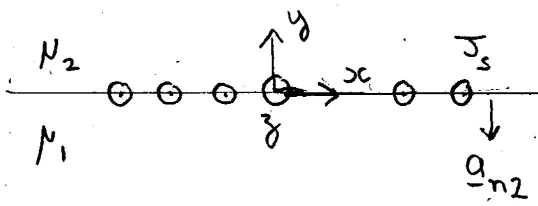
ECSE 353 EM FIELDS & WAVES CLASS TEST 2 SOLUTIONS 2002-10-22

1. D $\left(\text{EMF} = +\int_{-}^{+} \underline{E}_i \cdot d\underline{l} = -\int_{-}^{+} \underline{E} \cdot d\underline{l} \Rightarrow \int_{-}^{+} \underline{E} \cdot d\underline{l} = -\text{EMF} \right)$

2. B

3. A



$\underline{B}_2 = ?$

$\underline{B} = B_x \underline{a}_x + B_y \underline{a}_y$

$$B_{1n} = B_{2n} \Rightarrow B_{2y} = B_y$$

$$\underline{H}_{1t} - \underline{H}_{2t} = \underline{J}_s \times \underline{a}_{n2} \Rightarrow \frac{1}{\mu_1} B_x \underline{a}_x - \frac{1}{\mu_2} B_{2x} \underline{a}_x = J_s \underline{a}_z \times (-\underline{a}_y) = +J_s \underline{a}_x$$

$$\Rightarrow B_{2x} = \mu_2 \left(\frac{B_x}{\mu_1} - J_s \right)$$

4. D

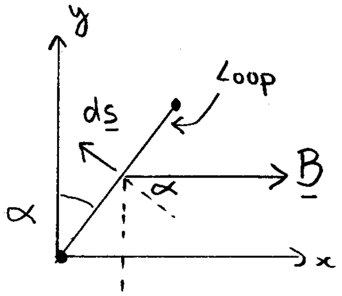
$$\underline{J}_m = \nabla \times \underline{M} = \nabla \times \left(\frac{1}{\mu_0} \underline{B} - \underline{H} \right) = \frac{1}{\mu_0} \nabla \times \underline{B} - \cancel{\nabla \times \underline{H}}$$

$$= \underline{J} = 0$$

$$= \frac{1}{\mu_0} \left[\underline{a}_R \frac{1}{R \sin\theta} \frac{\partial}{\partial \theta} (B_0 \sin\theta) - \underline{a}_\theta \frac{1}{R} \frac{\partial}{\partial R} (R B_0) \right]$$

$$= \frac{1}{\mu_0} \frac{B_0}{R} \left(\frac{\underline{a}_R}{\tan\theta} - \underline{a}_\theta \right)$$

5. (a)



$$\Phi = \int_S \underline{B} \cdot d\underline{s} = \int_S (B)(-\cos\alpha)\, ds$$

$$= -B \cos\alpha \, h^2$$

$$= -(50)(10^{-6})(10^{-2})^2 \cos\alpha$$

$$= -5 \cos\alpha \text{ nWb}$$

(b) Faraday: $\text{EMF} = -\dfrac{d\Phi}{dt} = -5 \sin\alpha \dfrac{d\alpha}{dt}$ nV

$= -5\omega \sin \omega t$ nV

But resistance $R = \dfrac{l}{\sigma S} = \dfrac{4h}{\sigma \pi b^2}$

$= \dfrac{(4)(10^{-2})}{(5.7)(10^7)(\pi)(10^{-3})^2} = 2.234 \times 10^{-4}$ Ω

So current $i(t) = \dfrac{\text{EMF}}{R}$

$= -\dfrac{(5)(10)(\sin 10t)(10^{-9})}{(2.234)(10^{-4})} = -0.224 \sin(10t)$ mA