請在答案卷上標明題號作答，寫在題目卷不計分。填充題的計算過程不計分，計算題請詳列過程。

$\varepsilon_0 = 10^{-9}/(36\pi)$ F/m,　$\mu_0 = 4\pi \times 10^{-7}$ H/m

1. [計算題] (24%= 3% x 8) For the following electric field for a uniform plane wave in a non-magnetic medium ($\mu = \mu_0$):

$$\mathbf{E} = 377\, e^{-0.001z} \cos(6\pi \times 10^8 t - 4\pi z)\, \mathbf{a}_x \quad \text{V/m},$$

please find **(a)** the **frequency**; **(b)** the **wavelength** (in the medium); **(c)** the **direction of propagation** of the wave; **(d)** the **permittivity** ε of the medium; **(e)** the **conductivity** σ of the medium; **(f)** the associated **magnetic field H**; **(g)** the **instantaneous Poynting vector** at $z = 0$; and **(h)** the **time-average Poynting vector** at $z = 0$.

2. [計算題] (10%= 5% x 2) In the system shown in Fig. 1, a (+) wave carrying power P is incident from line 1. **(a)** Find the **value of *R*** for which there is no reflected wave into line 1. **(b)** For the value of R found in (a), find the **power transmitted into each of lines 2 and 3**.

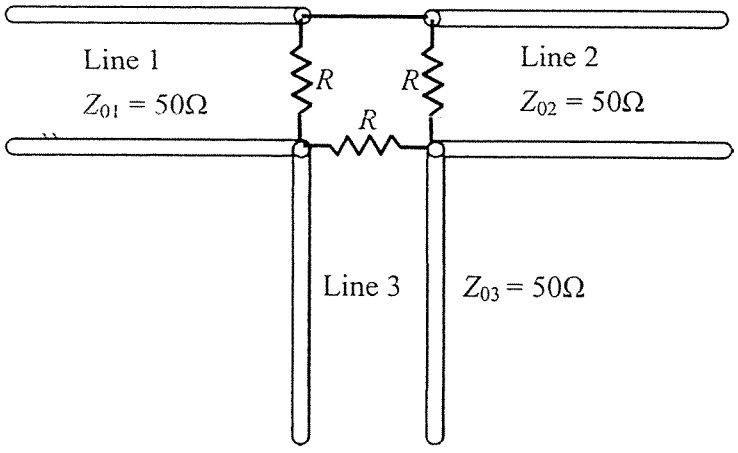

Fig. 1

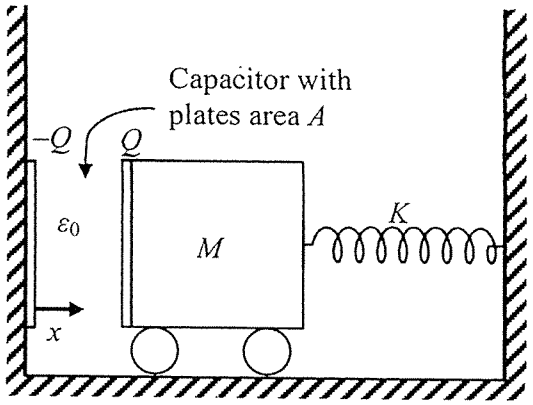

Fig. 2

3. [計算題] (16%= 8% x 2) In the system shown in Fig. 2, the mass M is set in motion in the following manner: (1) the mass is brought to rest at the equilibrium position $x = x_0$ with no charge on the capacitor plates; (2) the mass is constrained to that position and the capacitor plates are charged to $\pm Q$ as shown; and (3) the mass is released, thereby permitting frictionless motion. (a) Obtain the **differential equation** for the motion of M and (b) find the **solution**.

4. [填充題] (6% = 2% x 3) Please find the voltage reflection coefficient $\bar{\Gamma}_R$ in a transmission line for its corresponding standing-wave ratio (SWR). (請注意正負號)

(a) $\bar{\Gamma}_R$ = _____, if SWR = 1

(b) $\bar{\Gamma}_R$ = _____, if SWR = 2

(a) $\bar{\Gamma}_R$ = _____, if SWR = ∞

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5. [填充題] (8% = 4% x 2) Please find the directivity D of an antenna for its corresponding pattern function of power density, $f(\theta,\phi)$.
   (a) D = _____, if $f(\theta,\phi)=\sin^2\theta$
   (b) D = _____, if $f(\theta,\phi)=\sin^4\theta$

6. [填充題] (6% = 3% x 2) A cubic cavity resonator is made of perfectly electric conducting (PEC) walls and filled with a dielectric medium with relative permittivity ε_r. The dimensions of the resonator are $a = b = d = 14.14$ cm. Please find the lowest resonant frequency f_0 for its corresponding ε_r.
   (a) f_0 = _____ GHz, if $\varepsilon_r = 1$
   (b) f_0 = _____ GHz, if $\varepsilon_r = 4$

7. [計算題] (18%) A dielectric slab waveguide consists of a dielectric slab of relative permittivity $\varepsilon_{r1} = 4$ sandwiched between the air of relative permittivity $\varepsilon_{r2} = 1$. Optical waves are launched from the medium 1 to the air. Guided modes can exist in the slab when the incident angle θ_i is larger than the critical angle θ_c. The thickness of the slab is d. The operation wavelength is λ_0. The electric field component E_y of even transverse electric (TE) modes can be expressed as

$$E_y = \begin{cases} A\cos(k_{x1}x)\ \exp(-j\beta_z z) & \text{for } |x| < d/2 \\ B\exp(-\alpha_{x2}|x|)\ \exp(-j\beta_z z) & \text{for } |x| > d/2 \end{cases}$$

   (a) (8% = 4% x 2) Find the critical angle θ_c and Brewster angle θ_B for optical waves launched from the medium 1 to the air.
   (b) (4%) Find the ratio A/B.
   (c) (6%) Find the value of α_{x2} of the fundamental mode TE_0, if $d = 1\ \mu$m, $\lambda_0 = 0.5\ \mu$m, and $\theta_i = 83.43^\circ$.

8. [計算題] (12%) The propagation constants of left-handed and right handed circularly polarized waves are different in a medium. If a linearly x-polarized wave is launched into the medium and propagates over a distance d, it is still linearly polarized. However, its polarization will be rotated at an angle θ with respect to the x-axis. Assume the propagation constants of the two circularly polarized waves are β_1 and β_2, respectively. Please find the rotation angle θ in terms of β_1, β_2, and d.

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