※ 考生請注意：本試題 ☑可 ☐不可 使用計算機

1. Write down the Maxwell's equations in integration and differential forms, respectively. And for each of the Maxwell's equations, write down the corresponding boundary condition in vector form for two different media and the corresponding equation in terms of the scalar potential and the vector potential. (16%)
2. Find the amount of work required for rearrange a uniformly surface charge Q of radius a into a uniformly distributed volume charge of radius a. (15%)
3. For each of the following fields, determine if the polarization is right- or left-circular or elliptical. (16%)

   (a) $E_0\cos(\omega t-\beta y)\mathbf{a}_z+E_0\sin(\omega t-\beta y)\mathbf{a}_x$

   (b) $E_0\cos(\omega t+\beta x)\mathbf{a}_y+E_0\sin(\omega t+\beta x)\mathbf{a}_z$

   (c) $E_0\cos(\omega t+\beta y)\mathbf{a}_x-2E_0\sin(\omega t+\beta y)\mathbf{a}_z$

   (d) $E_0\cos(\omega t-\beta x)\mathbf{a}_z-E_0\sin(\omega t-\beta x+\pi/4)\mathbf{a}_y$.

4. A boundary separated free space from a perfect dielectric medium. At a point on the boundary, the electric field intensity on the free space side is $\mathbf{E}_1=E_0(4\mathbf{a}_x+2\mathbf{a}_y+5\mathbf{a}_z)$, whereas on the dielectric side, it is $\mathbf{E}_2=3E_0(\mathbf{a}_x+\mathbf{a}_z)$, where E_0 is a constant. Find the permittivity of the dielectric medium. (16%)
5. In the system shown below, assume uniform plane waves of frequency f incidient normally onto the interface from medium 1. (a) Find the SWR in medium 1 for $f=10^9$ Hz if $l=5$ cm. (b) Find the three lowest values of f for which complete transmission occures if $l=5$ cm. (c) Find the three lowest values of l for which complete transmittion occurs for $f=10^9$ Hz. (20%)

(背面仍有題目,請繼續作答)

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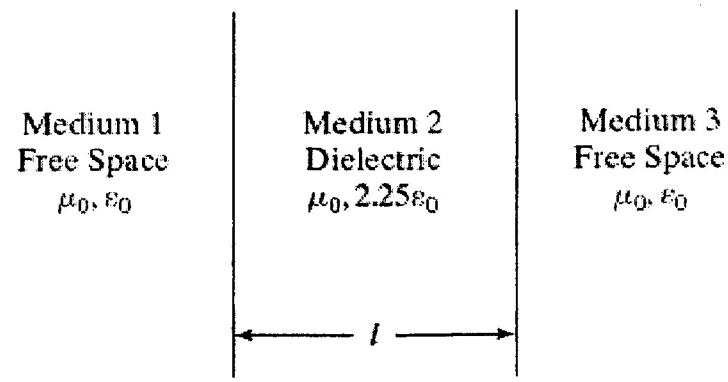

6. The electric far-field for a Hertzian dipole of length dl oriented along the z-axis and carrying current $I = I_0 \cos \omega t$ is given by

$$\mathbf{E} = -\frac{\eta \beta I_0 dl \sin\theta}{4\pi r} \sin(\omega t - \beta r)\mathbf{a}_\theta,$$

where η is the intrinsic impedance of the medium and β is the phase constant. Find the time-average power radiated by the dipole and the equivalent radiation resistance. (17%)

Some formula for your reference:

$$\nabla \bullet \nabla \times \mathbf{A} = 0, \quad \nabla \times \nabla \Phi = \mathbf{0}, \quad \nabla^2 \Phi = \nabla \bullet \nabla \Phi, \quad \nabla^2 \mathbf{A} = \nabla(\nabla \bullet \mathbf{A}) - \nabla \times \nabla \times \mathbf{A}$$

Intrinsic impedance of medium: $\overline{\eta} = \sqrt{\dfrac{j\omega\mu}{\sigma + j\omega\varepsilon}}$

In free space: $c = \dfrac{1}{\sqrt{\varepsilon_0 \mu_0}} = 3 \times 10^8$ m/s, $\eta_0 = \sqrt{\dfrac{\mu_0}{\varepsilon_0}} \approx 120\pi\Omega = 377\Omega$

$$\text{SWR} = \frac{1 + |\overline{\Gamma}_R|}{1 - |\overline{\Gamma}_R|}$$