中原大學 102 學年度 **碩士班** 入學考試

102/3/2　10:00 ~ 11:30　電子工程學系光電半導體組

誠實是我們珍視的美德，
我們喜愛「拒絕作弊，堅守正直」的你!

科目：　電磁學　　(共 1 頁 第 1 頁)

□可使用計算機，惟僅限不具可程式及多重記憶者　　■不可使用計算機

一. In the simple lossy medium of conductivity σ, permittivity ε and permeability μ:

1). Directly write down the Maxwells' equations for two time-varying fields $\vec{E}$ and $\vec{H}$ by considering charge source ρ. (8%)

2). Prove that four equations are inter-dependent and further-more resulted in a continuity equation from the Faradays' and general Amperes' law, respectively. (12%).

3). Derive the Lenzs' law for obtaining an electromotive force V_{emf} related with magnetic flux Ψ from the Faradays' law. (5%)

4). For simplicity, a uniform plane wave of the angular frequency ω propagates along $\hat{z}$ –direction in the lossy and source-free medium ($\rho = 0$). Derive the Helmholtz's differential wave equation for the complex electric field $\vec{E}$ (8%) with indicating complex propagation constant γ (2%)

5). By the way, verify the discharge (decaying) process by using continuity equation, $\rho(t) = \rho_0 \cdot e^{\frac{-t}{\tau_r}}$, with relaxation time $\tau_r = \frac{\varepsilon}{\sigma}$ and initial charge density ρ_0. (5%)

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二. A conducting sphere (electrode) of radius a is located in an external uniform electric field $\vec{E} = \hat{z}E_0, (E_0 = const.)$:

1). Employ what equation (2%) to solve the electric potential expressed as $V(r,\theta) = -E_0[1-(\frac{a}{r})^3]r \cdot \cos\theta$ at any point $P(r,\theta)$ outside the sphere.

2).Identify that electric flux lines are always normal to conducting surface.(3%) Meantime, find the surface charge density $\rho_s(\theta)$ induced on the conducting surface of sphere. (5%)

3). Solve the induced electric field $\vec{E}_i$ at the center of the sphere. (10%)

三. For one-sided abrupt-p^+n-diode of semiconductor permittivity ε_s, doping concentrations n_A and n_D in p^+ and n regions, respectively ($n_A >> n_D$):

1). Solve the electric profile E(x) in the n-depletion region ($0 \leqq x \leqq x_n$). (10%)

2). Derive the built-in potential (or potential barrier height) V_{bi} at thermal equilibrium. (10%)

四. Perfect electric conducting (PEC) interconnection ($\sigma_c \to \infty$) is deposited onto the oxide-dielectric layer of thickness d=50 nm and relative permittivity $\varepsilon_r = 4$ for attaining a characteristic impedance $Z_0 = 50\Omega$ of microstrip transmission line in IC-design :

1). Derive two distributed elements per unit length C' and L' for parameters ε and μ, respectively. (6%)

2). Evaluate the width w of microstrip-line. (10%)

3). Finally, calculate the propagating speed υ_p of the extremely high frequency digital signal via transmission line. (4%)