Course: M.Sc (Physics)

Semester	3
Paper Number	11 (MPHI4301)
Paper Title	Interdisciplinary: Physics of Soft Matter
No. of Credits	6
Course description/ objective	This course aims to introduce concept of forces, energies and time scales in condensed matter, introduce methods of medaling in soft matter. It also aims to introduce the random walk method to model transport in disordered materials and introduce the interplay of forces that are responsible for the self-assembly of particles in soft matter CO5: Expose how mechanical machinery works in biological systems
Course Outcome	CO1: The students shall recognize what may be defined as soft matter based on different length scales, response time scales, the different forces that help in self aggregation that is typical to soft matter. CO2: Modelling schemes based on lattice model, random walk, should give confidence to simulate complex growth schemes and dynamics of particles. CO3: Characteristics typical of colloids, liquid crystals and polymers shall be known CO4: This course will also enable the students to suitably model biological systems that have similar properties
Syllabus	**Interdisciplinary: Physics of soft matter[36 Lectures]** Soft matter: Introduction and Overview on soft matter systems: liquid crystals, colloidal systems, biological membranes, macro- molecules. [2 lectures] Forces, energies and time scales in condensed matter, Gases, liquids and solids - intermolecular forces, condensation and freezing. Viscous, elastic and visco-elastic behaviour response of matter to a shear stress [4 lectures] Macromolecules: DNAs-: Flory's model of DNA condensation; Polymorphism of liquid crystal states by low molecular mass double stranded DNA complexes; DNA condensation in water-polymeric solution; biological activity, Numerical methods for studying soft matter [5 lectures] Random walks, friction and diffusion: Brownian motion, other random walks: diffusion in the sub cellular world, equation for diffusion, precise statistical prediction of random processes, biological applications of diffusion. [6 lectures] Colloidal dispersions: Introduction, single colloidal particle in a liquid, Stokes' law, Brownian motion and Stokes-Einstein equation. Forces between colloidal particles – inter-atomic forces and inter-particle forces, van der Waals forces, electrostatic double layer forces. Self assembly in soft condensed matter: Introduction, self assembled phases in solutions of ampiphilic molecules. [8 lectures] Soft matter in nature: Biological polymers, nucleic acids, nucleic acid conformation – DNA, RNA, Proteins, stretching single macromolecules, Protein folding. [4 lectures] Enzymes and molecular machines: Molecular devices found in cells, purely mechanical machines, molecular implementation of mechanical principles, kinetics of real enzymes and machines. [4 lectures] Biological membranes: Electrosmotic effects, ion pumping, mitochondria as factories, powering flagellar motors. [3 lectures]

References	1. Soft Condensed Matter, Richard AL Jones, Oxford University press, 2002. 2. Biological Physics, Energy, Information, Life, Philip Nelson, 2002. 3. Principles of Condensed Matter Physics, PM Chaikin and TC Lubensky, Cambridge University press, 1995. 4. Biophysics - An Introduction, Rodney Cotterill, John Wiley, 2003.
Evaluation	Total: 50 CIA: 10 marks End Semester Examination: 40 marks