國立臺灣海洋大學一〇二學年度研究所碩士班暨碩士在職專班招生考試試題

考試科目： 電磁學

系所名稱： 光電科學研究所碩士班不分組

1.答案以橫式由左至右書寫。2.請依題號順序作答。

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1. A parallel-plate capacitor of plate area A is filled with two media of different dielectric constants k_1 and k_2 in two ways as shown in (a) Fig. 1a, and (b) Fig. 1b. Find the capacitance C for these two cases. (13 points)

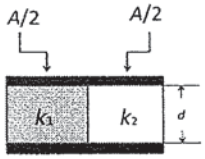

Fig. 1a

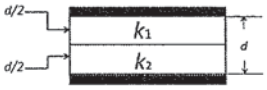

Fig. 1b

2. An infinitely long straight wire has a circular cross section with radius R. If the current density flowing along the wire is distributed over the cross section as $J(r)=Cr^3$ where C is a constant and r is the perpendicular distance from the axis of the wire, find the magnitude of the magnetic field $\vec{B}$ inside and outside the wire as a function of r. (10 points)

3. Two infinitely long straight wires, separated by a distance d, carry currents I_1 and I_2 flowing along the same direction respectively. Find the force per unit length acting on each wire. (11 points)

4. A square conducting loop with side length 10cm lies in the xy plane and has a resistance $10\,\Omega$. If the magnetic field at the location of the loop is given as

$$\vec{B}=15.0t^2\hat{x}+5.0t^3\hat{y}+2.0t^5\hat{z}\ \text{T},$$

where t is in unit of second, find the induced current in the loop when $t=1.0\,\text{sec}$ and $t=10.0\,\text{sec}$. (10 points)

5. An electric field in vacuum space is given as $\vec{E}=\hat{x}E_0\cos(\omega t-kz)$ V/m, where E_0, ω and k are all constants. Find (a) the magnetic field $\vec{B}$ (b) Poynting vector (c) time-averaged energy density of the electric field (d) time-averaged energy density of the magnetic field. (16 points)

6. A solid conductor of radius 2mm and 10m is to be replaced with a hollow conductor of inner radius 2mm. If the two conductors are made of the same material and have the same length and resistance, what must be the outer radius of the hollow conductor? (8 points)

7. Consider a semicircular ring of radius R extending from $\phi = -\pi/2$ to $\phi = +\pi/2$ on x-y plane. If the line charge density in the ring is given as $\lambda = C\cos\phi$, where C is a constant, find the electric field at any point on the z axis. (12 points)

8. Given a potential in form of $\varphi = (q/r)\exp(-\alpha r)$ where q and α are constant, find the charge distribution. (8 points)

9. Consider a thin and infinitely long conducting strip of width a which lies in xz plane and carries a current I flowing along z axis. In more specific words, we consider a current density in form of

$$\vec{J} = \hat{z}I\delta(y) \quad \text{if } |x| < a/2$$
$$0 \quad \text{if } |x| > a/2,$$

find the magnetic field $\vec{B}$. (12 points)