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1. Write down the followings:

(27%) a) the four basic postulates of time-varying electromagnetic fields for a given set of current and charge densities, $\underline{J}(\underline{r},t)$ and $\rho(\underline{r},t)$, in free space. (4%)

b) the constitutive relations of a medium with the relative permeability and relative permittivity, μ_r and ε_r. (3%)

c) the boundary conditions on electromagnetic fields across a boundary surface. (4%)

d) the equation of continuity. (3%)

e) the wave equations for the electric and magnetic fields, $\underline{E}(\underline{r},t)$ and $\underline{H}(\underline{r},t)$. (4%)

f) the mathematical expressions for the electric and magnetic fields in terms of the vector and scalar potentials.(4%)

g) Write down the mathematical expression of Faraday's law of induction, and explain how the Maxwell's equation is derived from Faraday's law of induction. (5%)

2. For a medium with the relative permeability and relative permittivity, μ_r and ε_r, assuming the angular (23%) frequency ω, do the following:

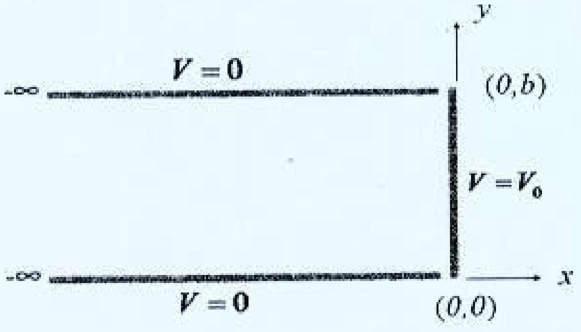
a) write down the time-harmonic Maxwell's equations for the medium.(8%)

b) write down the mathematic expressions of the electric and magnetic fields of a time-harmonic plane wave. (6%)

c) show that the amplitudes vectors of the electric and magnetic fields, $\underline{E}_0$ and $\underline{H}_0$ are perpendicular to each other, and they are both perpendicular to the propagation vector $\underline{k}$ (6%)

d) write down the dispersion relation of the medium (3%)

3. Two grounded, semi-infinite, parallel-plane electrodes are separated by a distance b. A third (10%) electrode perpendicular to and insulated from both is maintained at a constant potential V_0 at $x = 0$ as shown. Find the potential distribution in the enclosed region.(10%)



4. A uniform plane wave propagating in medium 1 with $\mu_{r1} = 1, \varepsilon_{r1} = 16$ has a magnetic field (in (18%) phasor form) given by $\underline{H}(x,y) = \underline{y}_0 H_0 e^{-j(3\pi x + 4\pi z)}$ where H_0 is a real constant. The wave is incident on the planar interface (located at $z=0$) of medium 2 with $\mu_{r2} = 1, \varepsilon_{r2} = 9$, as shown.

a) Match the boundary conditions at the interface and determine the reflection and transmission coefficients at the boundary $z = 0$.(10%)

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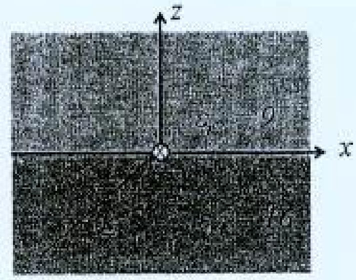
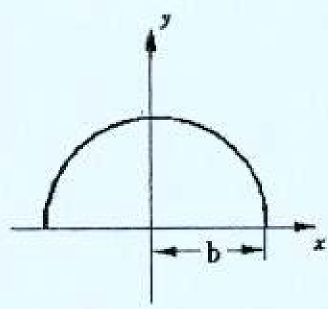
b) Determine the angle of incidence to minimize the reflection at $z = 0$.(4%)

c) Determine the minimum angle of incidence such that the incident wave is totally reflected at $z = 0$.(4%)



5. A line charge of uniform density ρ_l in free space forms a semicircle of radius b. Determine the magnitude and direction of the electric field intensity at the center of the semicircle.(10%)

(10%)



6. A uniform static magnetic field is directed along the z-axis. An electric charge q starts initially at $x=-x_0$ and $y = 0$, and is shot out at the initial velocity u_0 in the y-direction at $t=0$, as shown. Given the mass of the charge to be m_e, find the minimum time required for the charge to return to the initial position ($x=-x_0$, $y = 0$).(12%)

(12%)