MAJOR - PYL114 (Solid State Physics)

Time: 60 Minutes **5 May 2017** *Max. Marks:20*

NOTE: Using Mobile Phone in exam is strictly prohibited. If found, F-grade will be awarded

1. State the essential criteria that are responsible for the ferromagnetic nature in a given solid. 3

2. Why bulk ferromagnetic (FM) solids prefer to exist in **multi-domain state** in absence of field. 2

3. (a) **Plot** the variation of (i) Anisotropy energy K and (ii) Exchange energy of a Ferromagnetic solid as a function of domain wall thickness. Write the reason for such variations (within 4-5 lines). 2

   (b) What will be change in the domain wall thickness if the Anisotropy energy is doubled and T_C of the solid is halved? 1

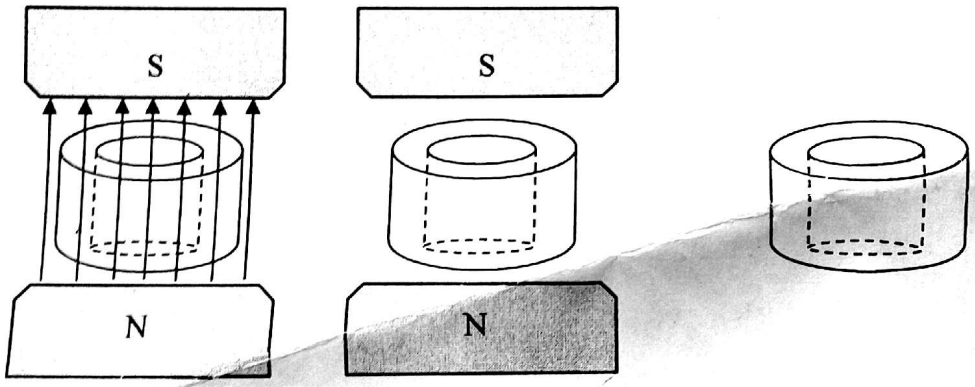
4. Consider a *domain* inside a Ferromagnetic *solid*. Let M and M_s are the magnitude of magnetization and saturation magnetization of the *domain* and *solid*, respectively. **Which one of the following correctly correlates** the M and M_s:

   (i) $M < M_s$ (ii) $M = M_s$

   (iii) $M > M_s$ (iv) *Any of the above three possibilities depending upon the field*?

   Justify your answer with proper reasoning (No Award for Incorrect reasoning). 1+1

5. A **hollow Type-I superconducting cylinder/ring** is placed in a magnetic field H_a ($<H_c$) at T >Tc (i.e., *normal* state) as shown in Fig. (a) below. Sketch the profiles (**No description**) of
   (i) **magnetic flux lines** and
   (ii) associated **screening currents**
   corresponding to the **two** *different* states as shown in Fig. (b) and Fig. (c) below. 5



(a) $T>T_C, H=H_a$ **(b) $T < T_C, H=H_a$** **(c) $T < T_C$ (H=0)**

6. **Indium metal** ^{115}In ($5s^2 4d^{10} 5p^1$) has a density of 7.31 g/cm^3, and T_C=3.4K. Calculate,
   (a) the density of Cooper pairs at T= 0 K, and
   (b) T_C of ^{100}In. 3

7. Lead has a T_C = 7.2 K and $H_C(0)$ = 800 G. A piece of lead is kept in an applied magnetic field of strength H_a and it is in normal state at room temperature. Now as it is cooled, it is found that it undergoes a transition from normal to superconducting state at 3.6 K. Find the value of field H_a (in **Gauss**).....2

Constants: e=1.6×10^{-19}C, m=9.1×10^{-31}kg, N_A=6.02×10^{23} /g-mol, μ_0=4π×10^{-7} H/m; k_B=1.38×10^{-23}J/K