502401、502501



國立台灣科技大學九十九學年度碩士班招生試題

系所組別： 電子工程系碩士班乙三組、丙組

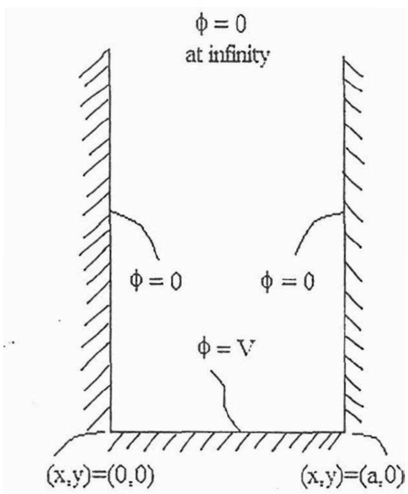
科　　目： 電磁學

(總分為100分)

(1) For a conducting sphere of radius "a" in a uniform electric field "$E_0$", please find the distribution of electric potential outside the sphere. (10%)

(2) A point charge "q" is brought to a position a distance "d" away from an infinite plane conductor held at zero potential. Find the work necessary to remove the charge "q" from its position to infinity. (10%)

(3) For a two-dimensional potential problem shown below, find the potential distribution $\phi(x,y)$. Both the conducting sidewalls held at zero potential extend to infinity. The bottom conducting plane is held at a potential of V. (10%)




(4) Find the energy density of magnetic field intensity "B" in free space. (10%)

(5) Find the energy density of electric field intensity "E" in free space. (10%)

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6. The equivalent circuit of a differential length $\Delta z$ of a transmission line is shown in Fig. 6.
   (a) Write down the formulas of the propagation constant $\gamma$ (2%) and the characteristic impedance $Z_0$, which are represented by $\omega$, $R$, $L$, $C$, and $G$. (2%)
   (b) For a lossless transmission line, write down the formula of the phase velocity $u_p$, which is represented by $\omega$, $R$, $L$, $C$, and $G$. (2%).

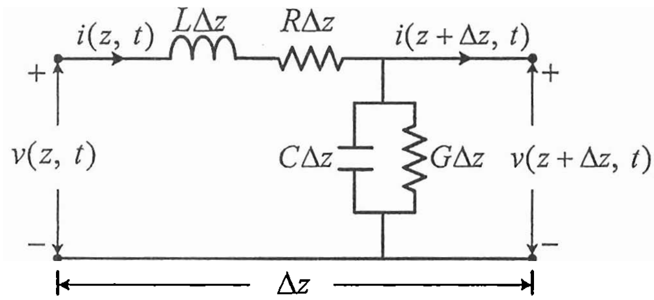


Fig. 6

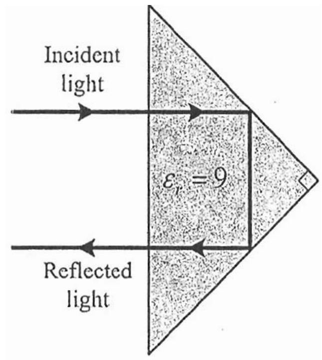


Fig. 7

7. A dielectric isosceles triangular prism shown in Fig. 7 is used in optical instruments. Assuming $\varepsilon_r = 9$, calculate the percentage of the incident light power reflected back by the prism. (10%)

8. Shown in Fig. 8 (a) is an open-circuited lossless transmission line with a length of 0.5 m. The impedance $Z_{in}$ measured at the input terminal is -*j*60 (Ω). Note that the length of transmission line is less than a quarter wavelength. Here, $\beta$ of the transmission line is 0.5 rad/m.
   (a) Find $Z_0$ of the transmission line. (6%)
   (b) Which lumped element can be used to model this open-stub?
   [Hint: R, L, G, or C] (4%)
   (c) When a conventional transmission line is periodically loaded by above- mentioned open-stubs as shown in Fig. 8 (b), how does the phase velocity $u_p$ change? (4%)
   [Hint: You can answer "fixed", "increase (become faster)" or "decrease (become slower)"]

