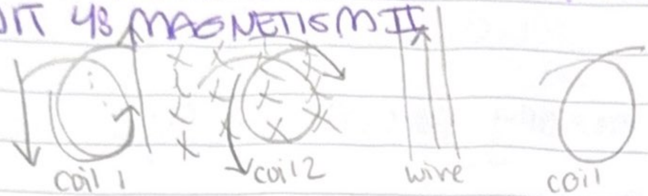
Haley Kivett

MIDTERM 2 ~ PHYS 135B

UNIT 4B MAGNETISM II

1)

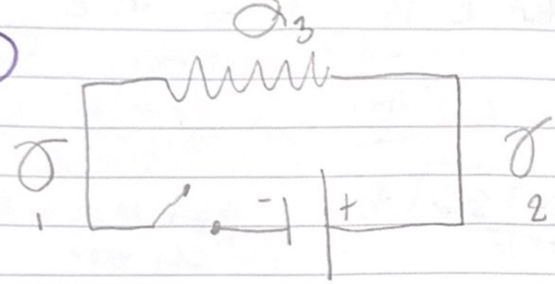


a) counterclockwise

b) clockwise

c) no change in magnetic flux → no induced current

2)



a) when closed coil 1 + 3 are counterclockwise coil 2 is clockwise

b) when closed too long there are no currents

c) when open coil 1+3 clockwise and coil 2 is counterclockwise

3) $\Delta\emptyset/\Delta t$ (V) $\emptyset$ = voltage / rate of change of voltage (sec) t = time / in respect to time

↳ so yes units are (V/s) or volts!

4) $B_i = 0$ $\quad B_f = 2$ $\quad \Delta B = 2$

$$\text{Emf}_i = -N\frac{\Delta\emptyset}{\Delta t} \quad \text{Emf}_i = -N\frac{\Delta B A\cos\theta}{\Delta t}$$

$$\text{Emf}_i = -1\,\frac{2(\pi(\frac{2.2}{2})\times10^{-2})^2\cos(0)}{0.25}$$

a) $\boxed{\text{Emf} = -3.04 \times 10^{-3}\,V}$

$$I = \frac{3.04\times10^{-3}}{0.01} \quad V = IR \quad I = V/R$$

b) $\boxed{I = 3.04\times10^{-1}\,A}$

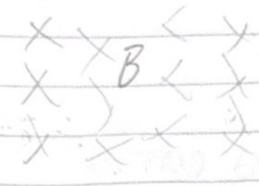
$P = IV$

$P = 3.04\times10^{-1}(3.04\times10^{-3})$

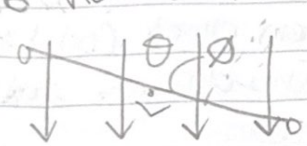
c) $\boxed{P = 9.24\times10^{-4}\,W}$

(5) $\mathcal{E} = \frac{\Delta \Phi}{\Delta t}$

top down view with all mutually perpendicular ($\perp$)



end view when $v \perp B$, but ℓ is not $\perp$ to B



(6) $V_P = N \cdot A \cdot B \cdot \omega$

$N = \frac{V_P}{AB\omega}$

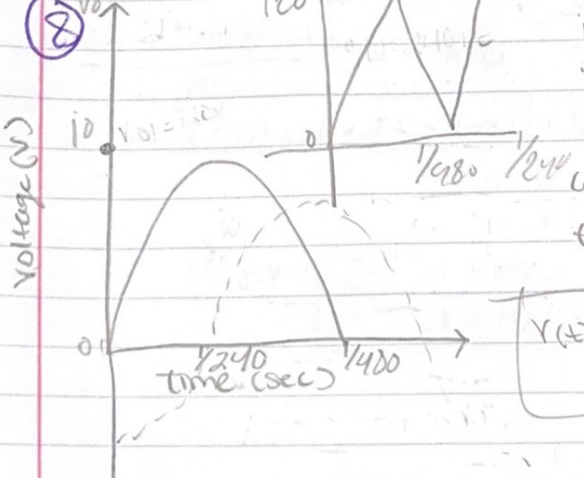
$N = \frac{18}{3\times10^{-4}(0.64)(1875)} \rightarrow \boxed{N = 50}$

