2025-05-05

INTRODUCTION TO SOFT MATTER PHYSICS

Dept of Physics-SEAS

SRM University-A.P

Registration Number: _____

Name: _____

Branch & Section: _____

SRM UNIVERSITY AP
Andhra Pradesh

SRM UNIVERSITY – AP, ANDHRA PRADESH

End Term Examination, May 2025

[Question Paper ID: **008783**]

Subject Title	:	INTRODUCTION TO SOFT MATTER PHYSICS	**Subject Code**	:	PHY 422
Batch	:	2022	**Max Marks**	:	50
Degree	:	B.Sc.	**Duration**	:	2 hours
Branch	:	Scie.	**QP Set**	:	---

Part A, (4 × 5 Marks = 20 Marks)

Answer **all** Questions

		Marks	BL	CO
1.	Define shear stress (σ) and shear strain (γ) in the context of the mechanical properties of a matter. For an ideal elastic material and ideal fluid, how σ and γ are related. If a material is kept constant σ for a time $t = 0$ to $t = t_0$, plot the response $\gamma(t)$ as functions of t for (a) polymeric gel and (b) polymeric fluid.	**5**	**5**	**1**	**4**
2.	The distribution end-to-end vector r of a freely jointed polymer is given by $$P(\vec{r}) = \left(\frac{3}{2\pi N b^2}\right)^{3/2} \exp\left(-\frac{3\vec{r}.\vec{r}}{2Nb^2}\right).$$ If the polymer is in a thermal bath of temperature T, find the expression of the therma force $\vec{f}$ to maintain the end-to-end distance $\vec{r}$.	**5**	**5**	**2**	**4**
3.	Consider the over-damped motion of a Brownian particle. Show that the mean squared displacement $\langle x(t)^2\rangle - \langle x(t)\rangle^2 \propto t$. What is the significance of proportionality constant?	**5**	**5**	**3**	**4,5**
4.	State the center limit theorem. Consider a distribution with two outcomes $x = 0$ and $x = 1$ with $P(1) = p$. Find the mean $\langle x\rangle$ and the variance $(\langle x^2\rangle - \langle x\rangle^2)$. Now consider N such an independent distribution? For a large N, what is the distribution of the $y = \sum_{i=1}^{N} x_i$?	**5**	**5**	**3**	**4**

Part B. (3 × 10 Marks = 30 Marks)

Answer **any 3** Questions

		Marks	BL	CO
5.	Consider a system of N non-interacting spins $\{s_i = \pm 1\}$ in a magnetic field h at temperature T. The Hamiltonian is given by $H = h\sum_i s_i$. If $M = \sum_i s_i$ denotes magnetization, find the following quantities $\langle M\rangle$ and $\langle (M - \langle M\rangle)^2\rangle$.	**10**	**10**	**4**	**4**
6.	Consider the following deformation for a 2 dimensional material, $$x' = x + \gamma y,\ \ y' = \gamma y.$$ White down the deformation matrix E. The free energy of the deformation is given by $$f(E) = \frac{1}{2} n_c k_B T \left(\lambda_1^2 + \lambda_2^2 - 2\right),$$ where $\lambda_{1,2}^2$ is the Eigenvalues of the matrix EE^T and n_c is a constant. Find the shear modulus G of the matrial.	**10**	**10**	**3**	**4**
7.					

	Write down the equation of motion for a Brownian particle in a fluid at temperature T, explain each terms. What will be the average kinetic energy of the particle? Find the relation between the strength of random noise, the temperature of the fluid, and the viscous drag.	**10**	**10**	**3**	**1,4**
8.	Two micron-sized bead connected by a spring with force constant k and natural length l. Considering a one-dimensional motion, write down the overdamped dynamics of the positions x_1 and x_2 of the two beads. How does the average distance between two beads $x = x_1 - x_2$ and the center of mass $X = (x_1 + x_2)/2$ evolve as a function of time t.	**10**	**10**	**3**	**4**

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