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陽明醫學工程研究所醫學電子組

1. As shown in the following figure, a positively charged line of charge density ρ_l parallel to the y axis is located z_0 above an infinite ground plate that is sitting on the x-y plane. What's the potential at P_1 (x_1, 0, z_1)? Show that the equal potential surface of P_1 is a cylinder, if $\sqrt{x_1^2 + (z_0 - z_1)^2} < z_0$. (15%)

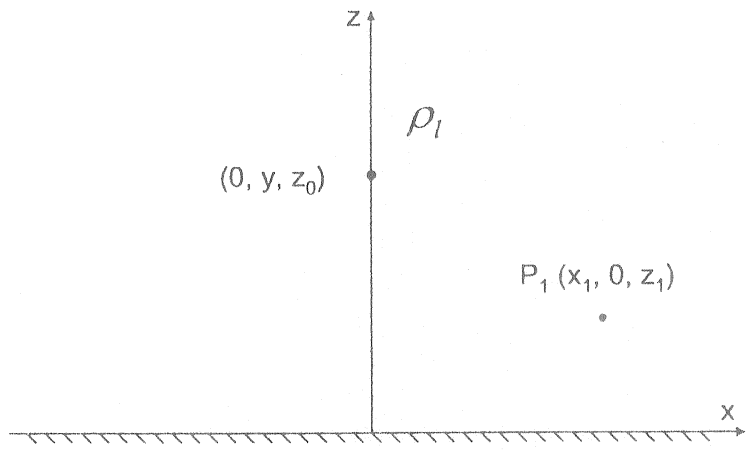

Fig. 1

2. Considering the equivalent case similar to the previous problem, determine the capacitance per unit length between two infinitely long, parallel, circular conducting wires of radius r_0. The center-to-center separation is $2z_0$. (10%)

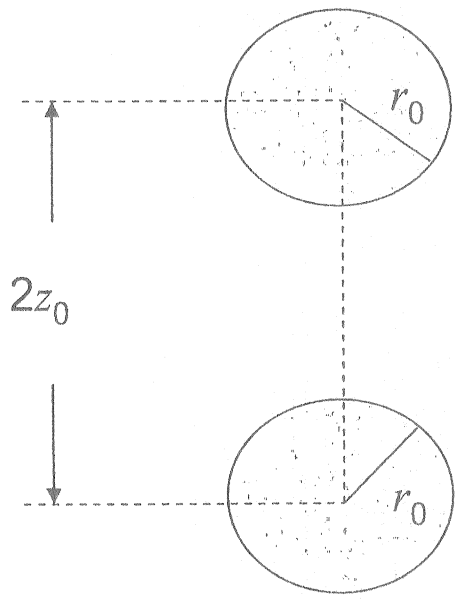

Fig. 2

注意：背面有試題

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3. Consider a magnetic actuator shown in the following figure. The core is made of a magnetic material with a permeability μ and has a constant cross area $A_c = t*h$. The air gap with separation g is shown on the structure. The total length of the core and the overlap length are denoted by L_c and L_{ol}, respectively. Please answer the following questions:
   (a) Neglect fringing fields, please represent the magnetic reluctance of the air gap (R_{gap}) and the reluctance of the magnetic core (R_{core}). (5%)
   (b) What is the total energy stored in the system including the core and the gap supposing the magnetic flux density is uniformly distributed inside the gap? (5%)
   (c) What is the force acting on the overlap parallel plates? (5%)

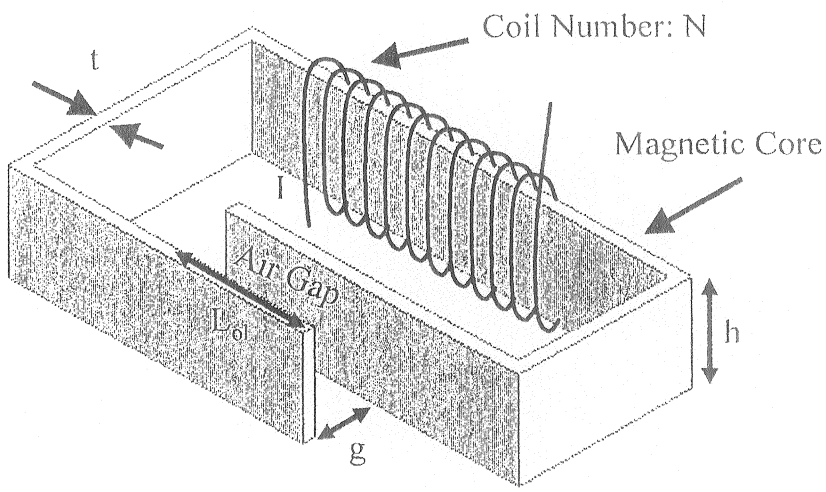

Fig. 3

4. A donut-shaped permanent magnet (magnetization parallel to the axis) can slide frictionlessly on a vertical rod, which is shown in the following figure. In addition, this rod is positioned at the center of a coil with a current **I** and a radius **R**. If we treat the magnet as a magnetic dipole with mass $\mathbf{m_d}$ and dipole moment **m**, this magnet will potentially "float" and keep a distance from the coil. Neglect the fringing field. What is the distance of **z** to balance the magnetic force and the gravity? (10%)

