1. (20%) Explain the following terms: a) Eddy current, b) Stokes's theorem, c) Dielectric constant, d) TEM, e) Antenna radiation patterns

2. (20%) Prove that a maximum power is transferred from a voltage source with an internal impedance Z_g to a load impedance Z_L over a lossless transmission line when $Z_i = Z_g^*$, where Z_i is the impedance looking into the loaded line. What is the maximum power-transfer efficiency?

3. (20%) A positive point charge Q is at the center of a spherical conducting shell of an inner radius R_i and an outer radius R_o. Determine $\overline{E}$ and V as functions of the radial distance R.

4. (20%) Prove the following:
   a. An elliptically polarized plane wave can be resolved into right-hand and left-hand circularly polarized waves.
   b. A circularly polarized plane wave can be obtained from a superposition of two oppositely directed elliptically polarized waves.

5. (20%) Find the radiation resistance of a Hertzian dipole.
   Hint: The radiating electric fields from a Hertzian dipole are,

$$\widetilde{H}_\phi = \frac{I_0 l k^2}{4\pi} e^{-jkR} \left[\frac{j}{kR} + \frac{1}{(kR)^2} \right] \sin\theta$$

$$\widetilde{E}_R = \frac{2I_0 l k^2}{4\pi} \eta_0 e^{-jkR} \left[\frac{1}{(kR)^2} - \frac{j}{(kR)^3} \right] \cos\theta$$

$$\widetilde{E}_\theta = \frac{I_0 l k^2}{4\pi} \eta_0 e^{-jkR} \left[\frac{j}{kR} + \frac{1}{(kR)^2} - \frac{j}{(kR)^3} \right] \sin\theta$$