NAME : KEY

EXAM

EXAM 2 EQUATION SHEET

CHAPTER 19:

$\mu_0 = 4\pi \times 10^{-7} \frac{Tm}{A}$

$F = qvB \sin\theta$ $\quad F = BI\ell \sin\theta$ $\quad \tau = NBIA \sin\theta$

$B = \frac{\mu_0 I}{2\pi r}$ $\quad B = \mu_0 n I$ $\quad n = \frac{N}{L}$ $\quad r = \frac{mv}{qB}$

CHAPTER 20:

$\Phi_B = BA\cos\theta$ $\quad \mathcal{E} = -N\frac{\Delta\Phi_B}{\Delta t}$ $\quad \mathcal{E} = B\ell v \sin\theta$

$\mathcal{E} = NBA\omega \sin(\omega t)$ $\quad \mathcal{E} = -L\frac{\Delta I}{\Delta t}$ $\quad L = \frac{N\Phi_B}{I}$

$L = \frac{\mu_0 N^2 A}{\ell}$ $\quad I = \frac{\Delta V}{R}\left(1 - e^{-t/\tau}\right)$ $\quad \tau = \frac{L}{R}$ $\quad PE_L = \frac{1}{2}LI^2$

CHAPTER 21:

$I_{RMS} = \frac{I_{MAX}}{\sqrt{2}}$ $\quad \Delta V_{RMS} = \frac{\Delta V_{MAX}}{\sqrt{2}}$ $\quad X_L = 2\pi f L$ $\quad X_C = \frac{1}{2\pi f C}$

$Z = \sqrt{R^2 + (X_L - X_C)^2}$ $\quad \Delta V_{RMS} = I_{RMS} Z$ $\quad P_{AVG} = I_{RMS}^2 R$

$\Delta V_{R,RMS} = I_{RMS} R$ $\quad \Delta V_{L,RMS} = I_{RMS} X_L$ $\quad \Delta V_{C,RMS} = I_{RMS} X_C$

$\Delta V_2 = \frac{N_2}{N_1}\Delta V_1$ $\quad I = \frac{E_{MAX}^2}{2\mu_0 c} = \frac{c B_{MAX}^2}{2\mu_0}$ $\quad \frac{E}{B} = c$

$c = f\lambda$ $\quad f_o = f_s\left(1 \pm \frac{u}{c}\right)$

OTHERS:

$F_k = \mu_k mg$

$g = 9.8\ m/s^2$

P

[1] An emf of 20.0 mV is induced in an 800-turn coil when the current is changing at a rate of 8.0 A/s. What is the magnetic flux through each turn of the coil at an instant when the current is 5.0 A?

$$|\mathcal{E}| = L\frac{\Delta I}{\Delta t} \Rightarrow L = \frac{|\mathcal{E}|}{\Delta I/\Delta t} = \frac{20.0\times10^{-3}\,V}{8.0\,A/s} = 2.5\,mH = L$$

$$L = \frac{N\Phi_B}{I} \Rightarrow \Phi_B = \frac{LI}{N} = \frac{(2.5\times10^{-3}\,H)(5.0\,A)}{800}$$

$$\boxed{\Phi_B = 1.56\times10^{-5}\ Tm^2}$$

[2] As a way of determining the inductance of a coil used in a research project, a student first connects the coil to a 20.0 V battery and measures a current of 0.36 A. The student then connects the coil to a generator with an RMS voltage of 30.0 V and a frequency of 60.0 Hz and measures an RMS current of 0.28 A. What is the inductance of the coil?

$$\Delta V_{DC} = I_{DC} R \implies R = \frac{\Delta V_{DC}}{I_{DC}} = \frac{20.0\ \text{V}}{0.36\ \text{A}} = 55.6\ \Omega = R$$

$$\Delta V_{RMS} = I_{RMS} Z \implies Z = \frac{\Delta V_{RMS}}{I_{RMS}} = \frac{30.0\ \text{V}}{0.28\ \text{A}} = 107\ \Omega = Z$$

$$Z = \sqrt{R^2 + X_L^2} \implies X_L = \sqrt{Z^2 - R^2} = \sqrt{(107\ \Omega)^2 - (55.6\ \Omega)^2}$$

$$X_L = 91.6\ \Omega$$

$$X_L = 2\pi f L \implies L = \frac{X_L}{2\pi f} = \frac{91.6\ \Omega}{(2\pi)(60.0\ \text{Hz})}$$

$$\boxed{L = 0.243\ \text{H}}$$

[3] In a model AC generator, a 500 turn rectangular coil 6.0 cm by 10.0 cm rotates at 120 rev/min in a uniform magnetic field of 0.6 T.

