Electromagnetic Waves Final
(Jan. 6th, 2014)

1. Write down the Maxwell equation in differential form and define each field quantity (10).

2. The magnetic field vector of an electromagnetic plane wave which propagates in free space at 3GHz is given as

$$\vec{H} = H_0 \cos(\omega t - \alpha x - \beta y)(\vec{e_x} + \vec{e_y})$$

a) Determine the constants α and β (10).
b) Find the direction of propagation and phase velocity (10).
c.) Express the electric field vector and complex Poynting vector (10).

3. The regions $(x < 0)$ and $(x > 0)$ are known to be free space (ε_0, μ_0) and a simple, good conducting medium $(4\varepsilon_0, \mu_0, \sigma)$ respectively. Inside the region $(x < 0)$, an incident plane electromagnetic wave whose magnetic field is always parallel to z axis propagates along +x direction at 1 MHz. The amplitude of the refracted wave at $(x = 0)$ plane is $|\vec{H_t}| = 1\ A/m$ and the amplitude reduces to 0.1 A/m at x = 3.664 m.
a) Determine the conductivity σ of the region $(x > 0)$ (10).
b) Determine the amplitude of incident magnetic field (10).
c) Determine the amplitude of the reflected electric field (10).
(for good conductors $\alpha = \sqrt{\pi f \sigma \mu}$, $\eta = (1+i)\frac{\alpha}{\sigma}$)

4. TE modes are excited inside a hollow, rectangular waveguide whose side lengths has a ratio of b/a = 1/3
a) Find the first 5 cutoff frequencies and define the corresponding modes (10).
b) Given that the long side is chosen as 6 cm, determine the frequency band for the case that only the first mode propagates (10).
c) For the chosen dimensions in (b), determine the frequency band for the case that only first two modes propagate (10).

$$c_0 = 3 \times 10^8 \frac{m}{s}, \qquad \epsilon_0 = \frac{10^{-9}}{36\pi} \frac{F}{m}, \qquad \mu_0 = 4\pi \times 10^{-7} \frac{H}{m},$$

Good Luck...
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