**University of Kerala**

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| Discipline | CHEMISTRY | | | | |
| Course Code | **UK3DSCCHE200** | | | | |
| Course Title | **PHYSICAL CHEMISTRY I** | | | | |
| Type of Course | **DSC** | | | | |
| Semester | 3 | | | | |
| Academic Level | 200 – 299 | | | | |
| Course Details | Credit | Lecture per week | Tutorial per week | Practical per week | Total Hours/Week |
| | 4 | 3 hours | - | 2 hours | 5 |
| Pre-requisites | 1. Higher secondary level science knowledge<br>2. Basic understanding of calculus is preferred. | | | | |
| Course Summary | This physical chemistry course covers a broad range of topics including solid state, liquid state, gaseous state, dilute solutions, and colloids, providing students with a comprehensive understanding of the properties and behaviours of matter at various states and concentrations. Through theoretical principles and practical experiments, students gain insights these topics and to apply their knowledge to solve real-world problems. | | | | |

**Detailed Syllabus:**

| Module | Unit | Content<br>PHYSICAL CHEMISTRY I | Hrs<br>75 |
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| **I** | **SOLID STATE** | | **9** |
| | 1 | Amorphous and Crystalline solids. Isotropy and anisotropy, size and shape of crystal, Interfacial angle, types of crystals: molecular crystals, ionic crystals, covalent crystals and metallic crystals- examples and properties. | 2 |
| | 2 | Symmetry of crystals- plane of symmetry, axis of symmetry, centre of symmetry (definitions and basic idea only), Seven basic crystal systems, Space lattice and unit cell, Bravais lattices, (unit cell parameters and examples of 14 Bravis lattices), close packing structures of cubic and orthorhombic space lattices. | 2 |
| | 3 | Law of constancy of interfacial angles, Laws of rational indices, Miller indices, Representation of lattice planes of cubic crystals, interplanar spacing in crystals, Determination of Avogadro number from crystallographic data | 2 |
| | 4 | X-ray diffraction studies of crystals, Bragg's equation – derivation and applications, Rotating crystal and powder method. Structure of NaCl and CsCl, Imperfections in crystals. Stoichiometric and | 2 |

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| | | Nonstoichiometric defects, point defects – Schottky and Frenkel defects, F-centre | |
| | 5 | Energy band theory of Conductor, Semiconductors and insulators, Glasses | 1 |
| **II** | **LIQUID STATE** | | **9** |
| | 6 | Physical properties of liquids; vapour pressure, surface tension, viscosity, and Refractive Index and their determination. Factors affecting surface tension and viscosity, Interfacial tension, Surface active agent, Explanation of cleansing action of detergents. | 3 |
| | 7 | Determination of Surface tension- capillary rise and stalagmometer method<br>Viscosity- Poiseuilles equation, Determination of viscosity- Ostwald's viscometer<br>Refractive index determination by Abbe refractometer | 3 |
| | 8 | Liquid crystals- introduction, characterization of liquid crystals, Types –smectic, nematic and cholesteric liquid crystals- examples; Disc shaped liquid crystals, Polymer liquid crystals. uses of liquid crystals | 3 |
| **III** | **GASEOUS STATE** | | **9** |
| | 9 | Ideal gas, Ideal gas equation, gas constant: values in different units ($JK^{-1}mol^{-1}$, L atm $K^{-1}mol^{-1}$, cal $K^{-1}mol^{-1}$)<br>Dalton' Law of Partial pressure- Definition and mathematical expression.<br>Postulates of Kinetic theory of Gases 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; variation of viscosity with temperature and pressure. | 2 |
| | 10 | Maxwell distribution and its use in evaluating molecular velocities (average, root mean square and most probable) and average kinetic energy, law of equipartitions of energy and degrees of freedom. | 2 |
| | 11 | 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 behaviour. Z-P plots of ideal gas and the real gases $H_2$, He, $NH_3$, CO and methane at 0°C, Z-P plots of $N_2$ at several temperatures. | 2 |
| | 12 | Vander Waals equation of state, its derivation and application in explaining real gas behaviour. Vander Waal's equation at low and high pressures and at high temperature. | 1 |
| | 13 | Law of corresponding states, liquefaction of gas, inversion temperature PV isotherm of Carbon dioxide, critical state, relation between critical constants and van der Waals constants, Correction factors, Experimental determination critical constants, Boyle temperature, Boyle temperature in terms of van der waal's constant. Virial equation of state and virial coefficients. (no derivations). | 2 |
| **IV** | **DILUTE SOLUTIONS AND COLLOIDS** | | **18** |

