1. A long coaxial cable carries a uniform volume charge ρ on the inner cylinder (radius a), and a uniform surface charge density on the outer cylindrical shell (radius b). This surface charge is negative and of just right magnitude so that the cable as a whole is electrically neutral. Find the electric field in each of the three regions: (a) inside the inner cylinder ($r < a$), (5%) (b) between the cylinder ($a < r < b$), (5%) (c) outside the cable ($r > b$). (5%) (d) Plot $|\vec{E}|$ as a function of r. (5%)

2. A "pure" dipole p is situated at the origin, pointing in the z-direction.
(a) What is the force on a point charge q at (a,0,0) (Cartesian coordinate)? (5%)
(b) What is the force on q at (0, 0, a)? (5%)
(c) How much work does it take to move q from (a,0,0) to (0, 0, a)? (5%)

3. An infinite solenoid with N turns per unit length, radius R. and current I.
(a) Find the vector potential at the position $r<R$. (5%)
(b) Find the vector potential at the position $r>R$. (5%)
(c) What is the magnetic field inside and outside the solenoid? (5%)

4. A waveguide is formed by two parallel copper sheets—σ_c (conductivity)=$5.75\text{x}10^7$ (S/m) separated by a 10 cm thick lossy dielectric—ε_r=2.15, μ_r=1, $\sigma=10^{-10}$(S/m). For an operating frequency of 10 GHz, find β (phase constant), α_d (attenuation constant due to losses in the dielectric), α_c (attenuation constant due to ohmic power loss in the imperfectly conducting walls), μ_p (phase velocity), μ_g (group velocity), and λ_g (guide wavelength) for
(a) the TEM mode (5%)
(b) the TM_1 mode (5%)
(c) the TE_2 mode (5%)

5. A uniform plane wave with parallel polarization represented as following is incident on a plane interface at Z=0, as shown in Fig. 1. Assuming $\varepsilon_2 < \varepsilon_1$ and $\theta_i > \theta_c$,

$$\bar{E}_i(x,z) = E_{i0}(\bar{a}_x \cos\theta_i - \bar{a}_z \sin\theta_i) e^{-j\beta_1(x\sin\theta_i + z\cos\theta_i)}$$

$$\bar{H}_i(x,z) = \bar{a}_y \frac{E_{i0}}{\eta_1} e^{-j\beta_1(x\sin\theta_i + z\cos\theta_i)}$$

(a) obtain the phasor expressions for the transmitted field ($\bar{E}t$, $\bar{H}t$) (10%)
(b) verify that average power transmitted into medium 2 vanishes (10%)

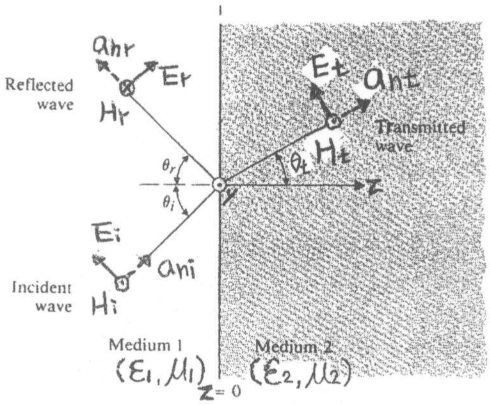

Fig. 1

6. Consider a thin film of refractive index n_2 and thickness d sandwiched between media of refractive indexes n_1 and n_3. Show that light incident from medium a has zero reflectance if $d = \frac{\lambda}{4}$ and $n_2 = \sqrt{n_1 n_3}$, where $\lambda = {}^{\lambda_0}/_{n_2}$. (15%)