



**Arab Academy for Science & Technology  
and Maritime Transport – Cairo Branch  
College of Engineering & technology  
Electronics & Communication Engineering Department**



**EC311 – Electronic Materials  
Problem Set No.13: Magnetism IV  
Duration: Week# 13**

**Physical Constants:**

$$\epsilon_0 = 10^{-9} / (36 \pi) = 8.854 \times 10^{-12} \text{ F/m}$$

$$e = 1.6 \times 10^{-19} \text{ C}$$

$$h = 6.63 \times 10^{-34} \text{ J-s}$$

$$\beta = 9.27 \times 10^{-24} \text{ J/T (or A m}^2\text{)}$$

$$\mu_0 = 4 \pi \times 10^{-7} \text{ H/m}$$

$$m = 9.1 \times 10^{-31} \text{ kg}$$

$$c = 3 \times 10^8 \text{ m/s}$$

P1) Considering all possible directions for the electronic orbits, show that the radius of the orbit has to be replaced by  $\frac{2r^2}{3}$  instead of  $r^2$  in the expression of  $\Delta \mu_m$  induced due the external magnetization.

P2) In the diamagnetic substance of atomic number  $Z=10$  and number of atoms per unit volume  $N = 10^{29} \text{ m}^{-3}$ , and the average square radius of the electron  $\langle r^2 \rangle$  is  $10^{-20} \text{ m}^2$ , calculate the magnetic susceptibility, also calculate the magnetization and relative permeability for  $B = 10 \text{ Web/m}^2$ .

P3) Indicate whether each of the following statements is true or false (give reasons) :

- a. The only magnetic material which its magnetic state depends on the material's past history is the ferromagnetic material. Therefore a plot of the magnetic flux density versus  $H$  leads to a double-value curve known as the hysteresis loop. (    )
- b. The magnetic field lines can penetrate a superconductor sample at any value of temperature. (    )
- c. Diamagnetic materials are the only magnetic materials that have +ve susceptibility,  $\chi$  and  $\mu_r > 1$ . (    )