Name:

Enrolment No:

UPES

End Semester Examination, December 2024

Course: Magnetic domain walls dynamics, and magnetic switching **Semester : VII**

Program: BSc + MSc Integrated 2021-25 Batch **Time : 03 hrs.**

Course Code: PHYS 4011P **Max. Marks : 100**

Instructions:

- Answer all questions in each section.
- Q 9 in Section B and Q11 in Section C has an internal choice.
- Write your answers clearly and concisely.
- Maintain proper labeling and numbering for all answers.
- Use appropriate diagrams and equations where necessary to support your answers.

SECTION A
(5Qx4M=20Marks)

S. No.		Marks	CO
Q 1	Discuss the origin and significance of the magnetic dipolar interaction.	**4**	**CO1**
Q 2	What are direct exchange interactions, and how do they differ from indirect exchange interactions?	**4**	**CO1**
Q 3	Describe the characteristics of Bloch and Neel walls in magnetic domain structures.	**4**	**CO2**
Q 4	Calculate the wavelength of an electron accelerated through a potential difference of 100 kV in a Lorentz transmission electron microscope (TEM).	**4**	**CO3**
Q 5	Discuss the law of approach to saturation and its relevance to spin dynamics.	**4**	**CO4**
SECTION B **(4Qx10M= 40 Marks)**			
Q 6	Derive the Landau-Lifshitz-Gilbert (LLG) equation and discuss its significance in magnetization dynamics.	**10**	**CO3**
Q 7	Explain the development of domain theory and how it contributes to the understanding of magnetic materials.	**10**	**CO2**
Q 8	What are the experimental components of Lorentz Transmission Electron Microscopy (Lorentz TEM) and how is it used for domain imaging? Given an objective lens numerical aperture (NA) of 0.1, determine the resolving power for a Lorentz TEM operating at 100 kV.	**10**	**CO3**
Q 9	Explain the basic working principle of Transmission X-ray Microscopy (TXM) and its advantages over other imaging techniques. Discuss the role of X-ray optics in achieving high-resolution imaging and the types of samples that are best suited for TXM analysis.	**10**	**CO4**

	OR An X-ray source emits radiation with a wavelength of 0.5 nm. If the resolution limit of a TXM setup is determined by Rayleigh's criterion ($\theta = 1.22\lambda/D$), and the numerical aperture (D) of the system is 0.1, calculate the minimum resolvable distance (θ) in nanometers.		
SECTION-C **(2Qx20M=40 Marks)**			
Q 10	Elaborate on the various types of exchange interactions in magnetic materials, focusing on the difference between direct, indirect, double, and anisotropic exchange interactions.	**20**	**CO2**
Q 11	Explain the Magneto-optical Kerr Effect (MOKE). Provide a comprehensive overview of the domain imaging method, emphasizing the principles and setup of Kerr microscopy, and include relevant diagrams to illustrate the process. Discuss the different configurations of MOKE and its practical applications in research and industry. Additionally, if the initial intensity of polarized light is 100 W/m² and the angle of polarization (θ) is 30°, calculate the transmitted intensity using Malus's Law. **OR** Describe the working principles of Atomic Force Microscopy (AFM) and Magnetic Force Microscopy (MFM). Highlight the key differences between these techniques, including their imaging capabilities and applications in material science and magnetic domain analysis.	**20**	**CO4**