國立中正大學
112學年度碩士班招生考試
試 題

[第1節]

科目名稱	電磁學
系所組別	電機工程學系-電磁晶片組

－作答注意事項－

※作答前請先核對「試題」、「試卷」與「准考證」之系所組別、科目名稱是否相符。

1. 預備鈴響時即可入場，但至考試開始鈴響前，不得翻閱試題，並不得書寫、畫記、作答。
2. 考試開始鈴響時，即可開始作答；考試結束鈴響畢，應即停止作答。
3. 入場後於考試開始40分鐘內不得離場。
4. 全部答題均須在試卷（答案卷）作答區內完成。
5. 試卷作答限用藍色或黑色筆（含鉛筆）書寫。
6. 試題須隨試卷繳還。

國立中正大學 112 學年度碩士班招生考試試題

科目名稱：電磁學　　本科目共 2 頁　第 1 頁

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1. (5%) Find ∇V for the scalar function $V = 2r^2\cos^2\phi$.

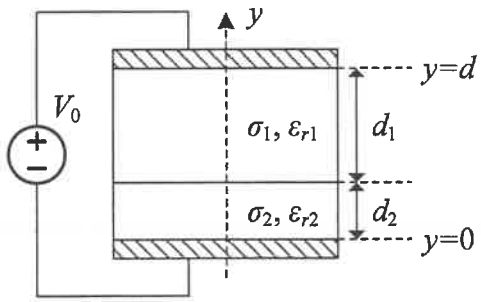


Fig. 1

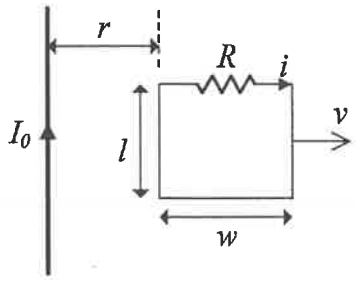


Fig. 2

2. (15%) An dc voltage V_0 is applied across a parallel-plate capacitor of area S as shown in Fig. 1. The space between the metal plates is filled with two different lossy dielectrics of thickness d_1 and d_2, dielectric constants ε_{r1} and ε_{r2}, and conductivities σ_1 and σ_2, respectively. Given $V_0 = 5$ V, $d_1 = 1$ mm, $d_2 = 0.5$ mm, $\sigma_1 = 2$ S/m, $\sigma_1 = 5$ S/m, $\varepsilon_{r1} = 4.4$ and $\varepsilon_{r2} = 2.2$, respectively, determine
   (a) (3%) The current density $\boldsymbol{J}$ between the plates.
   (b) (4%) The electric field intensities $\boldsymbol{E}$ in both dielectrics.
   (c) (4%) The surface charge densities on the metal plates
   (d) (4%) The surface charge density at the interface.

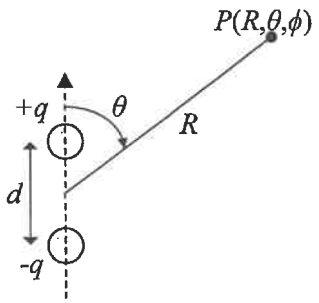


Fig. 3

3. (10%) Given a 4.0 cm radius solid wire centered on the z-axis with a volume current density $\boldsymbol{J} = \boldsymbol{a}_z 8r$ A/cm^3 (for r in cm), calculate and plot the magnetic field intensity $\boldsymbol{H}$ versus radial distance from the z-axis over the range $0 \le r \le 10$ cm.

4. (10%) A rectangular loop is moving with velocity v radially away from a wire that carries a dc current I_0 as shown in Fig. 2. Determine:
   (a) (5%) The magnetic flux through the loop as a function of time.
   (b) (5%) An expression for the current induced in the loop as a function of time.

