

國立臺北科技大學 110 學年度碩士班招生考試

系所組別：2402 光電工程系碩士班

第二節 電磁學 試題 (選考)

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注意事項：

1. 本試題共 5 題，每題 20 分，共 100 分。
2. 不必抄題，作答時請將試題題號及答案依照順序寫在答案卷上。
3. 全部答案均須在答案卷之答案欄內作答，否則不予計分。

1. Assuming that the electric field intensity is $\vec{E} = z\hat{a}_z$ (V/m), find the total electric charge contained inside a spherical surface with a radius R and centered at the origin. (20 分)
2. A d-c voltage V is applied across a cylindrical capacitor of length L. The radii of the inner and outer conductors are R and 4R, respectively. The space between the conductors is filled with two different lossy dielectrics having, respectively, permittivity ϵ_1 and conductivity σ_1 in the region $R < r < 2R$, and permittivity ϵ_2 and conductivity σ_2 in the region $2R < r < 4R$. Determine
 - (a) the current density in each region, (5 分)
 - (b) the surface charge density on the inner and outer conductors and at the interface between the two dielectrics. (15 分)
3. Consider a plane boundary ($y=0$) between air (region 1, $\mu_{r1} = 1$) and iron (region 2, $\mu_{r2} = 200$).
 - (a) Assuming $\vec{B}_1 = 5\hat{a}_x - 10\hat{a}_y$ (mT), find \vec{B}_2 and the angle that \vec{B}_2 makes with the interface. (10 分)
 - (b) Assuming $\vec{B}_2 = 10\hat{a}_x + 2\hat{a}_y$ (mT), find \vec{B}_1 and the angle that \vec{B}_1

makes with the interface. (10 分)

4. Given that $\vec{H} = 4 \cos(10\pi x) \sin(3\pi \times 10^9 t - \beta z) \hat{a}_y$ ($\frac{A}{m}$) in air, find \vec{E} and β . (20 分)
5. The \vec{E} -field of a uniform plane wave propagating in a dielectric medium is given by

$$\vec{E}(t, z) = 3 \sin\left(10^8 t - \frac{z}{\sqrt{2}}\right) \hat{a}_x + 2 \cos\left(10^8 t - z/\sqrt{2}\right) \hat{a}_y \left(\frac{V}{m}\right).$$
 - (a) Determine the velocity of the wave. (5 分)
 - (b) What is the relative dielectric constant (ϵ_r) of the medium. (5 分)
 - (c) What is the wave impedance (η) of the medium. (5 分)
 - (d) Find the corresponding \vec{H} -field. (5 分)