

※ 請於答案卷上非選擇題作答區標明題號作答。簡答題及作圖題計算過程不計分。計算題請詳列過程。
Useful constants: $\epsilon_0 = 10^{-9}/(36\pi)$ F/m, $\mu_0 = 4\pi \times 10^{-7}$ H/m

1. (簡答題) The core and cladding refractive indices of a fiber are 1.5 and 1.0, respectively. Its diameter is 100 μm . If it is a single mode fiber, the cut-off wavelength is _____ μm . (3%)
2. (簡答題) A plane wave is launched from free space to a nonmagnetic dielectric with $\epsilon_r = 3.0$. The dielectric and free space are separated by $z = 0$ plane. The magnetic field of the wave is parallel to the $z = 0$ plane. The incident angle is 60 degrees with respect to z -axis. The reflection coefficient is $\Gamma =$ _____. (3%)
3. (簡答題) Two dipole antennas in free space are situated at two points in x -axis, $(\lambda/2, 0, 0)$ and $(-\lambda/2, 0, 0)$, with currents $I_1 = I_0 \cos(\omega t + \frac{\pi}{2})$ and $I_2 = I_0 \cos(\omega t - \frac{\pi}{2})$, respectively, where λ and ω are the wavelength and angular frequency, respectively. The group pattern of the antenna array has maximum in _____ and minimum in _____. Note: Your answer should be some direction(s) or some plane(s). (6%)
4. (計算題) A parallel-plate resonator consists of two infinite, plane, perfectly conducting plates in the $z = 0$ and $z = d$ planes. The plates are separated by a perfect dielectric with dielectric constant ϵ and permeability μ . The electric field is given by $\mathbf{E} = E_0 \cos(\phi - nkz) \cos(n\omega t) \mathbf{a}_x$, where $n = 1, 2, 3, \dots$
 - (a) Write ϕ , k and ω in terms of d , ϵ , and μ . (6%)
 - (b) Find the energy stored in the resonator per unit area of the plates. (5%)
 - (c) If the plates are made of imperfect but good conductors with conductivity σ , find the quality factor Q of the resonator in term of d , ϵ , μ , and σ . (6%)
 - (d) The dielectric is made of glass with refractive index $n = 2.0$. The plates are made of aluminum with conductivity $\sigma = 3.5 \times 10^7$ (S/m), and separated by $d = 0.5$ cm. Compute the value of Q for the fundamental mode of oscillation. (4%)
5. (簡答題及作圖題) In the system shown in Figure 1, a passive nonlinear element having the indicated volt-ampere characteristics is connected to an initially charged line at $t = 0$.
 - (a) The voltage across the nonlinear element immediately after closure of the switch is _____ volt. (5%)
 - (b) Use the load-line technique to obtain and plot line voltage versus t from $t = 0$ up to $t = 7l/v_p$ at $z = 0$ (4%) and $z = l$. (4%)

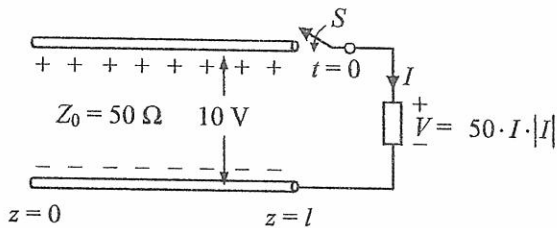


Figure 1 (for Question 5)

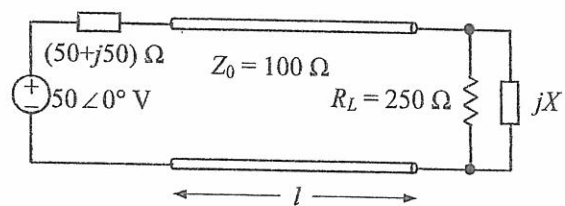


Figure 2 (for Question 6)

6. (計算題) In the system shown in Figure 2, the time-average power delivered to the resistor R_L is a maximum if a proper value of the reactance X is used.
 - (a) Find the value of the reactance X . (5%)
 - (b) Find the minimum value of the line length l . (5%)
 - (c) Find the maximum time-average power delivered to the load R_L . (5%)

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(d) Find the SWR on the line. (5%)

7. (計算題) Light can be treated as an electromagnetic wave. Consider a *plane wave* of infrared light which has a wavelength $\lambda_0 = 1.5 \times 10^{-6}$ m when it propagates in the *free space*. Answer the following questions.

(a) What is the frequency f (in Hz) of this electromagnetic wave when it propagates in the *free space*? (2%)

(b) Assume this electromagnetic wave enters a dielectric medium with a relative permittivity (i.e. dielectric constant) $\epsilon_r = 4$ and a relative permeability $\mu_r = 1$. What are the ①frequency f (in Hz) (2%), ②wavelength (2%), and ③phase velocity (2%) of this electromagnetic wave when it propagates in this dielectric medium?

8. (計算題) Consider a capacitor formed with two identical *circular* conductor plates and a dielectric *cylinder*. Figure 3 is the *side view* of the capacitor. Each plate has a radius R and the spacing between the plates is d . The dielectric cylinder has a radius r and a height h and is fixed at the center of the bottom plate. The cylinder material has a relative permittivity ϵ_r . A voltage V is applied between the plates and the free-space permittivity is ϵ_0 . Answer the following questions. [Note: (1) Please neglect the fringing of fields. (2) $R > r$; $d > h$.]

(a) Find the electric field intensity in region ①? (2%)

(b) Find the electric field intensity in region ②? (3%)

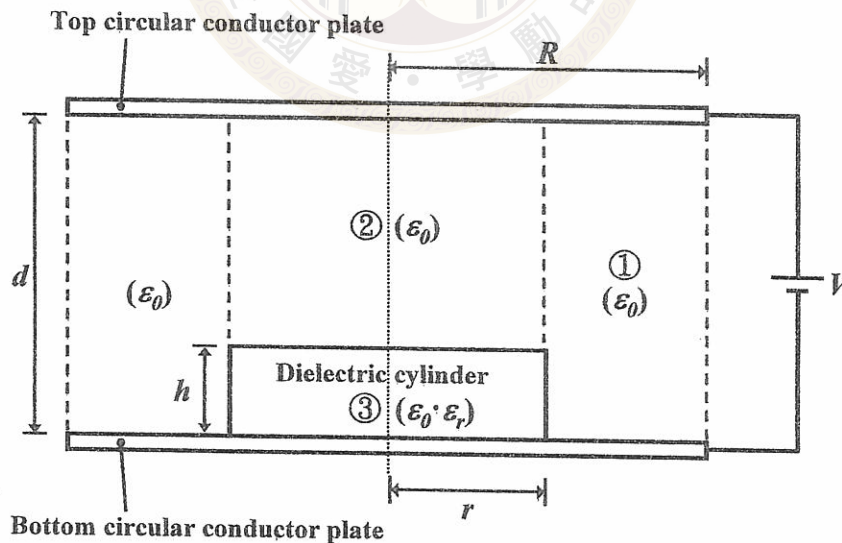
(c) Find the electric field intensity in region ③? (3%)

(d) Find the total charge on the *top plate*? (3%)

(e) Find the capacitance of this capacitor? (3%)

(f) Find the total electric stored energy W_e in the capacitor? (3%)

(g) Find the mechanical force F_e of electric origin exerted on the *top plate*? (7%) Is it upward or downward? (2%)



(Side view of the capacitor)

Figure 3 (for Question 8)

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