Uva Wellassa University of Sri Lanka
Faculty of Science and Technology
Department of Science and Technology
300 level 2nd Semester Examination – Jan./Feb. 2016
SCT 343-2 Functional Properties of Materials

Uva Wellassa University

Instructions to candidates
Duration: 02 hours
Number of questions: 04
Answer all questions
Mark allocation: 80 marks

Charge of an electron e = 1.6×10^{-19} C
Avagardo's Number $N_A = 6.022 \times 10^{23}$ atoms/mol
Universal gas constant R = 8.31 J/mol. K
Electric permittivity of a vacuum $\varepsilon_0 = 8.85 \times 10^{-12}$ F/m
Magnetic permeability of a vacuum $\mu_0 = 1.257 \times 10^{-6}$ H/m
Bohr magneton $\mu_B = 9.27 \times 10^{-24}$ A.m^2
Velocity of light in vacuum c = 3×10^8 ms^{-1}.

1.

a. **Briefly** explain the difference between electronic and ionic conduction.

(4 marks)

b. **Briefly** describe the three types of polarization.

(6 marks)

c. Some electrical parameters for an intrinsic semiconducting material at room temperature are given in the 1st row of the table given below. After doping, the same semiconducting material can be converted to a p-type extrinsic semiconductor. Then the relavent electrical parameters are given in the 2nd row of the table. Note that σ is the electrical conductivity, n is the number of eletrons per unit volume and p is the number of holes per unit volume.

	$\sigma\ (\Omega.m)^{-1}$	$n\ (m^{-3})$	$p\ (m^{-3})$
Intrinsic	7.5×10^4	7.3×10^{23}	7.3×10^{23}
Extrinsic (p type)	1.6×10^5	6.5×10^{22}	8×10^{24}

Using the given data calculate electron and hole mobilities for this semiconducting material.

(10 marks)

2.

a.

I. State the two sources of magnetic moments for electrons.

(3 marks)

II. Do all electrons have a net magnetic moment? Justify your answer.

(3 marks)

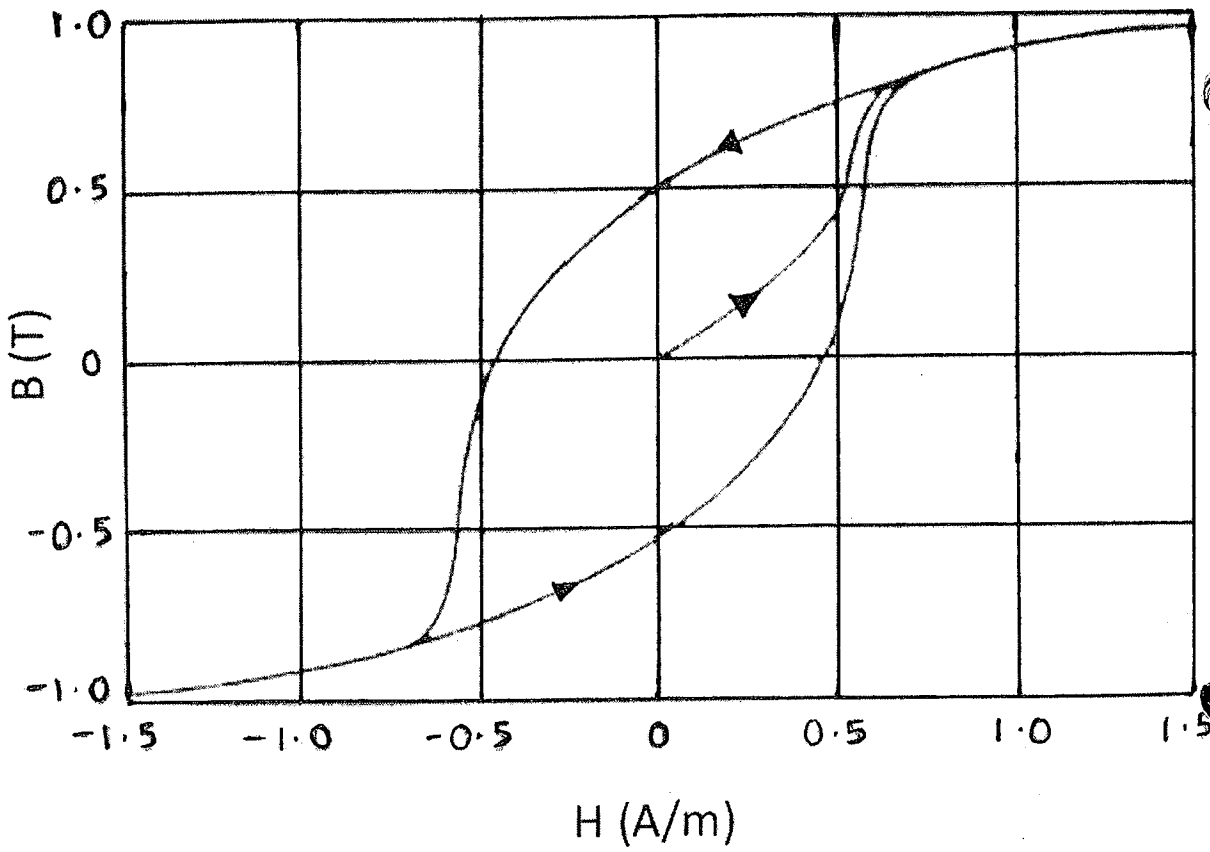
III. Do all atoms have a net magnetic moment? Justify your answer.

(3 marks)

b. **Briefly** explain what do you mean by "Magnetic Anisotropy"

(3 marks)

c. Figure below shows the B versus H curve for an alloy.



I. What is the approximate value of saturation flux density ?
II. What is the approximate value of saturation magnetization ?
III. What is the approximate value of remanent flux density ?
IV. What is the approximate value of coercivity ?

(8 marks)

3.

a. **Briefly** explain why metals are opaque to the light in visible region.

(3 marks)

b. Can a material have a positive index of refraction less than one? Justify your answer.

(3 marks)

c. Compute the velocity of light inside a material, which has a dielectric constant ε_r of 4.5 (at frequencies within the visible range) and a magnetic susceptibility of -3.17×10^{-5}.

(6 marks)

d. The transmissivity T of a transparent material to normally incident light is 0.80. If the index of refraction of this material is 1.5, and the thickness of this material is 25 mm, calculate the absorption coefficient for this material. All reflection losses should be considered. When calculating the reflection losses, assume light is transmitted from air into the material.

(8 marks)

4.

a. **Briefly** explain why metals are typically better thermal conductors than ceramic materials.

(3 marks)

b. For some ceramic materials, why does the thermal conductivity first decrease and then increase with rising temperature?

(3 marks)

c. For a metal, the heat capacity at constant volume C_v at 40 K is 0.48 J/mol.K and the Debye temperature is 440 K. Estimate the heat capacity at constant volume C_v for this metal at following temperatures:

I. at 60 K

II. at 500 K

(8 marks)

d. If a steel rod of 0.45 m long is heated from 25 ^{0}C to 95 ^{0}C while its ends are maintained rigid, determine the type and magnitude of stress that develops. Assume that at 25 ^{0}C, the rod is stress-free. Assume the modulus of elasticity is 207 GPa and the linear coefficient of thermal expansion is 16.0×10^{-6} $(^0C)^{-1}$ for steel.

(6 marks)