HERIOT-WATT UNIVERSITY
DEPARTMENT OF COMPUTING AND ELECTRICAL ENGINEERING

22.3MB1 Electromagnetics

Tutorial 1

1. Determine the electric field at a distance r from a uniform, straight, infinite line charge of density λCm^{-1}.

$$[E_r = \frac{\lambda}{2\pi\varepsilon r}]$$

2. Determine the electric field in the vicinity of a uniform infinite plane sheet of charge of density $\sigma\ Cm^{-2}$.

$$[E_n = \frac{\sigma}{2\varepsilon}]$$

3. Using Gauss's Law determine an expression for the electric field intensity inside an infinitely long cylindrical charge distribution of radius a and uniform charge density $\rho\ Cm^{-3}$ immersed in a medium of permittivity ε.

$$[E_r = \frac{\rho r}{2\varepsilon}]$$

4 Consider a parallel plate capacitor with a sheet of mica of the same area, A, between its plate. The plate separation is d and the thickness of the mica is a (d>a). Ignore fringing to derive that the capacitance is:

$$C = \frac{\varepsilon_0 A}{d + a(\frac{1-\varepsilon_m}{\varepsilon_m})}$$

where m is the relative dielectric constant of the mica.
Now derive the capacitance for i) a = 0 ii) a = d
What is the interest of using material such as Mica to realise capacitor instead of air?

5 Consider a infinite conductor. Calculates its inductance per unit length.
Hint: Fist calculate the Field, then the flux linkage (careful here) and finally deduce L.

$$[L = \frac{\mu_0}{8\pi}]$$

6 A toroid has a mean diameter D_{Av} and an effective area A_{eff}. If the toroidal core has a relative permeability μ_r, then find the expression for the inductance if a conductor is wrapped around the core N times. A current given by $i = 20\sin(50t)$ (A) is passed throught the coil. Find the voltage induced across the coil.

$$[L = \frac{4\,10^{-7}\mu_r N^2 A_{eff}}{D_{Av}}] \quad [V = \frac{4\,10^{-7}\mu_r N^2 A_{eff}}{D_{Av}}\cos(50t)]$$