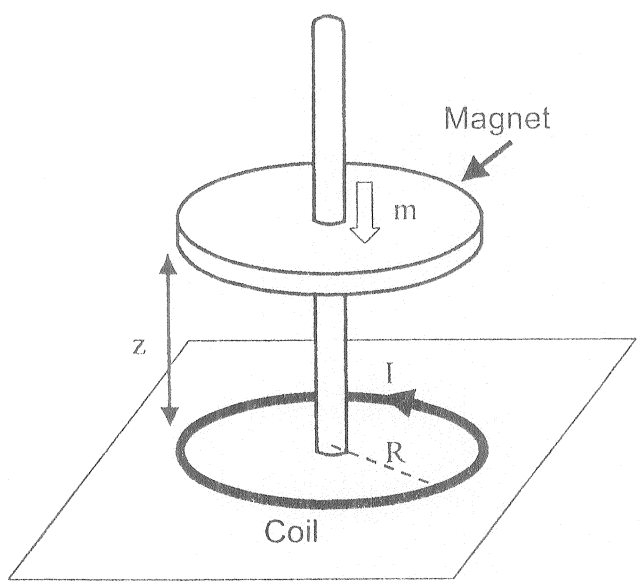

Fig. 4

注意：背面有試題

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5. In electromagnetic waves, we define intrinsic impedance for a medium and its unit is the same as those ohmic resistors. Are the above two terms physically the same though they have the same unit? Please discuss. (4%)

6. The mathematical expression for plane waves was well-known to you. Please verify the net energy transmission (or flow) of the above-mentioned plane wave is zero along the direction where the component of its propagation vector is pure imaginary. (6%)

7. A plane wave is obliquely incident from one dielectric medium into another dielectric medium.
   (a) Please verify the familiar Snell's law which holds for both states of polarizations. (4%)
   (b) Please derive the amplitude reflection and transmission coefficients of the TM-polarized wave. (7%)
   (c) Please explain why the reflectance of the TE-polarized wave is always greater than that of TM-polarized wave. (4%)

8. For the transmission line system shown below ($Z_S = Z_0 = 30$ Ohm, $l = 0.1$ m, $C_L = 100$ pF, $V_g = 1$ V and the switch is closed at $t = 0$):
   (a) Find the time T for the voltage signal traveling to the load C_L. Assuming the effective dielectric constant of the transmission line is 9.0. (5%)
   (b) Plot $V_L(t)$ across the load capacitor from $t = 0$ to ∞. Label the important values. (5%)

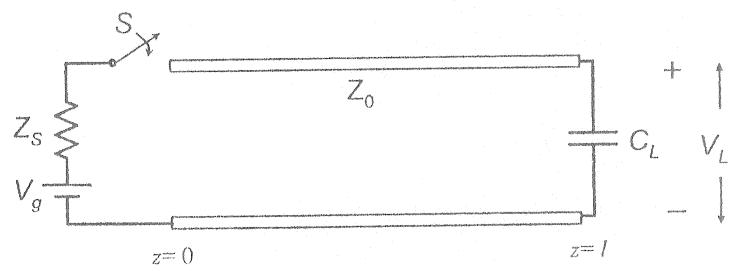

Fig. 5

9. (a) Determine the input reflection coefficient of the circuit, if Z_{in} is located at Point A in the Smith chart (50-ohm system). (5%)
   (b) If Z_L is removed and the transmission line is connected to the ground directly. To obtain a Z_{in} at Point B, what is the length l of the line ($Z_0 = 50$ ohm)? (5%)
   (c) Plot the imaginary part of Z_{in} as a function of l from 0 to one wavelength λ based on the circuit in (b). (5%)

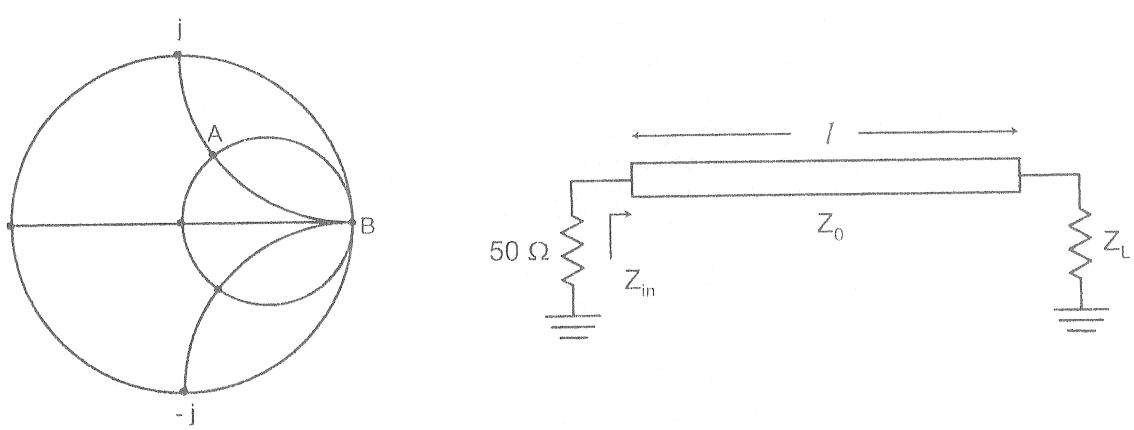

Fig. 6