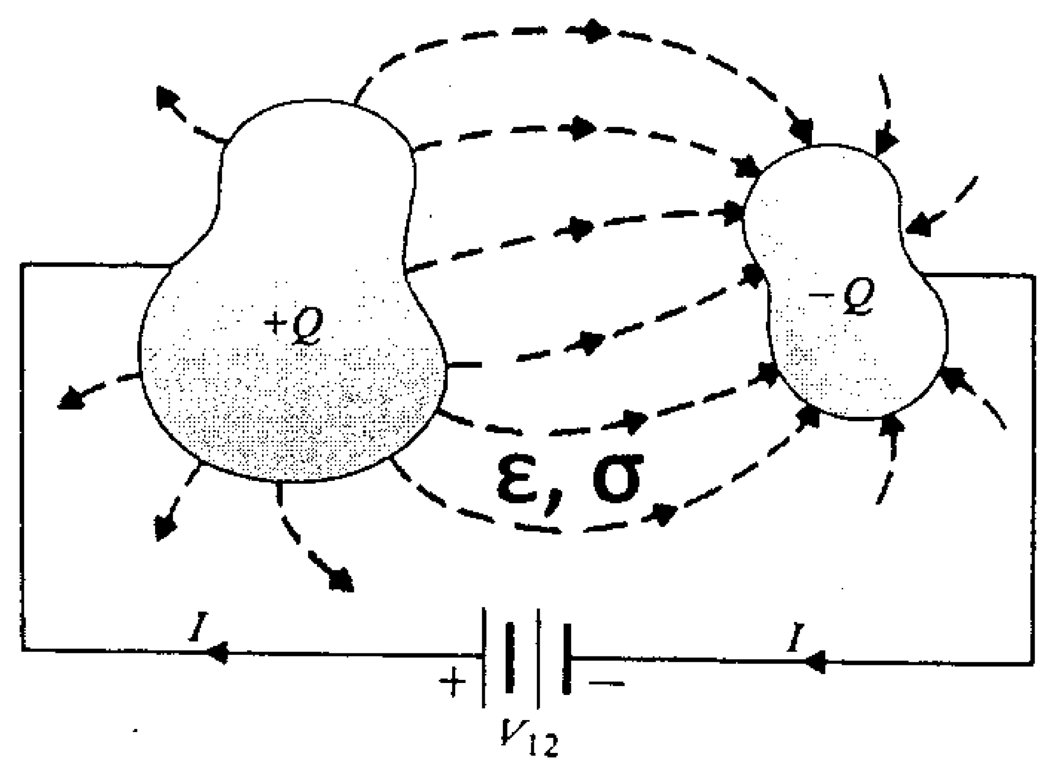
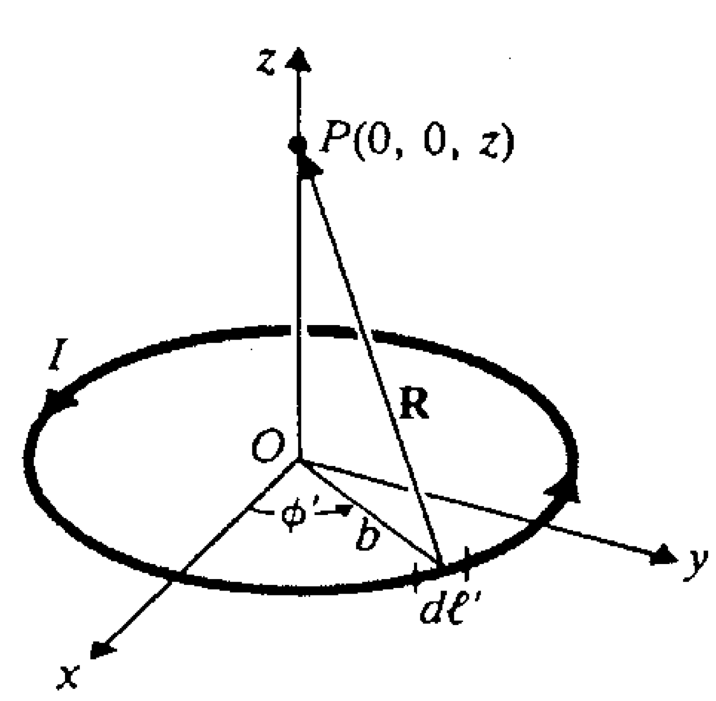
科目：電磁學 A(3008)　　校系所組：交通大學電子研究所(甲組、乙A組、乙B組)
交通大學電信工程研究所（乙組）
交通大學生醫工程研究所（乙組）
清華大學電子工程研究所
清華大學工程與系統科學系（丁組）

1. (a) Two conductors are immersed in a homogenous lossy dielectric with permittivity ε and conductivity σ in the following figure. A current will flow from the positive to the negative conductor and a current-density field will be established in the medium. Prove that the product of the capacitance and the leakage resistance of the two-conductor system is a constant. (5%)



(b) Find the leakage resistance per unit length between the inner and outer conductors of a coaxial cable that has an inner conductor of radius a, an outer conductor of inner radius b, and a medium with conductivity σ between the inner and outer conductors. (5%)

2. Using the Biot-Savart law and following figure, find the magnetic flux density ($\vec{\mathbf{B}}$) at a point $P(0, 0, z)$ on the axis of a circular loop of radius b that carries a direct current I. (10%)



3. Consider two long conducting lines carrying the same electric alternating current $i_1 = I_0 \cos(\omega t)$ and a loop of radius b in between in the following figure. The distances from the center of the loop to the two conducting lines are d_1 and d_2, respectively.

