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
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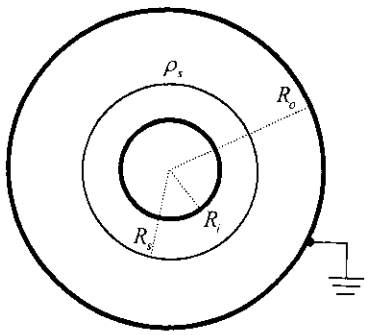
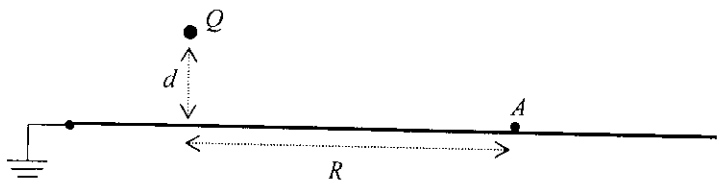
參考用

1. (10%) A group of charges distribute uniformly as a thin spherical shell of radius $R_s$. The surface charge density is denoted as $\rho_s$. 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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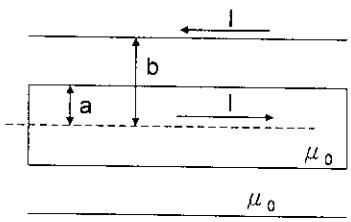
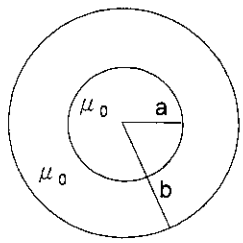
3. (15%) An air coaxial transmission line has a solid inner conductor of radius $a$ with uniform current I and a very thin outer conductor of inner radius $b$, as shown in following figure.
(a) Determine the magnetic flux density **B** in $r < a$, and $a < r < b$, respectively.
(b) Determine the stored 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:

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

(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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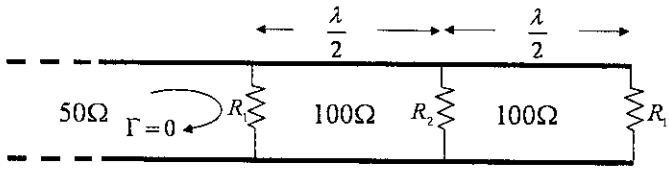
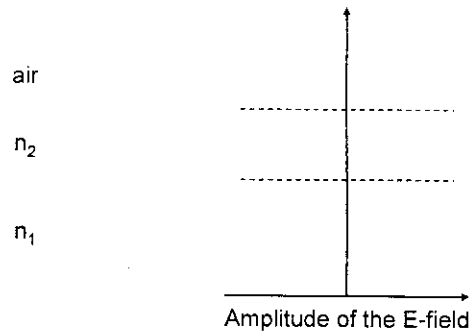
7. (15%) A signal generator is to feed power through a lossless transmission line with a characteristic impedance 50 Ω to the circuit shown below. The circuit is composed of three resistors ($R_1$, $R_2$, $R_1$) connected by two half-wavelength lossless transmission lines with a characteristic impedance 100 Ω. If the input reflection coefficient Γ= 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.