國立成功大學

110學年度碩士班招生考試試題

編　號：43

系　所：光電科學與工程學系

科　目：電磁學

日　期：0203

節　次：第 2 節

備　註：不可使用計算機

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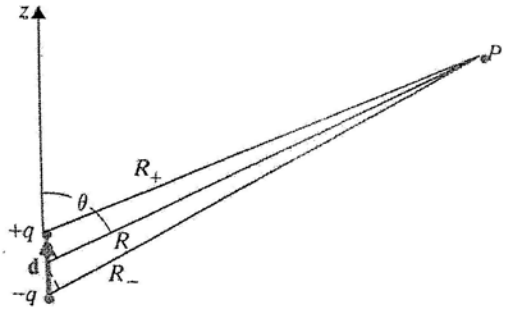
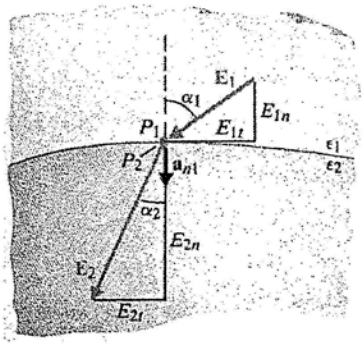
※ 考生請注意：本試題不可使用計算機。　請於答案卷(卡)作答，於本試題紙上作答者，不予計分。

1. A positive point charge Q is at the center of a spherical conducting shell of an inner radius R_i and an outer radius R_o. Determine the electric field and electric potential as functions of the radial distance R. (10%)
2. Consider an electric dipole consisting of charges of $+q$ and $-q$ with a small separation d. The distances from the charges to a field point P are designated R_+ and R_, as shown in following figure. Find the potential and electric field at P under the condition of $d \ll R$. (10%)



3. Two dielectric media with permittivities ϵ_1 and ϵ_2 are separated by a charge-free boundary as shown in following figure. The electric field intensity in medium 1 at the point P_1 has a magnitude E_1 and makes an angle α_1 with the normal. Determine the magnitude and direction of the electric field intensity at point P_2 in medium 2. (10%)



4. Find the magnetic flux density $\vec{B}$ at a point on the axis of a circular loop of radius b that carries a direct current I. (10%)
5. A rectangular loop in the xy-plane with sides b_1 and b_2 carrying a current I lies in a uniform magnetic field $\vec{B} = B_x\hat{x} + B_y\hat{y} + B_z\hat{z}$, as shown in following figure. Determine the force and torque on the loop. (10%)

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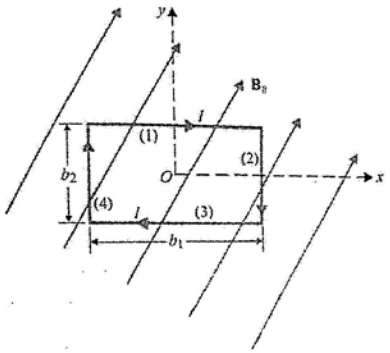

6. A charged particle is in motion at speed v , in a region of vacuum through which an electromagnetic wave is passing. In what direction should the particle be moving to minimize the total force acting on it? Consider both possibilities for the sign of the charge. (5%)
7. Calculate the energy of a system of four particles, each with charge q and located on the corner of a square of length L. (5%)
8. Write the expression for the electric field of a harmonic plan electromagnetic wave with a wavelength $532nm$ and an intensity of $56W/m^2$. The wave is traveling in the $+Z$ direction in vacuum and is linearly polarized at an angle of $45°$ to the x-axis. (5%)
9. A plane harmonic wave linearly polarized is incident at the Brewster angle on an interface between two dielectric media with $n_1 = 1.3$ and $n_2 = 1.6$. The electric field of the incident wave makes an angle of $60°$ with the normal to the plane of incidence. If the intensity of the incident wave is $3.5Wm^{-2}$, determine the intensities for the reflected and transmitted wave. (10%)
10. The circular parallel-plate capacitor is being charged up over time, with the voltage difference across the plates varying as $V = at$, where a is a constant. The plates have radius R, and the distance between them is L. We assume $L \ll R$, so that the electric field between the plates is uniform, and parallel to the axis. Find the induced magnetic field at a point between the plates, at a distance D from the axis. (10%)
11. A point light source at an unknow distance d under oil yields an illuminated circular area with diameter 15 m, seen from the air side of the interface. Find d. Assume the refractive index of the oil is 1.51. (5%)
12. Explain how the displacement current maintains the continuity of current in a circuit containing a capacitor. (5%)
13. The electric field of an electromagnetic wave traveling in vacuum is described by the following wave function: $\vec{E} = (4V/m)\cos[kx - (5 \times 10^9 s^{-1})t + 0.3]\hat{j}$ where k is the wavenumber in rad/m, x is in m, t is in s.

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Find the following quantities:

(a) amplitude. (b) frequency. (c) wavelength. (d) the direction of the travel of the wave. (e) the associated magnetic field wave. (5%)