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Midterm #3

Chapter 11

① a.) The direction of the magnetic field will be into the plane of the paper. $(-\hat{i} = \hat{j} \times (-\hat{k}))$

b.) The direction of the magnetic field will be to the left $(-\hat{k} = (-\hat{j}) \times (-\hat{i}))$

c.) The direction of the magnetic field will be out of the Page $(\hat{j} = -\hat{i} \times \hat{k})$

② a.) $F_E = F_B \Rightarrow qE = qvB\sin\theta$

$\theta = 90°$

$\rightarrow qE = qvB \Rightarrow E = VB \rightarrow \boxed{V = \frac{E}{B}}$

b.) e field is a constant $E = \frac{\Delta V}{\Delta x}$

$\rightarrow \Delta V = (VB)\Delta x \rightarrow \Delta V = B(\Delta x)v$

v = drift velocity.

$\rightarrow \Delta V = B(\Delta x) \cdot \frac{I}{nq_eA} \Rightarrow \boxed{\Delta V = \frac{B(\Delta x)I}{nq_eA}}$

$$\Delta V = \frac{1.33 \times (2\times10^{-2}) \times 10}{2\times10^{24} \times 1.6\times10^{-19} \times 1\times(10^{-3})^2}$$

$\boxed{\Delta V = 8.3125 \times 10^{-5}\ V}$

③ $|\vec{\tau}|_{max} = MB$

$M = IA$

$A = \pi R^2$

$\rightarrow |\vec{\tau}|_{max} = (I)(\pi R^2)(B)$

$\rightarrow |\vec{\tau}_{max}| = 1.05\times10^{4}\ Amps\,(3.14 \times 0.65\times10^{-15}\ m)(2.5\ T)$

$|\vec{\tau}_{max}| = 3.48\times10^{-26}\ N\cdot m$

Chapter 12

① a.) $B = \mu_0 nI$

$B = (4\pi \times 10^{-7}\ T\text{-}m/A) \times (500\ m^{-1}) \times (0.3\ Amps)$

$\boxed{B = 1.885 \times 10^{-4}\ T}$

b.) $B = (4\pi \times 10^{-7}\ T\text{-}m/A)\ 5000 \times (0.3_{Amps} \times 500\ m^{-1})$

$\boxed{B = 0.942\ T}$

② $\vec{F}_e = \vec{F}_n \Rightarrow q\vec{E} = q(\vec{v} \times \vec{B})$

$\theta = 90° \rightarrow qE = qvB \Rightarrow E = vB$

$\Rightarrow \boxed{v = E/B}$

b.) $\frac{mv^2}{r} = B_q v \rightarrow v = \frac{E}{B} \Rightarrow r = \frac{mE}{qB^2}$

$r = \frac{mv}{B_q}$

$\rightarrow r = \frac{mE}{qB^2} = \frac{(16)(1.67 \times 10^{-27}\ kg)(10\ V/m)}{(1.67 \times 10^{-19}\ C)(0.01T)^2}$

$\rightarrow \boxed{r = 0.016\ m}$

Chapter 13

① a.) Induced EMF — $\mathcal{E} = -N\frac{d\phi}{dt}$

$B = B_0\left(\frac{1}{2} + \frac{2}{\pi}\sin(2\pi ft) + \frac{2}{3\pi}\sin(6\pi ft) + \frac{2}{5\pi}\sin(10\pi ft)\right)$

$\therefore \frac{d\phi}{dt} = \frac{d(BA)}{dt} = A\left(\frac{dB}{dt}\right)$

$\rightarrow \frac{dB(t)}{dt} = B_0\left[\frac{2}{\pi}\cos(2\pi ft) \times 2\pi f + \frac{2}{3\pi} \times 6\pi f \cos(6\pi ft) + \frac{2}{5\pi} \times 10\pi f \cos(10\pi ft)\right]$

$\rightarrow \frac{dB(t)}{dt} = 4B_0 f\left[\cos(2\pi ft) + \cos(6\pi ft) + \cos(10\pi ft)\right]$

$\rightarrow \mathcal{E} = -NA \times 4B_0 f\left[\cos(2\pi ft) + \cos(6\pi ft) + \cos(10\pi ft)\right]$

$\mathcal{E} = -4\pi r^2 B_0 f\left[\cos(2\pi ft) + \cos(6\pi ft + \cos(10\pi ft)\right]$

b.) $\mathcal{E}(0) = -4\pi (0.1)^2 \times 0.1 \times 10^3 \left[\cos(0) + \cos(0) + \cos(0)\right] V$

$= |-37.70 V| \Rightarrow \boxed{37.70 V}$

c.) $|\mathcal{E}| = 4\pi \times (0.1)^2 \times 0.1 \times 10^3 \left[\cos(2\pi) + \cos(6\pi) + \cos(10\pi)\right]$

$= 4\pi \times (0.1)^2 \times 0.1 \times 10^3 \times 3 V$

$= 37.70 V$

→ Induced Current = $I = \frac{|\mathcal{E}_0|}{R} = \frac{37.70 V}{5.0 \Omega} = \boxed{7.54 A}$

Chapter 14

① $\mathcal{E} = -L \frac{dI}{dt}$

$\frac{dI}{dt} = \frac{-\mathcal{E}}{L} = \frac{-0.150 V}{0.50 H} = -0.3 A/s$

$\left|\frac{dI}{dt}\right| = 0.3 A/s$

② $\mathcal{E} = -L \frac{dI}{dt}$

$\mathcal{E} = L \frac{dI}{dt}$

$500 = 2 \times 10^{-3} H \frac{dI}{dt}$

$2.5 \times 10^5 = \frac{dI}{dt}$

$dI = 2.5 \times 10^5 dt$

$\int dI = \int 2.5 \times 10^5 dt$

→ $I = 2.5 \times 10^5 t$

$t = \frac{I}{2.5 \times 10^5}$

$t = \frac{0.100}{2.5 \times 10^5}$

$\boxed{t = 4 \times 10^{-7} sec}$