※ 考生請注意：本試題 ☑可 □不可 使用計算機

1. Charge is distributed with density $\rho = \rho_0 (r/a)^2$, where ρ_0 is a constant, in the sphere $r < a$. Find displacement field **D** everywhere and plot D_r versus r. (15%)

2. The electric-field intensity of a uniform plane wave propagating in free space is given by

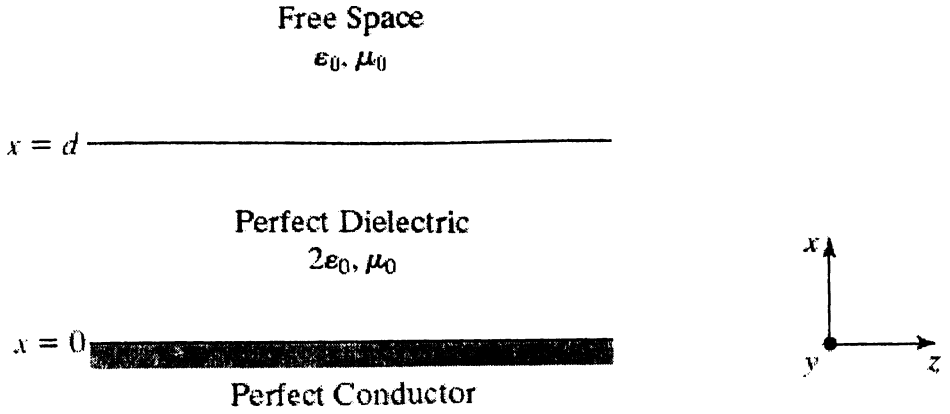
$$\mathbf{E} = 37.7 \cos\left(9\pi \times 10^7 t + 0.3\pi y\right)\mathbf{a}_x \text{ V/m}$$

Find: (a) the frequency; (b) the wavelength; (c) the direction of propagation of the wave; and (d) the associated magnetic-field intensity vector **H**. (15%)

3. In a space consisting three different media shown below, the region $x < 0$ is a perfect conductor, the region $0 < x < d$ is a perfect dielectric of $\varepsilon = 2\varepsilon_0$ and $\mu = \mu_0$, and the region $x > d$ is the free space. The electric and magnetic fields in the region $0 < x < d$ are given at a particular instant of time by

$$\mathbf{E} = E_1 \cos \pi x \sin 2\pi z \mathbf{a}_x + E_2 \sin \pi x \cos 2\pi z \mathbf{a}_z$$
$$\mathbf{H} = H_1 \cos \pi x \sin 2\pi z \mathbf{a}_y$$

Find (a) surface charge density and surface current density on the surface $x = 0$ and (b) **E** and **H** for $x = d+$, that is, immediately adjacent to the $x = d$ plane and on the free-space side, at that instant of time. (20%)



(背面仍有題目,請繼續作答)

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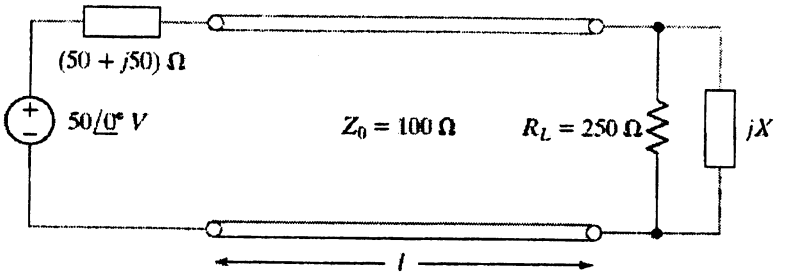
4. Consider a coaxial cylindrical conductors filled with a uniform dielectric medium of permittivity ε between an inner radius a and an outer radius b. Show that the capacitance per unit length of the cylindrical conductors is $2\pi\varepsilon/\ln(b/a)$. (15%)

5. In the system shown below, find the value of the reactance X and the minimum value of the electrical length l for which the time-average power delivered to the resistor R_L is a maximum. What are the values of this power and the SWR on the line? (20%)



6. The dimensions of a rectangular cavity resonator with air dielectric are $a = 4$ cm, $b = 2$ cm, and $d = 4$ cm. Find the three lowest frequencies of oscillation and specify the mode(s) of oscillation, TE_{mnl} and TM_{nml}, transverse with respect to the $d = 4$ cm direction, for each frequency. [Hint: The mode numbers $m, n = 0,1,2,...$, but not both zero for TE modes, and $m, n = 1,2,3,...$ for TM modes.](15%)

Some formula for reference:

Laplace's equation in cylindrical coordinate system:

$$\nabla^2\Phi = \frac{1}{r}\frac{\partial}{\partial r}\left(r\frac{\partial\Phi}{\partial r}\right) + \frac{1}{r^2}\frac{\partial^2\Phi}{\partial\phi^2} + \frac{\partial^2\Phi}{\partial z^2}$$

In free space: $c = \dfrac{1}{\sqrt{\varepsilon_0\mu_0}} = 3\times10^8$ m/s, $\eta_0 = \sqrt{\dfrac{\mu_0}{\varepsilon_0}} \approx 120\pi\Omega = 377\Omega$

$$\text{SWR} = \frac{1+|\Gamma_R|}{1-|\Gamma_R|}$$