中原大學 94 學年度碩士班入學考試

3 月 20 日 14:00~15:30 電子工程系固態組

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： 基本電磁學 （共 2 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

1. A spherical electrode of radius a is charged by Q,and is immersed into the lossy dielectric material of conductivity σ and permittivity ε :
   a) Determine the electric field En on the conducting surface.(5%)
   b) Determine the capacitance C for this single electrode.(5%)
   c) Prove, how long time is needed that the total charge Q is almost disappeared(discharged)from the electrode.(7%)
   d) Use the relaxation time to determine the resistance R.(3%)

2. An one-sided abrupt p^+n^-junction of semiconductor with permittivity ε_s and $N_A >> N_D$, derive the electric field E(x) distributed in the depletion n-region($0 \leqq x \leqq x_n$) (10%)
3. A p-type semiconductor chip of hole concentration N_p in rectangular shape with length l_x, thickness d_y and width W_z is exposed normal to the magnetic field B_z and injected by the current density $J_x = I_0/(d_y \cdot w_z)$. Determine the Hall-field E_H in y-direction in terms of J_x and B_z , if the hole charge is regarded as q.(10%)
4. Express the following two formulations:
   a) A (differential) current element $I_1 d\vec{l}_1$ exerts a magnetic force $d\vec{F}_{12}$ on the other current element $I_2 d\vec{l}_2$.(note their cross-products).(5%)
   b) An arbitrary loop C moves in the time-varying magnetic field $\vec{B}(t)$ with its velocity $\vec{v}$, express the induced electromotive force V_{ind} including two parts.(5%)
5. Provided that ρ and $\vec{J}$ are time-varying charge and current densities, exist in the lossless simple medium of permittivity ε and permeability μ ;
   a) Express the Maxwells ’ equations in terms of two time-varying fields $\vec{E}$ and $\vec{H}$ in the medium.(5%)
   b) Prove the $\vec{E}$ -field in relation to the both potentials V and $\vec{A}$.(3%) And what means the term: $\frac{\partial \vec{A}}{\partial t}$ =0.(2%)

c) Derive the inhomogeneous Helmholtz(wave) equation for the time-varying vector magnetic potential $\vec{A}$.(5%)

d) Similarly, solve the retarded potential $\tilde{V}(r)$ in phasor form at a distance r away from the time-varying point charge Q(t)=Q cos(ωt+ θ) using its phasor (complex) form expressed as $\tilde{Q}$ =Q · $e^{-j\theta}$.(5%)

e) In the preceding question(c), prove and explain the physical meaning of Lorentzs ' condition.(5%)

6. A Hertzian dipole antenna, i.e. a sinusoidal current i(t)=Io · cosωt flowing in a very short length l, is located on z-axis in the above-mentioned medium.

a) Determine both fields $\tilde{H}(r)$ and $\tilde{E}(r)$ in phasor form at a distance r away from the dipole antenna.(10%)

b) Prove that in the near-zone (β · r<<1),the electric field: $\tilde{E} = \frac{\tilde{q}l}{4\pi\varepsilon r^3}\left(\hat{r}2\cos\theta + \hat{\theta}\sin\theta\right)$ where the substitutions are $\tilde{I} = jw\tilde{q}$ and $\eta / \beta = 1/\omega\varepsilon$.(5%) By the way, compute the power density (Poynting ' s vector $\vec{S}$) to verify as a capacitor behavior.(5%)

c) Express the far-field components $\tilde{H}$ and $\tilde{E}$ for β · r>>1(5%)