科目：電磁學 A(3007)

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）
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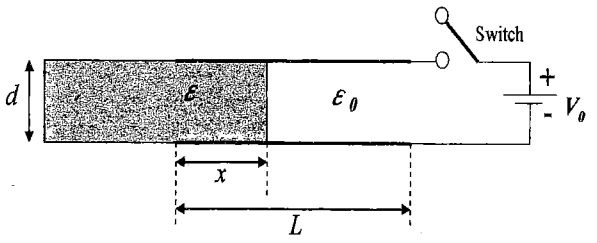
參考用

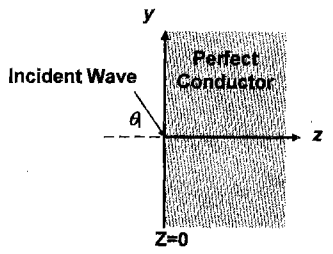
1. (15%) A parallel-plate capacitor of width W, length L, and separation d has a solid dielectric slab of permittivity ε in the space between the plates. The capacitor is to be charged to a voltage V_0 by a battery, as indicated in following figure. Assume that the dielectric slab is withdrawn to position shown.
   (a) Form Gauss's law to determine the system capacitance with voltage V_0.
   (b) Determine the force acting on the slab with the switch closed.
   (c) Determine the force acting on the slab after the switch is first opened.



2. In free space, a sinusoidal uniform plane wave with the electric field intensity

$$\vec{E}_i(y,z) = 2(\hat{a}_y + \hat{a}_z\sqrt{3})e^{j12(\sqrt{3}y - z)} \quad \text{(V/m)}$$

strikes the surface of the perfect conductor at $z = 0$ as shown,



   (a) (3%) Find the angular frequency of the wave.
   (b) (2%) Determine the angle of incidence θ_i.
   (c) (10%) Show that no average power is propagated in the z direction.

3. The plane wave propagating in the air has the electric field intensity as follows:

$$\vec{E}(t,x,z) = -\hat{a}_x 1.8\cos(2\pi ft - 4x - 3z) + \hat{a}_y 3\sin(2\pi ft - 4x - 3z) + \hat{a}_z 2.4\cos(2\pi ft - 4x - 3z) \quad \text{(V/m)}$$

(a) (3%) Find the frequency of the wave.
(b) (2%) Find the angle between the z-axis and the propagating direction.
(c) (6%) What polarization is this wave (linearly or circularly polarized)? Does the polarization rotate in right hand or left hand?
(d) (4%) If this wave incident on a plane boundary at $z = 0$ between the air and a medium of $\varepsilon_r = 16$, what are the transmission (refraction) angle and transmission coefficients for different polarization components of the wave?

注意：背面有試題

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參考用

4. (15%) If the characteristic impedance Z_0 of the transmission line is 50 Ω, please determine the input reflection coefficient Γ_{in} in the following cases:
   (a) The loading is one 100 Ω resistor in parallel with another 100 Ω resistor.
   (b) The loading is a capacitor C in series with an inductor L, and the frequency is set at the resonance frequency, i.e., $\omega = 2\pi f = \frac{1}{\sqrt{LC}}$.
   (c) The loading is a negative resistor with its resistance R equal to -50 Ω.

5. (15 points) Please make a simple sketch of the Smith chart and then indicate the following points on your Smith chart:
   (a) Normalized loading impedance z_L equal to $1-j$.
   (b) Input reflection coefficient equal to $0.5e^{j\pi}$.

6. A z-oriented hollow rectangular metallic waveguide has a uniform cross section of width a and height b. For allowed TE_{mn} and TM_{mn} modes, we can derive E_x, E_y, E_z, H_x, H_y, and H_z as functions of x, y, and z, and they are the superposition of plane waves. Let us consider TE_{mn} modes here and answer the following four problems without resorting to the well-known E_z-H_z formula.
   (a) (3%) Please explain why the ratio of E_x and H_y is a constant.
   (b) (3%) Please give the above ratio E_x/H_y and explain your result.
   (c) (3%) Please discuss whether the ratio E_y/H_z is a constant or not.
   (d) (3%) If we operate the waveguide which is used to guide a signal from a microwave source to an antenna under its cut-off frequency, please discuss what kinds of results may happen.

7. (13%) Let us consider a hollow rectangular metallic cavity (or cavity resonator) of size $a \times b \times d$. By using the Maxwell's equations, please derive E_y.