic addition and Aromatic Substitution Reactions (12 Lectures)

Electrophilic addition reactions (6 Lectures)

Alkenes: Reactions and mechanism-- Addition of bromine, addition of HX [Markownikoff's (with mechanism) and anti-Markownikoff's addition], hydration: oxymercuration-demercuration and hydroboration-oxidation reaction, cis-addition (alkaline KMnO4), ozonolysis, 1,3-dipolar cycloaddition, click reaction.

Aromatic Substitution Reactions (6 Lectures):

Electrophilic substitution (general mechanism); nitration (with mechanism), halogenations (chlorination and bromination), sulphonation and Friedel-Craft's reaction (alkylation and acylation) (up to 4 carbons on benzene); Reimer -Tiemann reaction, Houben–Hoesch condensation, Schotten–Baumann reaction, Fries rearrangement and Claisen rearrangement. Nucleophilic aromatic substitution, cine substitution.

CC: 2 (Practicals) 24 Lectures

Acid and Base Titrations:

1. Standardization of NaOH using oxalic acid.

2. Standardization of HCl/acetic acid using standardized NaOH.

3. Estimation of carbonate and hydroxide present together in mixture.

4. Estimation of carbonate and bicarbonate present together in a mixture.

5. Estimation of NH_4^+ by formol titration.

6. Standardization of potassium permanganate by oxalic acid

7. Estimation of Fe(II)/ Fe(III) in a solution

8. Standardization of EDTA using zinc acetate solution.

9. Estimation of hardness of water