(a) Calculate the induced current in the loop if the resistance of the loop is R. (10%)

(b) Show that, if $d_1 = d_2$, the induced current is zero by using your result in (a). (5%)

注意：背面有試題

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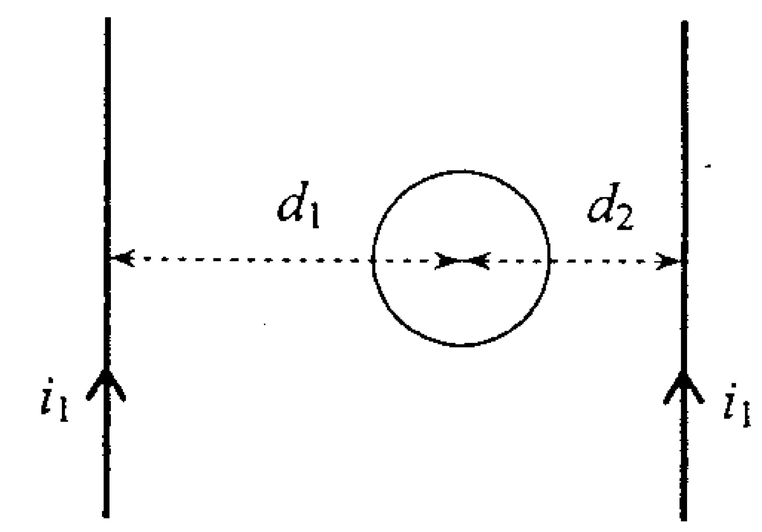
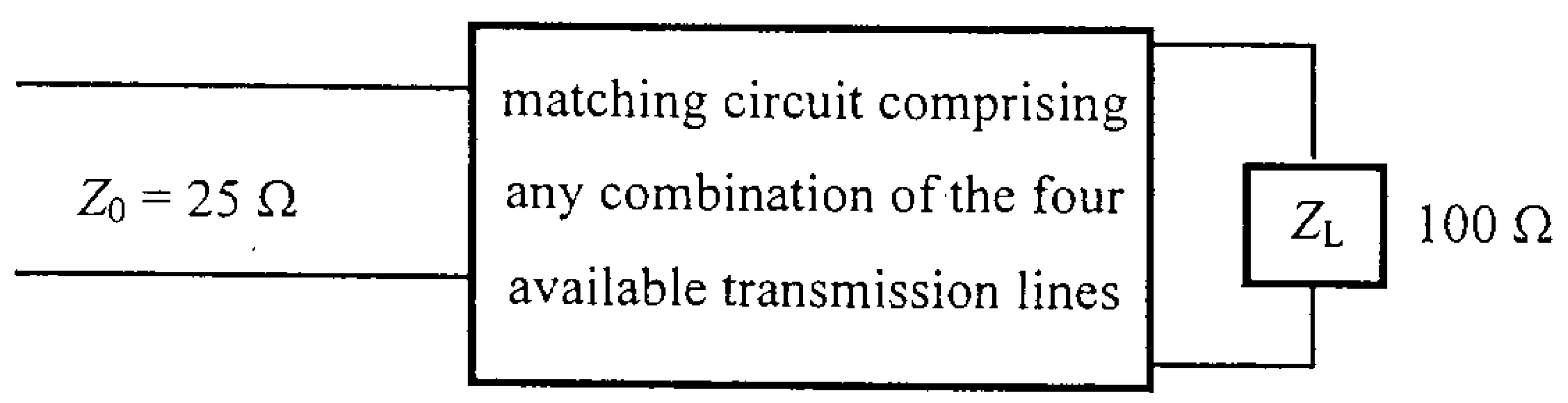


4. (a) Write down Maxwell's equations in the differential form. (5%)
   (b) Explain in mathematical and physical ways why the term of displacement current is necessary (10%).

5. The standing-wave ratio on a lossless 50Ω transmission line terminated in an unknown load impedance is found to be 3.0. The distance between successive voltage minima is 20 cm, and the first minimum is located at 5 cm from the load. Determine
   (a) the reflection coefficient, (6%)
   (b) the load impedance, and (6%)
   (c) the two shortest possible equivalent lengths and their associated terminating resistances of such a line inserted in place of the original load such that the input impedance seen into these replacement lines towards their terminal resistances is equal to the original load impedance found in (b). (8%)

6. A load $Z_L = 100\ \Omega$ is to be matched to a transmission line with characteristic impedance $Z_0 = 25\ \Omega$, as shown in the following figure. Four quarter-wave transmission lines, each of length = $\lambda/4$, with various characteristic impedances: $Z_1 = 45\ \Omega$, $Z_2 = 60\ \Omega$, $Z_3 = 75\ \Omega$, and $Z_4 = 90\ \Omega$ are available. Find a way to achieve this matching by using any combination of these four available transmission lines and draw the matching circuit. Details must be shown. Hint: Not necessary to use all four transmission lines. (5%)



註：背面有試題

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7. Consider a metallic rectangular waveguide.
   (a) DISCUSS the typical values for a and b as shown in the following figure. (3%)
   (b) Solve for $E_z(x, y, z)$ in the waveguide. (4%)
   (c) Solve for $H_z(x, y, z)$ in the waveguide. (12%)
   (d) How do cut-off modes behave within the waveguide and their likely effects? (3%)
   (e) Schematically draw and EXPLAIN the power attenuation coefficients of both TE_{mn} and TM_{mn} modes as functions of the operation frequencies (from a very-low frequency to very-high frequencies. (3%)