COLLEGE OF ENGINEERING & TECHNOLOGY

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Course : **Electronic Materials**
Course Code : **EC311**

Sheet 2
Problem on Dielectric Materials

1. Assuming a material has a FCC crystal structure, an electric filed is then applied on the material with an atomic number 29 and lattice constant of 3.6 A^0. The average displacement of electron relative to the nucleus is $1*10^{-8}$ A^0. Calculate the polarization. (Comment on your results).

2. Design a parallel plate capacitor using Mica that will have a capacitance of 0.0252 uF. We are able to obtain the Mica only in a thickness of 0.000254 cm. The Mica has at dielectric constant of 7 and dielectric strength of $40*10^6$ V/m. Also comment about how to get a capacitor with a high voltage.

3. Potential difference of 15 kV is applied across the terminals of a capacitor consisting of two circular plates, each having an area of 200 cm^2 separated by 1 mm of dielectric. The capacitance is $4.5*10^4$uF.

   Calculate the following:
   a) The charge density.
   b) The electric field.
   c) The dielectric constant of the dielectric.

4. The dipole moment for a general distribution of charges is defined as the sum

$$P = \sum_i q_i r_i$$

   Where q_i and r_i are the charge and position respectively, of the i^{th} charge and summation is overall the charges present. The choice ol the origin coordinate is arbitrary.

   (a) Show that the above reduced to (p=qd) for the special case of two equal and opposite charges (Take arbitrary origin).
   (b) If the charges system has an overall electrically neutrality, then the dipole moment is independent of the choice of orbit.

5. The field E_3 due to dipole inside the cavity depends on the symmetry of the crystal and in general dose not vanishes in a non cubic crystal. Assuming that this filed has the form:

$$E_3 = (b/E_o)P$$

Where b is a constant, calculate the dielectric constant ϵ_r in such a substance.

6. Show that this equation

$$\epsilon_r = \frac{1 + \frac{2}{3\epsilon_o} N\alpha}{1 - \frac{N\alpha}{3\epsilon_o}}$$

Can be reduced to,

$$\epsilon_r = 1 + \frac{N\alpha}{\epsilon_o}$$

In gaseous substance (i.e. substance in which N is very small).