

國立中正大學

111 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。

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科目名稱：電磁學

本科目共 3 頁 第 1 頁

系所組別：電機工程學系-電磁晶片組

1. (8%) The potential field in a uniform material with dielectric constant $\epsilon_r = 80$ is $V = 2x^2y^4$ (V). Find
 - (a) (4%) The electric field intensity \vec{E} .
 - (b) (4%) The polarization vector \vec{P} .

2. (12%) A boundary separating two dielectric media with permittivities $\epsilon_1 = 23\epsilon_0$ ($z > 0$) and $\epsilon_2 = 4\epsilon_0$ ($z < 0$) lies in the x - y plane. The boundary has a surface charge density $\rho_s = 2.653 \times 10^{-10}$ C/m² and the electric field intensity in medium 1 at the boundary is $\vec{E}_1 = \hat{a}_x 5 + \hat{a}_y 10 + \hat{a}_z 2$ (V/m). Find:
 - (a) (4%) The tangential electric field in medium 2.
 - (b) (4%) The normal electric field in medium 2.
 - (c) (4%) The angle between \vec{E}_2 and z axis.

3. (10%) A coaxial cable as shown in Fig. 1 consists of two concentric, conducting cylindrical surfaces of inner and outer radii a and b , respectively. An insulating material of dielectric constant ϵ_r fills the space between the two surfaces. Two charges $+Q$ and $-Q$ uniformly distribute on the inner and outer surfaces. Given $\epsilon_r = 2.3$, $a = 0.5$ cm, $b = 2$ cm, $l = 100$ cm, and $Q = 0.2$ nC. determine:
 - (a) (3%) The electric field in the dielectric medium.
 - (b) (3%) The unit-length capacitance of the cable.
 - (c) (4%) The stored electrostatic energy in the dielectric medium

4. (12%) An infinitely long conductor wire carrying current I is situated next to a rectangular loop as shown in Fig. 2. Given $I = 5$ A, $d = 1$ cm, $a = 2$ cm, $b = 8$ cm, determine:
 - (a) (4%) The net magnetic force acting on the loop.
 - (b) (4%) The magnetic flux that penetrates the loop.
 - (c) (4%) The mutual inductance between the wire and the loop.

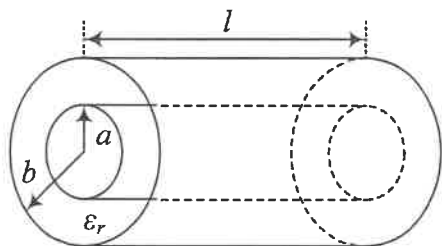


Fig. 1

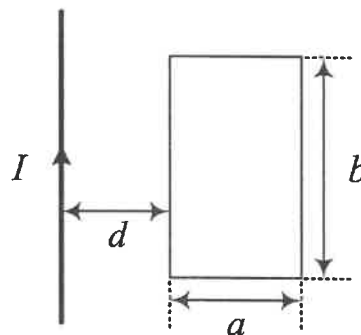


Fig. 2

5. (8%) Two infinite insulated conducting plates maintained at potentials 0 and V_0 form a wedge-shaped configuration, as shown in Fig. 3. Determine the potential distributions for the regions:
 - (a) (4%) $0 < \phi < \alpha$
 - (b) (4%) $\alpha < \phi < 2\pi$

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科目名稱：電磁學

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系所組別：電機工程學系-電磁晶片組

6. (18%) A $75\text{-}\Omega$ transmission line is terminated with a complex impedance $Z_L = 45 + j60$. Please determine:
- (3%) Is this load an inductive load or capacitive load?
 - (3%) The load reflection coefficient Γ_L .
 - (3%) The voltage standing wave ratio VSWR?
 - (3%) Find the first V_{\min} position nearest to the load (in wavelength).
 - (6%) To match this load, please design your matching network that includes a quarter-wavelength transformer.
7. (10%) In a material for which conductivity $\sigma = 6\text{ S/m}$ and $\epsilon_r = 4$, the electric field intensity is $\vec{E}(t) = 150 \sin(10^{10}t)$ (V/m). Find:
- (3%) Conductor current J_c
 - (3%) Displacement current J_d
 - (4%) The frequency (Hz) at which J_c and J_d have equal magnitude
8. (10%) Consider a light ray normally incident on one side of the $45^\circ\text{-}90^\circ\text{-}45^\circ$ right-angled prism ($\epsilon_r=2.3$), and exits the prism through two reflective surfaces. Assume that due to manufacturing error, one of the angles of this prism is 46° , and the other complementary angle is 44° , as shown in Fig. 4. Determine the angle θ where the light exits the prism. (hint: $\sin(46^\circ)=0.719$)

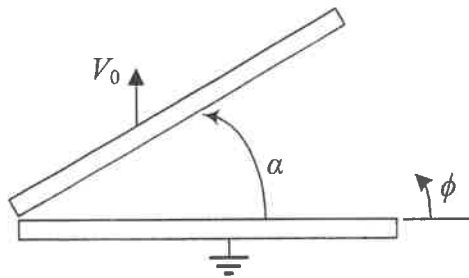


Fig. 3

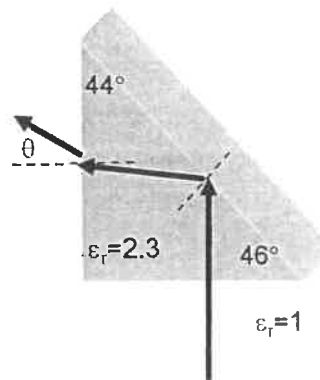


Fig. 4

9. (12%) Please answer the following questions:
- (4%) Will it make sense to define VSWR in a conductive medium? Cite reasons to justify your answers.
 - (4%) Why is the underwater communication using EM wave so difficult? Cite reasons to justify your answers.
 - (4%) The ray trace between the satellite (in space) and GPS antenna (on earth surface) is likely shown as below (Fig. 5). Why is it a curved path instead of a straight path? Cite reasons to justify your answers.

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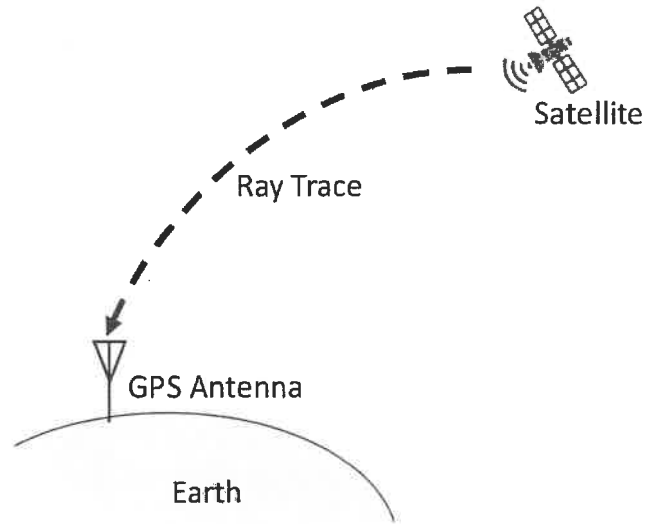


Fig. 5