

國立中山大學 107 學年度碩士暨碩士專班招生考試試題

科目名稱：電磁學【光電所碩士班】

題號：435002

※本科目依簡章規定「可以」使用計算機（廠牌、功能不拘）（問答申論題） 共 1 頁第 1 頁

1. (10%) A square of side w carries a surface charge density $\rho_s(x, y, 0) = \rho_0|xy|$, as shown in Fig. 1. Please find the electric field intensity above the center of the square $E(0,0,z)$, for $z > 0$.
2. A point charge Q with mass m is located at distances $\alpha\ell$ and ℓ , respectively, from two grounded perpendicular conducting half-planes, as shown in Fig. 2, where $\alpha = \left(\frac{2\pi}{2+\pi}\right)^{\frac{2}{3}} > 1$. After releasing the charge from rest, please determine, (ignore radiation loss)
 - (a) (10%) how long will it take for the charge to strike a plane, and
 - (b) (10%) the position where the charge will strike.
3. A point charge Q is located at a distance ℓ from a plane interface at $z = 0$, which separates two semi-finite dielectric media with dielectric constants ϵ_1 and ϵ_2 , as shown in Fig. 3(i). To determine the electric potential $V(x, y, z)$, the image method could be used, as follows. For $z > 0$, the potential is determined by adding an image charge Q' at the symmetrical position, as shown in Fig. 3(ii), and both Q and Q' act with dielectric constant ϵ_1 . For $z < 0$, it is determined by adding an image charge Q'' at the position of actual charge Q , as shown in Fig. 3(iii), and both Q and Q'' act with dielectric constant ϵ_2 . The values of Q' and Q'' must satisfy the boundary conditions at $z = 0$. Please determine,
 - (a) (10%) the values of Q' and Q'' ,
 - (b) (6%) the electric potential $V(x, y, z)$, and
 - (c) (10%) the polarization-charge density on the interface.
4. (10%) As shown in Fig. 4, a conducting circular loop of radius b is next to an infinitely long straight conducting wire, but they are not coplanar. The shortest distances from the wire to the loop center and the plane where the loop exists are ℓ and $\ell \sin \theta$, respectively. Please determine the mutual inductance between the loop and wire.
5. (12%) A uniform plane wave of an angular frequency ω is incident from air on a flat perfect conductor at an angle of incidence θ_i with parallel polarization, as shown in Fig. 5. Please find the surface charge density ρ_s and surface current density \mathbf{J}_s on the conductor, in terms of the magnitude of \mathbf{E}_i , E_{i0} .
6. (10%) Beginning with the Maxwell's equations, please show that the propagation of an electromagnetic wave in a source-free nonconducting simple medium is transverse. That is, show that \mathbf{E} and \mathbf{H} are perpendicular to each other, and both are transverse to the direction of propagation.
7. For a ferromagnetic material,
 - (a) (4%) Please draw a hysteresis loop and explain hysteresis, and
 - (b) (8%) define hysteresis loss, incremental permeability, residual flux density and coercive field intensity in accordance with the hysteresis loop in 7(a).

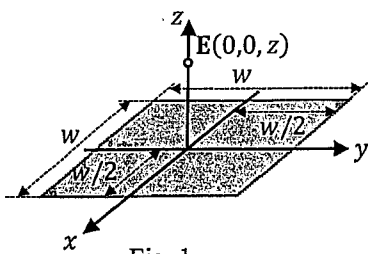


Fig. 1

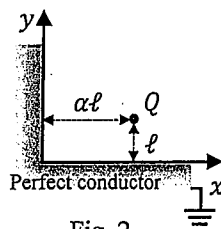


Fig. 2

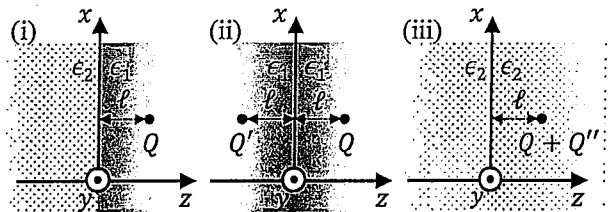


Fig. 3

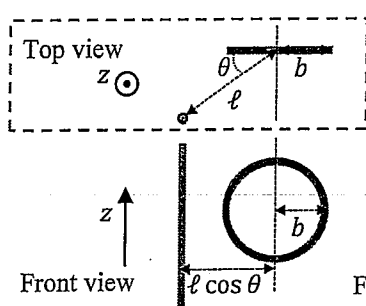


Fig. 4

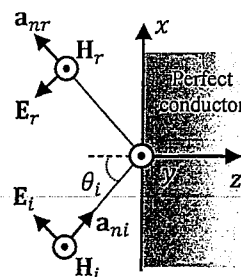


Fig. 5