Semester	**6**
Course	**Major**
Paper Code	C3CH230632T / C3CH230632P
Paper Title	Physical Chemistry 5
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 I: Phase Equilibria and Colligative Properties (12 Lectures)** 1. Definition of phase and thermodynamic condition of equilibrium between phases 2. Components and degrees of freedom 3. Phase rule and its derivation 4. Phase equilibrium for one component system (for example H_2O, S, CO_2) 5. Degrees of freedom at different regions of the phase diagram: interpretation of area, line and point in the phase diagram 6. Position of triple point in phase diagram and prediction of melting or sublimation of a pure substance 7. First and second order phase transitions 8. Clapeyron equation 9. Clausius-Clapeyron equation 10. Trouton's rule 11. Liquid-vapor equilibrium for two component system: ideal solution 12. Non-ideality, azeotrope 13. Raoult's law and vapour pressure of a two component ideal solution 14. Non-volatile solute: Raoult's law of relative lowering of vapour pressure 15. Effect of addition of non-volatile solute on boiling point 16. Change in phase diagram due to addition of solute in a pure liquid: effect on freezing and boiling point of the solute 17. Chemical potential versus temperature line of one component system existing in three different phases

	18. phase transition temperature and its variation due to addition of non-volatile solute that does not solidify with the solvent 19. Variation of phase transition temperature with pressure 20. Thermodynamic derivation of boiling point elevation 21. Addition of solute that does not solidify with solute: thermodynamics of freezing point depression 22. Freezing point elevation and boiling point depression 23. Osmotic pressure of a solution: thermodynamic derivation 24. Vapour pressure versus mole fraction (in liquid and vapour) diagram 25. Non-ideality in two component system: implication in vapour pressure diagram 26. Henry's law 27. Duhem-Margules equation and its consequences 28. Constant boiling mixture 29. Two component partially miscible solution: Critical solution temperature 30. Lever rule and its application 31. Freezing point diagram: simple eutectic systems 32. Compound formation: implication in freezing point diagram 33. Ideal solution and ideally dilute solution **Module II: Spectroscopy 1 (12 Lectures)** 1. Spectroscopy- Nature of electromagnetic radiation, range of wavelength 2. Quantum mechanical picture of light-matter interaction: first order perturbation theory 3. Transition moment integral and allowed transitions 4. Einstein coefficient for spontaneous and stimulated transition 5. Stimulated emission and lasers and 3-level system 6. Width and intensity of transition, line broadening (Uncertainty broadening) 7. Rotational spectroscopy: rigid and non-rigid rotors (diatomic only) 8. Selection rule and spectrum 9. Isotope effect

	10. Hyperfine structure (effect of nuclear spin) **Module III: Hydrophilic Colloids (12 Lectures)** 1. Surfactants: variation in surface tension of water with surfactant addition. 2. Thermodynamics of interfacial adsorption: Gibbs adsorption isotherm. 3. Surface excess concentration: determination and significance. 4. Self-aggregation of surfactants in aqueous solution: micellization. 5. Spontaneity of micellization: iceberg model. 6. Types of surfactant: variation in cmc within homologous series. 7. Thermodynamics of micellization: mass action and pseudo-phase model. 8. Surfactant structure and shape of aggregate: packing fraction. 9. Viscosity of liquids. 10. Temperature dependence of viscosity of liquid. 11. Poiseuille equation and Measurement of viscosity. **Practical** 1. pH-metric estimation of amino acid (Glycine) 2. Determination of formal potential of Fe^{3+}/Fe^{2+} system using potentiometry 3. Determination of solubility product of $AgCl$ by potentiometry 4. Determination of concentration of strong and a weak acid in a mixture by conductometric method 5. Verification of Ostwald dilution law 6. Kinetics of perdisulphate-KI reaction using spectrocolourimeter
Learning Outcomes	**Theory:** 1. Concept of ideal solutions and formulation of Raoult's and Henry's laws. From this, the effect of a solute on certain thermodynamic properties of the solution will be discussed. Application to phase equilibria governed by the famous phase rule of Gibbs, which shows the extent to which various parameters can be varied with preservation of the equilibrium between phases. Application to systems of

	gradually increasing complexity with the help of phase diagrams. 2. After eigenstates and eigenvalues have been obtained from quantum mechanical recipes, transitions between the energy levels resulting from interaction with electromagnetic radiation, become very important. Students will be exposed to selection rules governing transitions, unravelling of molecular parameters, explanation of intensity patterns and ratios, presence of isotopes etc. The focus will be on rotational excitation of the molecules. 3. Colloids, forming a micro heterogeneous phase deserve a separate treatment in terms of stability and coagulation, scattering power, double layered potential and various electrokinetic phenomena. Soft colloidal systems will also be dealt with in sufficient detail. **Practical:** 1. Various experiments involving measurement of strengths of solutions, solubility product and reaction rate constants are determined using potentiometric, pH-metric, potentiometric and conductometric methods.
Reading/Reference Lists	**Theory:** 1. Castellan, G. W. Physical Chemistry, Narosa. 2. Levine, I. N. Physical Chemistry, Tata McGraw-Hill. 3. Moore, W. J. Physical Chemistry, Orient Longman. 4. Glasstone, S, Thermodynamics for Chemists, EWP. 5. Denbigh, K. The Principles of Chemical Equilibrium Cambridge University Press. 6. Silbey, R. J. Alberty, R. A. Bawendi, M. G., Physical Chemistry, Wiley. 7. Banwell, C. N. Fundamentals of Molecular Spectroscopy, Tata McGraw-Hill. 8. Barrow, G. M. Molecular Spectroscopy, McGraw-Hill. 9. Hollas, J.M. Modern Spectroscopy, Wiley India. 10. McHale, J. L. Molecular Spectroscopy, Pearson Education. 11. Wayne, C. E. & Wayne, R. P. Photochemistry, OUP. 12. Brown, J. M. Molecular Spectroscopy, OUP. 13. Heimz, P. C., Rajagopalan, R., Principle of Colloid and Surface Chemistry, Marcel Dekker. 14. Shaw, D. J., Introduction to Colloid and Surface Chemistry, Butterworth Heinemann. 15. Ohshima, H., Theory of Colloid and Interfacial Electric Phenomena, Elsevier. **Practicals:**

	16. 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: 38; Attendance:2
Paper Structure for Theory Semester Exam	Answer THREE out of FOUR questions, of 15 marks each.	