M. Sc. Physics Examination, 2022

(2nd Year, 2nd Semester)

Soft Condensed Matter Physics

Paper – PG/SC/CBS/PHY/TH/305

Time : Two hours Full Marks : 40

Answer ***any four*** questions.

1. a) What are soft materials? Give at least three characteristic features of soft materials.
   b) Define tensor order parameter quantifying the degree of molecular ordering.
   c) Why do liquid crystalline materials show birefringence?
   d) Why does beautiful texture appear when we looked at the liquid crystalline material under cross polarizer? (1+3)+2+2+2
2. a) What are the basic assumptions of Landau theory? Explain nematic to isotropic phase transition using Landau phenomenological theory.
   b) What are amphiphilic molecules? Explain why do these molecules lead to self-assembly in aqueous solvent? (2+5)+(1+2)
3. a) Define mean and Gaussian curvature of the membrane? What is the origin of spontaneous curvature? Write down the curvature elastic free energy of membrane.

b) What are the typical values of bending modulus and stretching modulus of the artificial membranes made from phospholipids.

c) Why hydrogen bonding is important in biological soft materials? What is the typical value of hydrogen bonding in soft materials? (2+2+2)+1+(2+1)

4. a) State the Stokes-Einstein equation for the diffusion of spherical particles. How does the diffusion co-efficient of soft materials, such as polymers and micelles, differ from that of the small molecules in a liquid? What do you mean by the hydrodynamic radius?

b) How does the degree of polydispersity affect the properties of soft matter? What do you mean by the polydispersity index?

c) Distinguish between condensation and addition polymerizations with the help of suitable examples. (2+1+2)+(2+1)+2

5. a) For the characterization of polymers, distinguish between the information obtained from wide-angle and small-angle X-ray scattering.

b) For an ideal or Gaussian polymer, how do you estimate the average size of the polymer chain? What will be the expression of its free energy?

c) Why do polyelectrolytes have extended rod-like conformation? Describe how polyelectrolyte hydrogels can swell up to several times their initial volume in water. 4+(2+1)+(1+2)

6. a) What will be the difference between the size of colloidal particles acquired from transmission electron microscopy and dynamic light scattering? Explain.

b) Explain the basic concepts of the DLVO theory.

c) What do you mean by the zeta potential of colloidal particles? Describe with a suitable diagram, how the potential varies with the distance from the surface of the colloid.

d) What advantages does steric stabilization of colloids have over charge stabilization? 2+3+(2+1)+2