國立臺灣師範大學 100 學年度碩士班招生考試試題

科目：電磁學　　　　　　　　　　　　　適用系所：光電科技研究所

注意：1.本試題共 2 頁，請依序在答案卷上作答，並標明題號，不必抄題。2.答案必須寫在指定作答區內，否則不予計分。

第 1-5 題選擇題，不須計算過程. 第 6-12 題為計算題，需含計算過程.

1. The so-called longitudinal wave is defined by: the medium is displaced in the direction (a) perpendicular, (b) parallel, (c) glancing, (d) circled, (e) irrelevant　to that of the motion of the wave. **(4 分)**

2. Consider the disturbance given by the expression:

$$\mathbf{E}(z,t) = \left[\hat{a}_x \cos(\omega t) + \hat{a}_y \cos(\omega t - \pi/2)\right] E_o \sin(kz).\quad \textbf{(4 分)}$$

   What kind of polarization is it? (a) non-polarized, (b) linearly-polarized, (c) left-handed circular wave, (d) right-handed circular wave, (e) left-handed circular standing wave (f) right-handed circular standing wave, (g) none of the above.

3. Determine which of the following describe traveling waves:

   (a) $\Psi(y,t) = \exp\left[-\left(a^2 y^2 + b^2 t^2 - 2abty\right)\right]$, (b) $\Psi(z,t) = A\sin\left(az^2 - bt^2\right)$,

   (c) $\Psi(x,t) = A\sin\left[2\pi\left(\dfrac{x}{a} + \dfrac{t}{b}\right)^2\right]$,　　　(d) $\Psi(x,t) = A\cos^2\left[2\pi(t-x)\right]$. **(8 分)**

4. The electric field of an electromagnetic wave traveling in the positive x-direction is given by

   $\mathbf{E} = \hat{a}_y E_0 \sin\left(\dfrac{\pi z}{z_0}\right)\cos(kx - \omega t)$. From wave equation, $k = ?$

   (a) $\dfrac{c}{\omega}\sqrt{1 - \left(\dfrac{\pi c}{\omega z_0}\right)^2}$, (b) $\dfrac{\omega}{c}\sqrt{1 - \left(\dfrac{\omega z_0}{\pi c}\right)^2}$, (c) $\dfrac{\omega}{c}\sqrt{1 - \left(\dfrac{\pi c}{\omega z_0}\right)^2}$

   (d) $c\left/\sqrt{1 - \left(\dfrac{\pi c}{\omega z_0}\right)^2}\right.$, (e) $c\left/\sqrt{1 - \left(\dfrac{\omega z_0}{\pi c}\right)^2}\right.$, (f) $\omega\left/\sqrt{1 - \left(\dfrac{\pi c}{\omega z_0}\right)^2}\right.$,

   (g) none of the above. **(8 分)**

5. A non-symmetrical 3-slab optical fiber is constructed with core thickness d $(-d/2 < y < d/2)$ and refractive index n_1, two cladding layers with refractive indices n_3 $(y > d/2)$ and n_2 $(y < -d/2)$, where $n_1 > n_2 > n_3$. The cross section is shown in Figure 1. What is the minimum incident ray angle θ_m that a guided mode could have in this structure?

   (a) $\cos^{-1}\left(\sqrt{n_1^2 - n_2^2}\right)$, (b) $\cos^{-1}\left(\sqrt{n_1^2 - n_3^2}\right)$, (c) $\cos^{-1}\left(\sqrt{n_2^2 - n_3^2}\right)$, (d) $\sin^{-1}\left(\sqrt{n_1^2 - n_2^2}\right)$,

   (e) $\sin^{-1}\left(\sqrt{n_1^2 - n_3^2}\right)$, (f) $\sin^{-1}\left(\sqrt{n_2^2 - n_3^2}\right)$, (g) none of the above. **(8 分)**
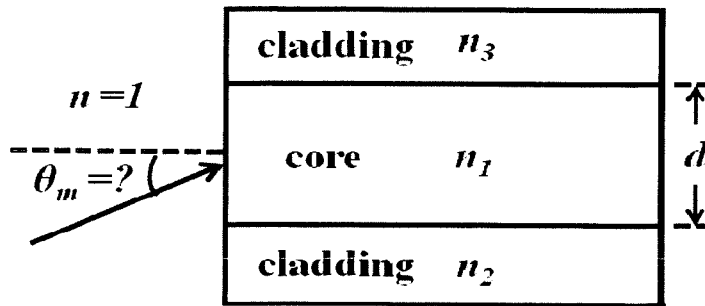
Figure 1

6. The phasor of electric field of a light is given by $\mathbf{E(R)} = \mathbf{E}_0 \exp\left(-jk\hat{a}_n \cdot \mathbf{R}\right)$, indicating that it is propagating along +R-direction in space. How can you identify that it is a transverse wave? **(8 分)**

7. The electric field intensity of a linearly polarized uniform plane wave propagating in the +z-direction in seawater is $\mathbf{E}(0,t) = \hat{a}_x 100\cos\left(10^7 \pi t\right)$ (V/m) at z = 0. The constitutive parameters of seawater are $\varepsilon_r = 72$, $\mu_r = 1$, and $\sigma = 4$ (S/m). Determine (1) the loss tangent (2) the attenuation constant, (3) the phase constant, (4) the phase velocity, and (5) the skin depth. **(10 分)**

8. A 100 W light bulb converts 2% of its electric power into light. The radiation is distributed evenly over a solid angle $\Omega = 1$ sterad by a reflector. What is the amplitude E_0 of the light field at a distance of $d = 50$ cm from the bulb? ($\varepsilon_0 = 8.85 \times 10^{-12}$ F/m, $\mu_0 = 4\pi \times 10^{-7}$ H/m) **(10 分)**

9. Determine **E**-field at point (1,1,0) if (1) $V = V_0 e^{-x} \sin\left(\dfrac{\pi y}{4}\right)$ (Cartesian Coordinate) ; (2) $V = E_0 R \cos\theta$ (Spherical Coordinate). **(10 分)**

10. Find the energy required to assemble a uniform sphere of charge of radius b and volume charge density ρ. **(10 分)**

11. An air coaxial transmission line has a solid inner conductor of radius a and a very thin outer conductor of inner radius b. Determine the inductance per unit length of the line. **(10 分)**

12. Show that the polarization angles for internal and external reflection at a given interface are complementary. **(10 分)**