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| | 14 | Dilute solutions: Binary solutions, Concentration- Molarity, Molality, Normality and Mole fraction. (numerical problems) | 2 |
| | 15 | Raoult's Law for solutions of non-volatile solutes, vapour pressure of ideal solutions and relative lowering of vapour pressure. | 1 |
| | 16 | Colligative properties- lowering of vapour pressure; elevation of boiling point and depression in freezing point; molal elevation constant, molal depression constant, Thermodynamic derivation of $\Delta T$; Osmosis and Osmotic pressure, van't Hoff equation; Isotonic, hypertonic and hypotonic solutions, Abnormal molecular mass and van't Hoff factor, Determination of degree of dissociation and association, Reverse osmosis (numerical problems). | 4 |
| | 17 | Experimental determination of molecular mass of solutes by cooling curve method, Rast's and Beckmann methods | 2 |
| | 18 | **Colloids:** Classification of colloids – Preparation of colloids | 2 |
| | 19 | Purification of colloids – dialysis, electrodialysis, hot dialysis, ultra filtration ultra centrifugation | 2 |
| | 20 | Kinetic, optical and electrical properties of colloids – Tyndall effect & applications - Ultra microscope, Electrical double layer and zeta potential - Coagulation of colloids, Hardy-Schulz rule, Gold number, sedimentation and streaming potential | 3 |
| | 21 | Gels: Elastic and non-elastic gels, Imbibition and syneresis, Micelles and critical micelle concentration | 1 |
| | 22 | Application of colloids – Cottrell precipitator, purification of water and delta formation. | 1 |
| **V** | **PRACTICALS: PHYSICAL CHEMISTRY PRACTICALS** | | **30** |
| | | **A minimum of 8 practical experiments (Minimum one each from A & B)** | |
| | 23 | **A. Lowering of freezing point**<br>1. Determination of $K_f$ of solid solvent using a solute of known molecular mass. (Solvent: Naphthalene, biphenyl) (Solute: Naphthalene, biphenyl, 1,4-dichlorobenzene, diphenylamine)<br>2. Determination of molecular mass of the solute using a solvent of known $K_f$. (Solvent: Naphthalene, biphenyl) (Solute: Naphthalene, biphenyl, 1,4-dichlorobenzene, diphenylamine) | 8 |
| | 24 | **B. Depression of transition temperature**<br>3. Determination of molal transition point depression constant (Kt) of salt hydrate using solute of known molecular mass. (Salt hydrates: sodium thiosulphate penta hydrate, hydrated sodium acetate) (solutes: Urea, Glucose).<br>4. Determination of molecular mass of the solute using a solvent of known molal transition point depression constant (Kt). (Salt hydrates: sodium thiosulphate penta hydrate, hydrated sodium acetate) (solutes: Urea, Glucose) | 8 |
| | 25 | **C. Surface tension:**<br>5. Determination of Surface tension of any three liquids | 4 |

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| | | 6. Surface tension of binary mixtures and determination of concentration of an unknown mixture | |
| | 26 | **D. Viscosity:**<br>7. Determination of viscosity of any three liquids<br>8. Viscosity of binary mixtures and determination of concentration of an unknown mixture | 4 |
| | 27 | **E. Refractive index experiments:**<br>9. Determination of refractive indices of any three liquids<br>10. Refractive indices of KCl solutions of different concentrations and determination of concentration of unknown KCl solution | 4 |
| | 28 | **F. Solid state:**<br>11. Indexing powder XRD patterns and determination of unit cell parameters of simple and/or bcc and/or fcc systems (Instructors must provide the powder XRD patterns and ask students to index it and calculate unit cell parameters) | |

**References:**

**Textbooks**


1. P W Atkins, "*Physical Chemistry*", Oxford University Press
2. R L Madan, *Physical Chemistry*, Mc Graw Hill
3. Glasstone and Lewis, *Elements of Physical Chemistry*, Macmillan
4. Puri, Sharma & Pathania, *Principles of Physical Chemistry*, Vishal Publishing Co
5. P. C. Rakhit, *Physical Chemistry*, Sarat Book House, Calcutta
6. J. B. Yadav *Advanced Practical Physical Chemistry*, Krishna Prakashan Media (P) Ltd


**For Further Reading**


1. R J Selby and RA Alberty, *Physical Chemistry*, John Wiley &sons
2. Levin, *Physical Chemistry*, 5th edn, TMH.
3. Gurdeep Raj, *Advanced Physical Chemistry*, Goel publishing house
4. G W Castellan, "*Physical Chemistry*", Narosa Publishing House
5. B. Viswanathan, P. S. Raghavan, *A Practical Physical Chemistry*, Viva Books.


**Course Outcomes**

| No. | Upon completion of the course the graduate will be able to | Cognitive Level | PSO addressed |
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| CO-1 | Critically analyze the structural distinctions and physical properties of crystalline and amorphous solids through symmetry concepts, crystallographic parameters, packing arrangements, X-ray diffraction techniques, and defect analysis to interpret their influence on material behavior and electronic properties. | An | PSO -1,2,3 |