Name: Enrolment No:	

UPES

End Semester Examination, May 2024

Course: Nanomagnetic Materials and Applications **Semester: II**
Program: BSc + Integrated MSc **Time: 03 hours**
Course Code: PHYS 3044P **Max. Marks: 100**

Instructions:

- All questions are compulsory (**Q. No. 6** and **Q. No. 10** has an internal choice).
- All **highlighted** representations are **vector quantities**.
- Scientific calculators can be used for calculations.

SECTION A
(5Qx4M=20Marks)

S. No.		Marks	CO
Q 1.	Discuss the origin of nanomagnetic behavior.	**4**	**CO1**
Q 2.	Compare and contrast the magnetic behavior of small particles with that of bulk materials.	**4**	**CO1**
Q 3.	What is the Stoner-Wohlfarth model, and what does it propose about the behavior of magnetic materials?	**4**	**CO1**
Q 4.	For a different material, if χ is measured as 0.05 at 300 K, and E_a is 0.3 eV, calculate the pre-exponential factor (ν).	**4**	**CO1**
Q 5.	How does the Giant Magnetoresistance (GMR) effect revolutionize data storage technology? Explain with examples.	**4**	**CO2**

SECTION B
(4Qx10M= 40 Marks)

S. No.		Marks	CO
Q 6.	Discuss the concept of anisotropy in thin films, focusing on perpendicular and in-plane anisotropy. Provide examples and discuss their significance in material science and technological applications. **OR** Discuss the factors that contribute to the anisotropic behavior of electrical resistance in Anisotropic Magnetoresistance (AMR) materials.	**10**	**CO2**
Q 7.	Evaluate the potential of superparamagnetic particles in biomedical applications, highlighting recent advancements and challenges.	**10**	**CO1**
Q 8.	Discuss the principles of exchange bias and interlayer exchange coupling in thin films and multilayers.	**10**	**CO2**
Q 9.	Propose a combined experimental approach using both vibrating sample magnetometer (VSM) techniques to investigate the magnetic properties of a novel magnetic material, outlining the complementary information that each technique can provide and the experimental parameters to be considered.	**10**	**CO2**

SECTION-C (2Qx20M=40 Marks)			
Q 10.	Discuss the advancements in magneto-transport phenomena, focusing on tunnel magnetoresistance (TMR) and its applications. A tunnel junction consists of two ferromagnetic layers separated by a thin insulating barrier. The junction has an area of 100 nm^2 and a barrier thickness of 1 nm. The magnetization of one layer is fixed while the other layer can switch its magnetization direction. Given that the resistance of the junction is 100 Ω when the magnetization of the free layer is parallel to that of the fixed layer, and 150 Ω when the magnetizations are antiparallel, calculate the tunnel magnetoresistance (TMR) of the junction. **OR** A sample of a semiconductor has a Hall coefficient of 3.2×10^{-9} m^3/C. When a current of 20 mA is passed through it and a magnetic field of 0.5 T is applied perpendicular to the current, a Hall voltage of 2 mV is measured across the sample. Calculate the charge carrier density and the mobility of charge carriers in the material.	**20**	**CO2**
Q 11.	**(a)** Evaluate the prospects of magneto-transport phenomena in advancing nanomagnetism research. **(b)** Explain the operation of a Hall effect sensor and discuss its applications in automotive systems.	**20**	**CO2**

Constant	Standard Values
Planck's Constant (h)	6.63×10^{-34} Joule − sec
Permittivity of free space (ε_0)	8.85×10^{-12} Farad/meter
Velocity of light (c)	3×10^{8} m/sec
Boltzmann constant (k_B)	1.38×10^{-23} JK^{-1}
Rest mass of an Electron (m_o)	9.11×10^{-31} kg
Mass of the proton (m_p)	1.67×10^{-27}kg
Charge of an electron (e)	1.6×10^{-19} C