

Problem Solution #7

Problem 1

$$B_{1n} = B_{2n}$$

$$\int \vec{H} \cdot d\vec{l} = NI \quad \vec{H} = \frac{\vec{B}}{\mu} \quad \frac{B}{\mu}l + \frac{B}{\mu_0}g = NI$$

$$\text{as } \mu \rightarrow \infty, \quad B = \frac{NI\mu_0}{g}$$

$$\Phi = \int \vec{B} \cdot d\vec{s} = \frac{NI\mu_0}{g} A = \frac{10 \times 6 \times 4\pi \times 10^{-7} \times 2 \times 10^{-3}}{1.9 \times 10^{-3}} \approx 7.9 \times 10^{-5} \text{ (Wb)}$$

$$\Lambda = N\Phi \quad L = \frac{\Lambda}{I} = \frac{N\Phi}{I} = \frac{10 \times 7.9 \times 10^{-5}}{6} \approx 1.32 \times 10^{-4} \text{ (H)}$$

$$\text{as } \mu_r = 2000, \quad \mu = \mu_r \mu_0 \quad B = NI\mu_0 / \left(\frac{l}{2000} + g \right)$$

$$\Phi = \int \vec{B} \cdot d\vec{s} = NI\mu_0 A / \left(\frac{l}{2000} + g \right) = \frac{10 \times 6 \times 4\pi \times 10^{-7} \times 2 \times 10^{-3}}{\left(\frac{0.85}{2000} + 1.9 \times 10^{-3} \right)} \approx 6.5 \times 10^{-5} \text{ (Wb)}$$

$$L = \frac{\Lambda}{I} = \frac{N\Phi}{I} = \frac{10 \times 6.5 \times 10^{-5}}{6} \approx 1.08 \times 10^{-4} \text{ (H)}$$

Problem 2

$$\Phi = \int \vec{B} \cdot d\vec{s} = BA$$

$$V = -N \frac{d\Phi}{dt} = -NA \frac{dB}{dt} = -100 \times 0.1 \times 1.2 \times 377 \cos(377t) = -4524 \cos(377t) \text{ (V)}$$

Problem 3

$$I = \frac{V}{R} \quad F = BIl = \frac{BVI}{R}$$

$$\text{When } V_{\text{induced}} = V, \quad v = v_{\text{max}} \cdot V_{\text{induced}} = Blv \Rightarrow v_{\text{max}} = \frac{V}{Bl}$$

Problem 4

$$B = \frac{\mu_0 I}{2\pi r} \quad V_{\text{induced}} = \frac{\mu_0 I}{2\pi r} \Big|_{r=y_0} - \frac{\mu_0 I}{2\pi r} \Big|_{r=y_0+0.1} = 2 \times 10^{-6} \left(\frac{1}{y_0} - \frac{1}{y_0+0.1} \right)$$

$$I = \frac{V_{\text{induced}}}{R} = 10^{-7} \times \left(\frac{1}{y_0} - \frac{1}{y_0+0.1} \right) A$$