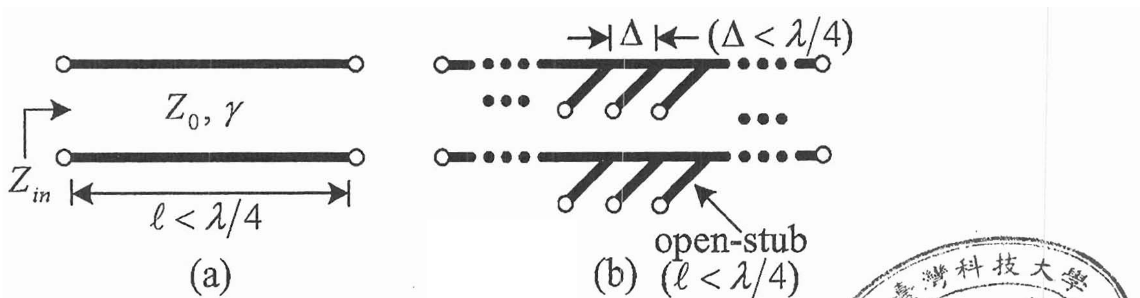


Fig. 8

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9. A rectangular waveguide shown in Fig. 9 (a) with inner dimensions $a$=2 cm and $b$=1 cm, which is filled with polyethylene $\varepsilon_r$=2.25, $\mu_r$=1.
   (a) Determine the cutoff frequency $f_c$ of the waveguide shown in Fig. 9 (a). (4%)
   [Hint: Find the cutoff frequency of fundamental mode.]
   (b) When the metallic ridges are inserted in the center of the waveguide as shown in Fig. 9 (b), one can obtain a double-ridge waveguide. Similar to a transmission line, it can also be modeled by the circuit model shown in Fig. 6. By inserting metallic ridges, which component in Fig. 6 will have a significant change? (3%) [Hint: You can answer "No" or "R, L, C, or G (choose one)/increase or decrease (choose one)".]
   (c) As compared with the conventional waveguide shown in Fig. 9 (a), how does the cutoff frequency $f_c$ of the double-ridge waveguide change? (3%) [Hint: You can answer "fixed", "increase (to a higher frequency)" or "decrease (to a lower frequency)"]

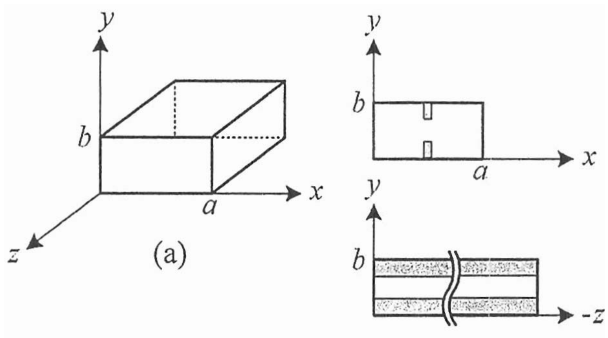


Fig. 9

10. A uniform plane wave is incident from air on a very large, perfectly conducting wall at an angle of incident $\theta_i$ with perpendicular polarization. Find the induced current $\vec{J}_s$ on the wall surface (10%) [Hint: The total magnetic field in the air is

$$\vec{H}_0(x,z) = -2\frac{E_i}{\eta_0}[\hat{a}_x \cos\theta_i \cos(\beta_0 z\cos\theta_i)e^{-j\beta_0 x\sin\theta_i} + \hat{a}_z j\sin\theta_i \sin(\beta_0 z\cos\theta_i)e^{-j\beta_0 x\sin\theta_i}].]$$

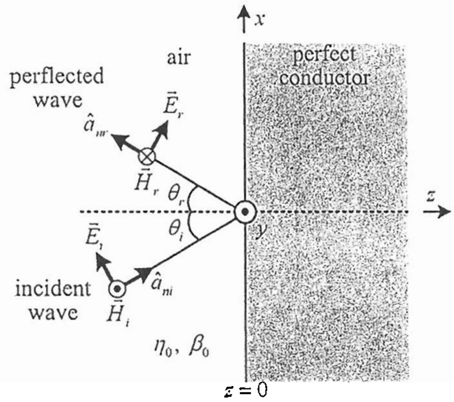


Fig. 10