國立臺灣大學 105 學年度碩士班招生考試試題

1. (20%) For the electric field given in the free space by $\vec{E} = 2te^{-t^2}\vec{a}_z$ V/m, find the electric displacement current corssing an area of 0.1 m^2 in the *xy* plane from the $-z$ side to the $+z$ side for each of the following values of *t*:
   (a) $t = 0$;
   (b) $t = 1$s.

2. (10%) For the electric field given by $\vec{E} = E_0 \cos(6\pi \times 10^8 t - 2\pi z)\vec{a}_x$ V/m, find the corresponding magnetic flux density $\vec{B}$ of the field.

3. (20%) The electric field of a uniform plane wave is given by $\vec{E} = \cos(\omega t + 60^\circ)\vec{a}_x + \cos(\omega t + \alpha)\vec{a}_y$ V/m. Find the value of α for each of the following cases:
   (a) $\vec{E}$ is linearly polarized along a line lying in the first and third quadrants;
   (b) $\vec{E}$ is circularly polarized with the sense of rotation from the $+x$ direction toward the $+y$ direction with time.

4. (30%) Consider a uniform plane wave propagating in a nonmagnetic medium (σ=2 S/m, $\varepsilon = 2\varepsilon_0$, $\mu = \mu_0$) in the positive *z* direction. The electric field of the wave at *z*=0 is given by

   $$\vec{E}\big|_{z=0} = \cos(5 \times 10^4 \pi t)\vec{a}_x \text{ V/m}$$

   Find the following:
   (a) the phase velocity;
   (b) the wavelength;
   (c) the electric field for *z*>0;
   (d) the magnetic field for *z*>0;
   (e) the instantaneous Poynting vector for *z*>0;
   (f) the time average power flow across a surface of area 1 m^2 in the *z*=0 plane at *t*=0.

5. (20%) Region 1 ($z > 0$) is free space, whereas region 2 ($z < 0$) is another medium.
   (a) Find the surface current density $\vec{J}_s(0,0,0)$ at *t*=0 if region 2 is a perfect conductor and $\vec{H}(0,0,0+) = H_0(\vec{a}_x - 2\vec{a}_y)\cos\omega t$.
   (b) Find the magnetic field $\vec{H}(0,0,0+)$ if region 2 is a magnetic material of $\mu = 2\mu_0$ and $\vec{H}(0,0,0-) = H_0(2\vec{a}_x + \vec{a}_z)$.

試題隨卷繳回