

10 Abhishek Kumar Gupta

29/11/2023

12

89

Roll No:

NATIONAL INSTITUTE OF TECHNOLOGY, HAMIRPUR, H.P

Department of Materials Science and Engineering

End -Term Examination

Advanced Functional Oxide Materials (MS-451)

Duration: 3 hrs

Maximum Marks: 50

Attempt all the following questions.

- Q.1 a)** Why good conductors (Cu, Ag, Au) generally do not exhibit superconducting behaviour? Why ideal conductors are said to have a memory, while superconductors do not?
- b)** Explain Flux pinning and state the different pinning mechanisms?
- c)** What made the discovery of superconductors based on iron (Fe) in the early 2000s surprising?
- d)** Explain and draw the energy band diagram (Energy vs Density of states) for a Normal metal ($T > T_c$) and a superconductor ($T < T_c$)? (2+3+2+3)
- Q.2 a)** Derive Curie-Weiss Law with reference to the equation, $P = (\epsilon_r' - 1)\epsilon_0 E = N\alpha E'$, where P is Polarization, ϵ_r' is relative dielectric permittivity, E is applied field, α is polarizability and E' is local field. (4)
- b)** Identify the essential characteristic features of magnetic materials required for:
1) Read/write heads; 2) Data storage, particularly in hard disks. (2)
- c)** Describe the four different polarization mechanisms for dielectric materials? Draw the schematic between dielectric constant and frequency showing various mechanisms? (4)
- Q.3 a)** State the key principles by which spin information is transferred from one ferromagnetic material to another through an insulator? Explain the construction and working of a spin valve? How is GMR effect achieved in a spin valve to make a real magnetic switch (with Resistance vs Magnetic field graph)? (3+2+2)
- b)** What are dilute magnetic semiconductors? State the reasons that led to the development of such materials in industries? (2+1)
- Q.4** What are multiferroic materials? Distinguish between Type I and Type II Multiferroics with examples? State the requirements of a multiferroic material? (2+4+3)
- Q.5** State the differences between Nanocomposites and conventional composite materials with examples? (3)
- Q.6** State the most suitable nanocomposite with its reinforcement and matrix which is widely used for the following applications: -
1. Retrofitting of bridges
 2. Scratch resistant coating in a car
 3. Biomedical implants
 4. Gas barriers for packaging and sports goods (2x4)