5. (10%) An electric dipole as shown in Fig. 3 consists of positive charge $+q = 10e$ and negative charge $-q = -10e$ with a small separation of 5×10^{-12} m, where $e = 1.6\times10^{-19}$ C is the elementary charge. Find:
   (a) (3%) The dipole moment of the electric dipole.

(b) (3%) The electric potential V at P as $R \gg d$ in terms of spherical coordinates.

(c) (4%) The electric field intensity $\boldsymbol{E}$ at P as $R \gg d$ in terms of spherical coordinates.

6. (24%) An EM-wave (frequency= 1×10^9 Hz) traveling in a dielectric medium (medium-1) impinges normally upon a perfect conductor (medium-2). Figure below shows the magnitude plot of E-field standing waves generated in medium-1

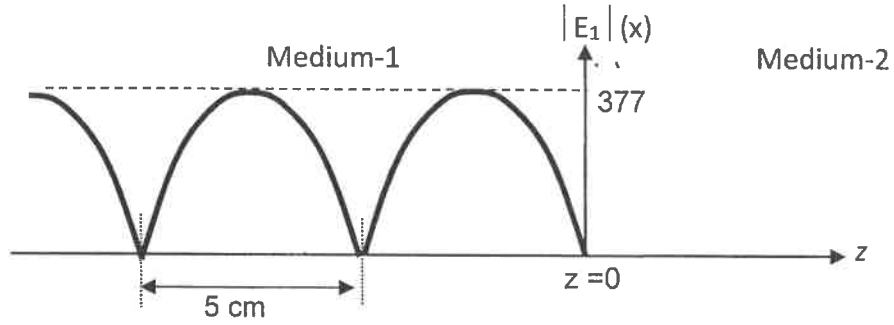


Fig. 4

(a) (3%) Find the standing wave ratio (SWR)

(b) (3%) Determine the wavelength λ of this wave.

(c) (3%) Find the propagation velocity v_p.

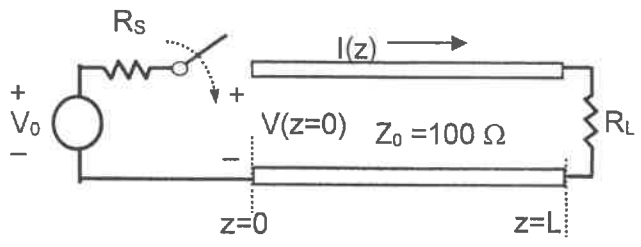
(d) (3%) Determine the propagation constant β of this wave.

(e) (3%) What is the dielectric constant of medium-1?

(f) (3%) What is the characteristic impedance of medium-1?

(g) (6%) Find the mathematical expressions for the incident E-field and H-field.

7. (26%) A 100-Ohm dielectric-filled (ε_r=2) transmission line is excited by connecting it to the voltage source at t = 0 shown as below. The voltage V(z=0, t) observed at the input of the line is given by :



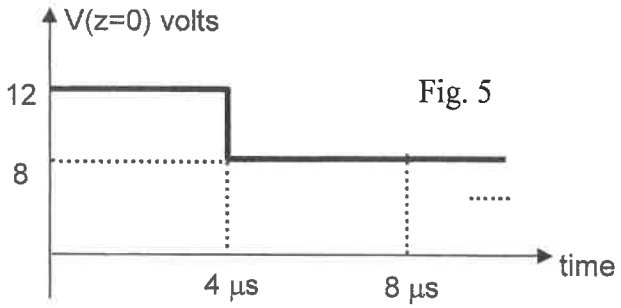


Fig. 5

(a) (3%) What is the length L of this line?

(b) (3%) What is the value of the load R_L?

(c) (3%) What is the value of the load R_S?

(d) (3%) What is the value of generator voltage V_0?

(e) (3%) What is the capacitance C per meter of this transmission line?

(f) (5%) Plot the bounce (Reflection) diagram (Time vs. z).

(g) (6%) Plot voltage vs. time observed at z = 0.4L.