(a) What is the maximum emf induced in the coil?

$$\omega = \left(120 \frac{\text{rev}}{\text{min}}\right)\left(\frac{2\pi \text{ rad}}{1 \text{ rev}}\right)\left(\frac{1 \text{ min}}{60 \text{ s}}\right) = 12.6 \frac{\text{rad}}{\text{s}}$$

$$|\mathcal{E}| = NBA\omega \sin(\omega t)$$

- THE MAXIMUM EMF OCCURS WHEN $\sin(\omega t) = 1$, SO:

$$\mathcal{E}_{MAX} = NBA\omega = (500)(0.6\,T)(0.06\,m \times 0.1\,m)\left(12.6 \frac{\text{rad}}{\text{s}}\right)$$

$$\boxed{\mathcal{E}_{MAX} = 22.7\ V}$$

(b) If the emf is 0 when t=0, then what is the emf (magnitude and direction) when t = 0.4 s?

$$\mathcal{E} = NBA\omega \sin(\omega t) = \mathcal{E}_{MAX} \sin(\omega t)$$

$$\mathcal{E} = 22.7\,V \sin\left[\left(12.6 \frac{\text{rad}}{\text{s}}\right)(0.4\,s)\right]$$

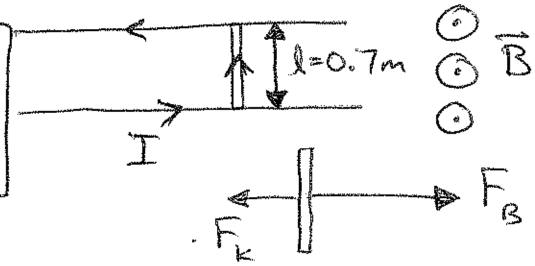
$$\mathcal{E} = (22.7\,V)(-0.947)$$

$$\boxed{\mathcal{E} = -21.5\ V}$$

[4] A 0.4 kg metal rod carrying a current of 12.0 A glides on two horizontal rails that are 0.7 m apart. What vertical magnetic field is required to keep the rod moving at a constant speed if the coefficient of kinetic friction between the rod and the rails is 0.15?

$$\sum F = ma = 0$$

CONSTANT SPEED MEANS ZERO ACCELERATION



$$F_B - F_k = 0 \implies F_B = F_k$$

$$BIl \sin\theta = \mu_k mg$$

• SINCE B AND I ARE PERPENDICULAR, $\theta = 90^\circ$ AND $\sin\theta = 1$

$$BIl = \mu_k mg$$

$$B = \frac{\mu_k mg}{Il} = \frac{(0.15)(0.4\,kg)(9.8\,m/s^2)}{(12.0\,A)(0.7m)}$$

$$\boxed{B = 0.07\ T}$$

[5] An AC source operating at 60 Hz and a maximum voltage of 150 V is connected in series to a 0.5 μF capacitor and a 1.8 kΩ resistor.

(a) What is the maximum value of the current in this circuit?

$\Delta V_{MAX} = I_{MAX} Z$ $\quad Z = \sqrt{R^2 + X_C^2}$ $\quad X_C = \frac{1}{2\pi f C} = 5305\ \Omega$

$I_{MAX} = \frac{\Delta V_{MAX}}{Z}$ $\quad Z = \sqrt{(1800\ \Omega)^2 + (5305\ \Omega)^2} = 5602\ \Omega$

$I_{MAX} = \frac{150\ V}{5602\ \Omega} = \boxed{0.0268\ A = I_{MAX}}$

(b) What are the maximum potential differences across each component?

$\Delta V_{R,MAX} = I_{MAX} R = \boxed{48.2\ V = \Delta V_{R,MAX}}$

$\Delta V_{C,MAX} = I_{MAX} X_C = \boxed{142\ V = \Delta V_{C,MAX}}$

1	2	3	4	5	TOTAL