參考用

1. A parallel-plate capacitor with plates having the shape of circular disks has the region between its plates filled with a dielectric of permittivity ε . The dielectric is imperfect, having a conductivity σ . The capacitance of the capacitor is C. The capacitor is charged to a potential difference V_0 and is isolated.
   (a) Find the charge on the capacitor as a function of time. (7 %)
   (b) Find the displacement current in the dielectric. (7 %)
   (c) Find the magnetic field in the dielectric. (8 %)

2. The permittivity of the dielectric in a parallel-plate capacitor is a function of distance x between the plates (x = 0 at one plate and x = d at the other plate) as given by

$$\varepsilon = \varepsilon_0 e^x \quad .$$

   (a) Find the capacitance if the area of the plate is S. (9 %)
   (b) Determine the stored energy if the capacitor is charged to a potential difference V_0 . (9 %)

3. A metal sphere of radius r_1 and charge Q is enclosed by a dielectric shell of permittivity ε , inner radius r_2 ($r_2 > r_1$), and outer radius r_3 . The medium elsewhere is air.
   (a) Find the potential distribution as a function of radius r. (10 %)
   (b) Find the polarization vector $\vec{P}$ and the bound charges in the dielectric shell. (12 %)

4. Consider (a) DC current source, (b) high frequency current source, determine the inductance per unit length of an air coaxial transmission line that has a solid inner conductor of radius a and a very thin outer conductor of inner radius b. (18 %)

5. Given the electromagnetic wave in a homogeneous medium

$$\vec{E} = E_0 \sin\omega(t - \sqrt{\mu\varepsilon}\, z)\,\hat{x} + E_0 \cos\omega(t - \sqrt{\mu\varepsilon}\, z)\,\hat{y}$$

   where E_0 is a constant. Find the corresponding magnetic field $\vec{H}$ and the average Poynting vector. (20 %)