國立臺灣科技大學 111 學年度碩士班招生試題

系所組別：光電工程研究所碩士班

科　　目：電磁學

(總分為 100 分；所有試題務必於答案卷內頁依序作答，否則不予計分)

1. Given two point charges: q_1 = +2(nC) at (0.1 m, 0.0 m, 0.8 m) and q_2 = -3(nC) at (0.0 m, -0.2 m, 1.0 m) in vacuum. (The permittivity $(\varepsilon_0) = \frac{1}{36\pi} \times 10^{-9}$ (F/m))

   (a) Determine the electric field intensity at q_1 due to q_2. (5%)

   (b) The magnitude of the force experienced by q_1. (5%)

2. A cylindrical bar of silicon has a radius of 1 mm and a length of 20 mm. If a voltage of 2 V is applied between the ends of the bar and the electron mobility (μ_e) = 0.135 ($m^2/V \cdot s$), hole mobility (μ_h) = 0.048 ($m^2/aV \cdot s$), electron concentration (N_e) = 1.5×10^{16} (electrons/m^3), and hole concentration (N_h) = 1.5×10^{16} (holes/m^3). Please find:

   (Charge of electron ($-e$) = -1.6×10^{-19} C)

   (a) The conductivity of silicon. (4%)

   (b) The current I flowing in the bar. (4%)

   (c) The electron and hole drift velocities. (4%)

   (d) The resistance of the bar. (4%)

   (e) The power dissipated in the bar. (4%)

3. Given the magnetic field intensity ($\overline{H}$) = $10\rho^2 \hat{a}_\phi$ (A/m):

   (a) Determine the current density. (10%)

   (b) Find the total current in the $\hat{a}_z$ direction through the circular surface $\rho = 1$, $0 < \phi < 2\pi$, $z = 0$. (10%)

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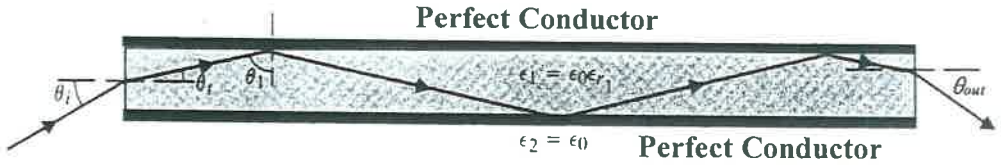
4. Consider the Maxwell's equations in phasor form shown below. (a) Please write down the equations that govern the electrostatic problems. (5%) (b) Please write down the equations that govern the magnetostatic problems. (5%)

$$\nabla \times \boldsymbol{E} = -j\omega\mu\boldsymbol{H}$$
$$\nabla \times \boldsymbol{H} = \boldsymbol{J} + j\omega\varepsilon\boldsymbol{E}$$
$$\nabla \cdot \boldsymbol{E} = \rho/\varepsilon$$
$$\nabla \cdot \boldsymbol{H} = 0$$

5. Consider the parallel-plate waveguide filled with the material of relative dielectric constant ε_{r1}=4 shown below. Assume a plane wave incidents on the left side of the parallel-plate waveguide with an angle θ_i=30°. (a) Please calculate the angles θ_t, θ_1, and θ_{out}. (10%) (b) When the perfect conductors of the parallel-plate waveguide are removed, will the plane penetrate out of the upper and lower boundaries? Why? (10%) (sin30°=1/2, sin14.48°=1/4)



6. Consider the transmission line circuit shown below. (a) When the impedance $Z=Z_0$, please write down the expressions for the reflection coefficient Γ and transmission coefficient T. (10%) (b) What should the value of the impedance Z be so that the reflection coefficient Γ will be zero? (10%)