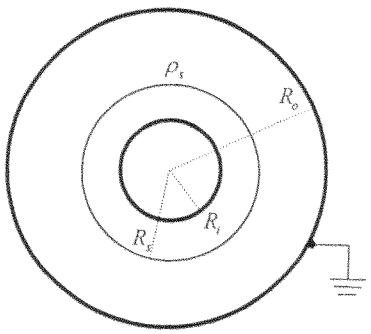
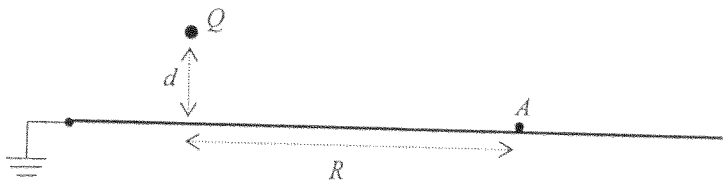
科目：電磁學 A(5007)

校系所組：中大電機工程學系(固態組)
交大電子研究所(甲組、乙組)、電信工程研究所(乙組)
清大電子工程研究所、工程與系統科學系
清大電機工程學系乙組、通訊工程研究所甲組

1. (10%) A group of charges distribute uniformly as a thin spherical shell of radius R_s. The surface charge density is denoted as ρ_s. These charges are inside the region bounded by two conducting spherical shells, as shown in the figure. All the shells share the same center. The outer conducting shell of radius R_o is grounded. Determine the electric field intensity and electric potential at R_1, R_2, R_3, and R_4, where $R_1 > R_o > R_2 > R_s > R_3 > R_4 = R_i$.



2. (10%) A positive point charge Q is located at a distance d above a very large grounded conducting plane, as shown in the figure. Assuming that the conducting plane is on the x-y plane in Cartesian coordinates. Find the electric field intensity at the point A on the plane, where $R >> d$.



注意：背面有試題

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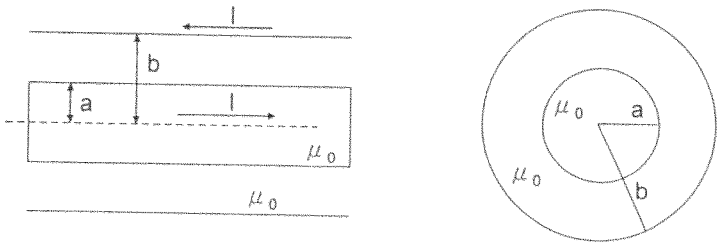
3. (15%) An air coaxial transmission line has a solid inner conductor of radius a with uniform current I and a very thin outer conductor of inner radius b, as shown in following figure.
   (a) Determine the magnetic flux density **B** in $r < a$, and $a < r < b$, respectively.
   (b) Determine the stored magnetic energy W_m per unit length in $r < a$, and $a < r < b$, respectively.
   (c) Use (a) & (b) results, determine the inductance L per unit length.



4. Consider two fields whose electrical field and magnetic flux density are $(\mathbf{E}_a, \mathbf{B}_a)$ and $(\mathbf{E}_b, \mathbf{B}_b)$, respectively in a linear and isotropic medium.
   (a) (10%) Please prove that

$$\left[\nabla\cdot(\mathbf{E}_a\times\mathbf{B}_b-\mathbf{E}_b\times\mathbf{B}_a)\right]_p=0$$

   while the medium is a nonmagnetic material and P is not a source point.
   (b) (5%) If the medium is a magnetic material, please prove that

$$\left[\nabla\cdot(\mathbf{E}_a\times\mathbf{H}_b-\mathbf{E}_b\times\mathbf{H}_a)\right]_p=0 \ .$$

5. The electrical field intensity in a source free dielectric medium is given as the following:

$$\mathbf{E}=e^{j(\omega t-ax-kz)}\hat{y} \qquad \text{V/m}$$

   (a) (6%) Find the corresponding **H** field.
   (b) (3%) What is the necessary condition for these fields to exist?
   (c) (6%) Calculate the time-average electrical energy density, magnetic energy density, and the Poynting vector.

6. (a) (5%) 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.
   (b) (5%) What is the maximum power transfer efficiency?

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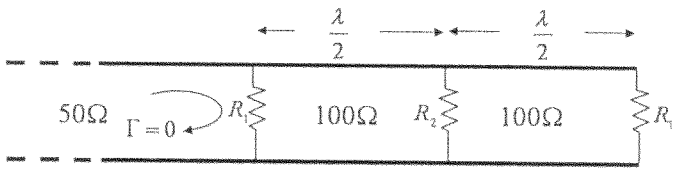
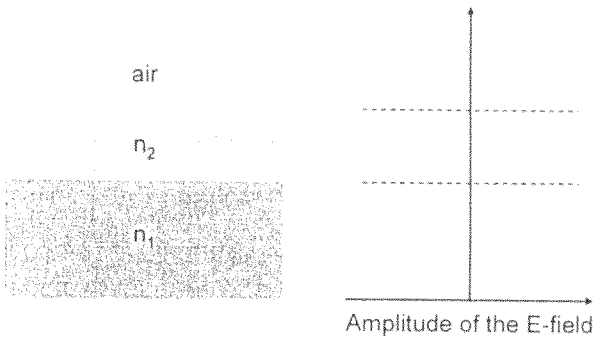
7. (15%) A signal generator is to feed power through a lossless transmission line with a characteristic impedance 50 Ω to the circuit shown below. The circuit is composed of three resistors (R_1, R_2, R_1) connected by two half-wavelength lossless transmission lines with a characteristic impedance 100 Ω. If the input reflection coefficient $\Gamma = 0$, and the ratio of power consumed in the three resistors is 1 : 2 : 1 ($= P_{R1} : P_{R2} : P_{R1}$), find R_1 and R_2.



8. (a) (5%) Sketch the field distributions for the TE_2 guided mode for the following asymmetric planar dielectric waveguide, where the reflective index $n_1 = 3.5$ and $n_2 = 3.6$. Make sure the evanescent field in different regions is plotted explicitly.



(b) (5%) Plot the dispersion relation $\omega(\beta)$ of this waveguide for the different TE_m modes with $m = 0$, 1, and 2.