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

EC311 – Electronic Materials
Problem Set No.5: Dielectrics III
Duration: Week# 5

Physical Constants:
Avogadro's number (N_A) = 6.02x10^{23} atoms/mol
ε_o = 8.85 x 10^{-12} F/m

P1) A sphere with dielectric constant ε_r and a radius R, is brought in a homogeneous field E_0, the sphere is surrounded by vacuum. Show that the field inside the sphere is homogeneous and given by $\frac{3E_0}{\varepsilon_r + 2}$.

P2) Starting from the polarization vector P, derive the Clausius-Mossitti relation.

P3) Show that the expression $\varepsilon_r = 1 + \frac{\frac{N\alpha}{\varepsilon_0}}{1 - \frac{N\alpha}{3\varepsilon_0}}$ reduces to $\varepsilon_r = 1 + \left(\frac{N\alpha}{\varepsilon_0}\right)$ in gaseous substances i.e. substances in which ($N\alpha/\epsilon_0$) are very small.

P4) Calculate the polarizability of a material that has a density of 10 gm/ cm^3 a molecular weight of 59, and a dielectric constant ϵ_r= 4.

P5) Consider a pure silicon crystal that has ε_r = 11.9 and the number of Si atoms per unit volume, N, is 5 x 10^{28} m^{-3}.

a. What is the electronic polarizability due to the valence electrons per Si atom?

b. Suppose that a Si crystal sample is electroded on opposite faces and has a voltage applied across it. By how much is the local field greater than Maxwell's field E?