Name: **Enrolment No:**	

UPES

End Semester Examination, December 2023

Course: M Sc (H) Physics **Semester: III**

Program: Magnetic nanostructures: Fabrication and Characterization **Time : 03 hrs.**

Course Code: PHYS8075P **Max. Marks: 100**

Instructions: All questions are compulsory

SECTION A
(5Qx4M=20Marks)

S. No.		Marks	CO
Q 1	Discuss the history of nanomaterials and their significance in the field of nanotechnology.	**4**	**CO1**
Q 2	A particle is confined in a one-dimensional box of length 5.0 nm. Calculate the energy of the particle in its ground state.	**4**	**CO1**
Q 3	Describe the energy at the nanoscale, focusing on surface characteristics and electrostatic and steric stabilization. How do these factors influence the behavior of nanomaterials?	**4**	**CO1**
Q 4	The Curie temperature for a ferromagnetic substance is 300K. If magnetic susceptibility of the substance is 0.6 at 450K temperature, then find out Curie constant.	**4**	**CO2**
Q 5	What is the Blocking Temperature in magnetic nanostructures? How does it relate to their magnetic properties, and why is it important in magnetism studies?	**4**	**CO2**
SECTION B **(4Qx10M= 40 Marks)**			
Q 6	Elaborate on the techniques of nanofabrication, including photolithography and its limitations, electron beam lithography, and nanoimprint.	**10**	**CO2**
Q 7	Discuss ferrofluids and their unique properties. How are ferrofluids used in practical applications, and what distinguishes them from other magnetic materials?	**10**	**CO2**
Q 8	Compare various magnetic measurement techniques, such as the Vibrating Sample Magnetometer, and SQUID. When and why would you choose a specific technique for characterizing magnetic nanostructures?	**10**	**CO3**
Q 9	Explain the role of X-ray-based techniques like X-Ray Magnetic Circular Dichroism and synchrotron radiation sources in characterizing magnetic nanostructures. **OR**	**10**	**CO3**

	What is the energy barrier (in eV) for a superparamagnetic material with a characteristic time of 5×10^{-10} seconds and a relaxation time of 1 second at 300 K? In this case, what is the blocking temperature of the material if the measurement time is 100 seconds?		
SECTION-C (2Qx20M=40 Marks)			
Q 10	Provide an in-depth discussion of Magneto-optical characterization, with a focus on Magneto-Optical Kerr Effect (MOKE). How can MOKE be used to study magnetic nanostructures, and what are its applications? **OR** You want to resolve features as small as 1 nm using electron beam lithography. Calculate the energy required for the electrons to achieve this resolution.	**20**	**CO3**
Q 11	Calculate the magnetic susceptibility (χ) of a material with a pre-exponential factor (ν) of 1×10^{12} s^{-1}, an activation energy (E_a) of 0.2 eV, and a temperature (T) of 500 K.	**20**	**CO3**