Semester	**3**
Course	**Major**
Paper Code	C2CH230312T
Paper Title	Physical Chemistry 2
No. of Credits	3 Theory+1 Practical
Theory / Practical / Composite	Composite
Minimum No. of preparatory hours per week a student has to devote	10
Number of Modules	03
Syllabus	*Module 1. Chemical Thermodynamics II (12 Lectures)* 1. Need for the Second Law: reversibility and spontaneity of a process 2. Caratheodory's principle 3. Principle of increase in entropy of the universe in natural processes 4. Clausius inequality 5. heat engine and refrigerator 6. Entropy change of the universe and maximum work for reversibility 7. Carnot cycle, efficiency 8. Kelvin-Plank and Clausius Statements of the second law; their equivalence: impossibility of attaining absolute zero of temperature 9. Carnot theorem 10. Combined first and second law 11. Thermodynamic equations of states 12. Auxiliary state functions – Gibbs and Helmholtz free energies, calculation in their change in different types of processes 13. Maxwell relations 14. Revisiting Joule-Thomson experiment: isenthalpic lines and T-P diagram 15. Temperature dependence of Gibbs free energy: Gibbs-Helmholtz equations 16. Gibbs free energy of real gases and fugacity 17. Chemical potential of pure substances 18. Partial molar quantities 19. Gibbs-Duhem equation *Module 2: Quantum Mechanics II (12 Lectures)* 1. Operators, Linear operators 2. Hermitian operators: definition and properties

	3. Postulates of Quantum Mechanics 4. Schrödinger equation 5. Solution of Schrödinger equation as wave function and energy (eigenvalues and eigenfunctions) 6. Commutators and their implication with respect to x, px. 7. Expectation values 8. Properties of eigenfunctions 9. Energy quantization 10. Simple systems: 1-D, 2-D, 3-D box (eigenvalues, eigenfunctions, expectation values, quantum numbers, degeneracy, probability density) 11. Simple Harmonic Oscillator: Setting the Schrödinger equation, derivation, eigenvalues and eigenfunctions, zero-point energy 12. Tunneling- Basic concepts *Module 3: Electrochemistry I (12 Lectures)* 1. Flow of charge through conductor: metallic and electrolytic conduction 2. Week and strong electrolytes: Arrhenius classification 3. Forces on an ion and its dynamics in an ideal solution across an applied potential difference 4. Validity of Ohm's law and resistance equation in electrolytic solution 5. Conductance, specific conductance, equivalent conductance and their inter-relation 6. Mobility of ions in ideal solution: inter-relation to conductance, specific conductance and equivalent conductance 7. Reason for choosing conductance instead of resistance 8. Variation in conductance, specific conductance and equivalent conductance with concentration variation in ideal solution of strong and weak electrolytes 9. Effect of dilution, dielectric constant of solvent, viscosity of solvent and temperature on conductance of strong and weak electrolytes 10. Origin of non-ideality in electrolytic solution: activity and mean ionic activity of an electrolyte 11. Electrophoretic effect: effect of non-ideality on viscous force acting on an ion in electrolytic solution 12. Asymmetric effect: effect of local electric field due to asymmetric ionic atmosphere 13. Debye-Huckel limiting law: expression of mean ionic activity coefficient in ideally dilute solution 14. Determination of acidity constant of a weak acid: Ostwald dilution law, ionic product of water, determination of ionic radii 15. Infinitely dilute solution and withdrawal of ion-ion interaction in electrolytic solution: Kohlrausch's law 16. Transport number and its determination: Hittorf and moving boundary method

	17. Effect of concentration and temperature variation on transport number 18. Abnormal transport number 19. True and apparent transport number 20. Conductometric acid-base and precipitation titrations **Practicals:** 1. Study of first order kinetics of decomposition of H_2O_2 by clock method 2. Study of kinetics of hydrolysis of esters by titrimetric method 3. Kinetics of base catalysed ester hydrolysis by conductometric method 4. Determination of thermodynamic solubility product of KHTa 5. pH-metric estimation of monobasic and dibasic acid and determination of pK_a or pK_2, wherever applicable 6. Determination of solubility product of a sparingly soluble salt (AgCl) by conductometric method.
Learning Outcomes	Theory: 1. They will also develop the concepts of classical thermodynamics at the macroscopic level and learn through problem solving at different levels of complexity. 2. The Schrodinger equation will be introduced with the ground work of operators. Some examples with zero and non-zero potentials will be discussed. Solution of the corresponding Schrodinger equation, leading to the eigenstates and corresponding eigenvalues will be analysed. 3. The focus here is on molecular motion. The concept of flux and the relation between flux and force will be introduced. Expressions will be derived that govern the migration of properties through

	matter. One of the most useful consequences of this general approach is the formulation of the diffusion equation. Practicals: 1. Study of kinetics titrimetrically and conductometrically 2. Study of solubility product of sparingly soluble salts titrimetrically and conductometrically.	
Reading/Reference Lists	1. Glasstone, S, Thermodynamics for Chemists, EWP. 2. Zemansky, M. W. & Dittman, R.H. Heat and Thermodynamics, TataMcGraw-Hill. 3. Denbigh, K. The Principles of Chemical Equilibrium Cambridge University Press. 4 Nag, A. K, Physical Chemistry Vol. 1, 2, Mcgraw Hill. 5. Klotz, I.M., Rosenberg, R. M. Chemical Thermodynamics: Basic Concepts and Methods, Wiley. 6. Sears, F. W., Salinger, G. L., Thermodynamics, Kinetic Theory, and Statistical Thermodynamics (Addison-Wesley Principles of Physics Series), Pearson; 3rd edition 7. Metiu, H., Physical Chemistry: Thermodynamics, Taylor and Francis. 8. Kaufman, M., Principles of Thermodynamics, Taylor and Francis. 9. Honig, J. M., Thermodynamics, Academic Press. 10. Glasstone, S. An Introduction to Electrochemistry, East-West Press. 11. Levine, I. N. Quantum Chemistry, PHI. 12. Atkins, P. W. and Friedman, Molecular Quantum Mechanics, Oxford. 13. Eisberg, R., Resnick, R, Quantum Physics of Atoms, Molecules, Solids, Nuclei and Particles, 2ed, Wiley. 14. Griffiths, D. J., Introduction to Quantum Mechanics, Cambridge India. 15. Heimz, P. C., Rajagopalan, R., Principles of Colloid and Surface Chemistry, Marcel Dekker. Practicals: 1. Mukherjee, G. N., University Hand Book of Undergraduate Chemistry Experiments	
Evaluation	Theory: 60 Internal: 15 (CIA: 10; Other form of Assessment: 2; Attendance: 3) Semester Exam: 45	Practical: 40 CA: 30 ; Attendance:2 Semester Exam: 8
Paper Structure for Theory Semester Exam	Answer SEVEN out of NINE questions, of 10 marks each.	