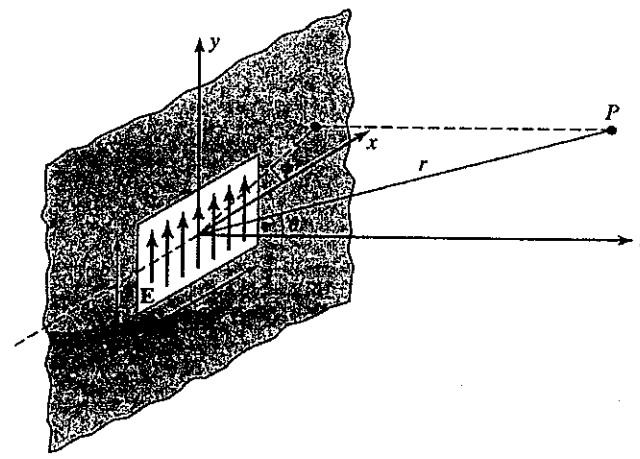
※ 請於**答案卷**上**非選擇題作答區**標明題號作答。計算題請詳列過程。 $\varepsilon_0 = 10^{-9}/(36\pi)$ [F/m], $\mu_0 = 4\pi\times10^{-7}$ [H/m]

1. **(15% = 5%*3；本大題為填充題，過程不計分，請於答案卷作答)** A film with a refractive index n_f and thickness d_f is coated on a substrate with a refractive index $n_s = 3.24$. A plane wave with a free-space wavelength $\lambda = 1440$ nm is normally incident on the film.
   (a) If there is no reflection, $n_f =$ _____①_____ and $d_f =$ _____②_____.
   (b) Using the n_f obtained in (a), $d_f =$ _____③_____ for maximum reflection.

2. **(本大題共 25%)** The figure below shows a rectangular aperture antenna with a uniform field distribution $\boldsymbol{E} = \overline{\mathrm{E}(x, y, 0)} = E_0 \boldsymbol{a}_y$ across its aperture. Assume $r >> a, b > \lambda$, where λ is the free-space wavelength.



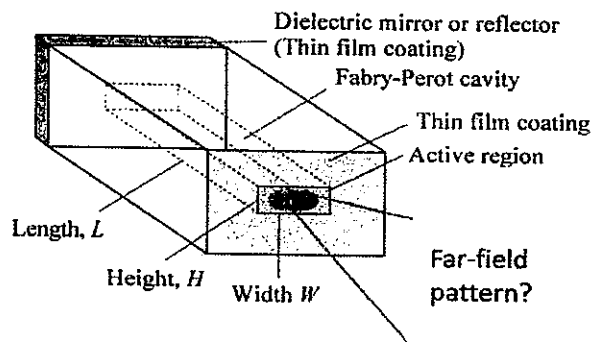
The far-field electric field at a point $P(r, \theta, \phi)$ is approximated as

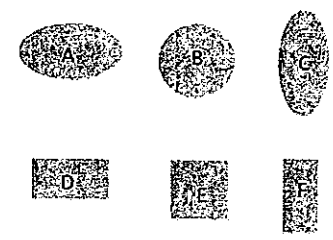
$$\overline{\mathrm{E}}(r,\theta,\phi) \approx \frac{j\beta E_0 \exp(-j\beta r)}{2\pi r} \int_{x'=-a/2}^{a/2} \int_{y'=-b/2}^{b/2} E_0 \exp\left(j\beta \sin\theta\left(x'\cos\phi + y'\sin\phi\right)\right) dx'dy'.$$

(a) **(10%)** Find the far-field at $\phi = 0$ $\left|\overline{\mathrm{E}}(r,\theta,\phi)\right|_{\phi=0}$, and that at $\phi = 90°$ $\left|\overline{\mathrm{E}}(r,\theta,\phi)\right|_{\phi=90°}$.

(b) **(10%)** Using the results from (a), find their beam widths between the first nulls (BWFN), $[\mathrm{BWFN}]_{\phi=0}$ and $[\mathrm{BWFN}]_{\phi=90°}$, in terms of a, b and λ.

(c) **(5%)** The radiation from the facet of a semiconductor laser can be approximated as that of a rectangular aperture antenna, as shown in the figure on the left below. Using the results obtained in (b) and $W > H$, which of the patterns (A–F) in the figure on the right below would the far-field look like?





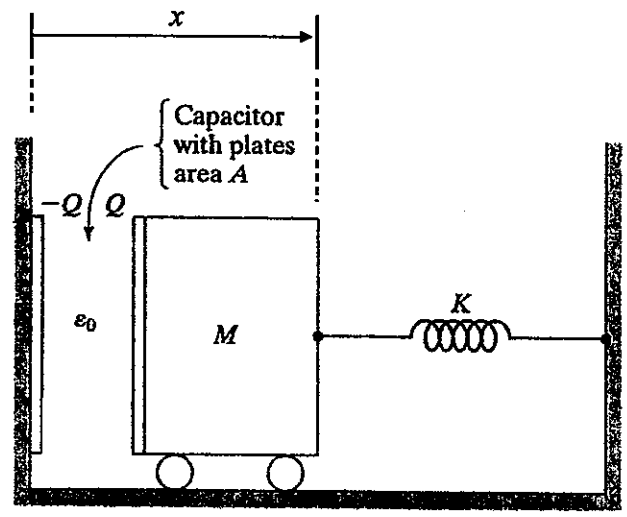
3. **(10%)** For a plane wave propagation in a uniform material medium with a refractive index $n = n(\omega)$, the phase constant is given by $\beta = \frac{\omega n}{c}$. Please show that $\frac{d^2\beta}{d\omega^2} = -\frac{\lambda_0}{c}\frac{d^2n}{d\lambda_0^2}\frac{d\lambda_0}{d\omega}$ at a wavelength λ_0.

見背面

※ 請於答案卷上非選擇題作答區標明題號作答。計算題請詳列過程。 $\varepsilon_0 = 10^{-9}/(36\pi)$ [F/m], $\mu_0 = 4\pi\times10^{-7}$ [H/m]

4. **(本大題共 25%)** Consider a uniform plane wave propagating in free space. The electric field of the wave is $\mathbf{E} = E_0 \cdot \cos(20\pi\times10^{12}\,t - \beta\times y)\,\mathbf{a}_x$. The speed of light in free space is 3×10^8 m/s.
   (a) **(5%)** In which direction is the wave propagating? Choose one among $+x$, $-x$, $+y$, $-y$, $+z$, and $-z$.
   (b) **(5%)** Find β (in rad/m)?
   (c) If this wave enters a medium which has a refractive index of n = 1.5, find the phase velocity **(5%)**, wavelength **(5%)**, and frequency f in Hz **(5%)** of the wave in this medium.

5. **(本大題共 25%)** In the system shown below, 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 in the figure; and (3) the mass is released, thereby permitting frictionless motion. Obtain the differential equation for x **(10%)** and find the solution as a function of time t **(15%)**.



(In this snapshot, $x = x_0$)

試題隨卷繳回