(7) $\left(\frac{V_S}{V_P} = \frac{N_S}{N_P}\right) \rightarrow \frac{V_P}{V_S} = \frac{N_P}{N_S} \rightarrow \frac{240}{120} = \frac{N_P}{N_S} = \boxed{2}$

$\left(\frac{I_S}{I_P} = \frac{N_P}{N_S}\right) = \frac{I_P}{I_S} = \frac{N_S}{N_P} \rightarrow \boxed{\frac{I_P}{I_S} = 1/2}$

c) need to switch coils or plug in output so it becomes new input

(8)



induced emf in coil 3 is $V(t) = V_0 \sin(\omega t)$

$\omega t = n\pi$, $t = \frac{n\pi}{\omega}$ $\Big\}$ $\frac{\pi}{240\pi} = \frac{1}{240}$ sec

$\boxed{V(t) = 0 \searrow 1/240 \text{ sec}}$

9 $EMF = -L\frac{\Delta I}{\Delta t}$ $\rightarrow \Delta t = \frac{2\times10^{-3}(0.1)}{500}$

$\downarrow$

$\Delta t = L\frac{\Delta I}{Emf}$ $\boxed{\Delta t = 4\times10^{-7} s}$

10 $EMF = 25\left(\frac{100}{80\times10^{-3}}\right)$ $E_{ind} = 1/2\ LI^2$

$E = 1/2(25)(100)^2$

a) $\boxed{Emf = 3.13\times10^4\ V}$ b) $\boxed{E = 1.25\times10^5\ J}$

choose any value for A

Solanoid

length = 1m

$L = 25\ H$

$N_0 = 4\times10^{-7}\ H/m$

$P = J/s = watts$ c)

$P = \frac{1.25\times10^5}{80\times10^{-3}} = \boxed{1.56\times10^6\ w}$

$L = \frac{N_0 N^2 A}{l}$

$N^2 = \frac{L\cdot l}{N_0 A}$

$N^2 = \frac{25\times1m}{4\pi\times10^{-7}\times A}$ $\rightarrow N = \sqrt{\frac{25}{4\pi\times10^{-7}\times A}}$ $\rightarrow n = \frac{N}{l} = \sqrt{\frac{25}{4\pi\times10^{-7} A}}$

11 $R\cdot\tau = L$ $R = \frac{L}{\tau}$

$5\times10^6(20\times10^{-9}) = L$ $R = \frac{0.1}{1\times10^{-9}}$

a) $\boxed{0.100\ H = L}$ b) $\boxed{R = 1\times10^8\ \Omega}$

$I(t) = I_0 e^{-t/\tau}$

$\rightarrow I(3.0ns) = I_0\cdot e^{-\frac{3.0ns}{1.000}}$ $e^{-3.0} \approx 0.049787$

% final ~~current flows~~ 3.0ns $\approx \boxed{4.9787\%}$

$X_L = 2\pi f L$

$X_L = 2\pi\times10{,}000\times1$

$\boxed{X_L = 62{,}832\ \Omega}$ $\approx 62.8k\Omega$

12 $X_L = 2\times10^3$

$R = 15\times10^3$

$L = ?$

$\frac{X_L}{2\pi f} = L$

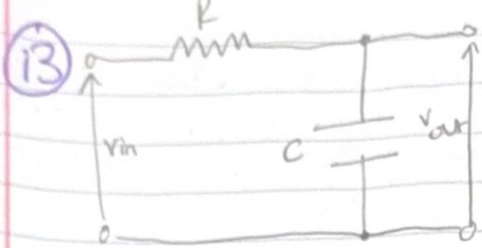
$\frac{2\times10^3}{2\pi(15\times10^3)} = L$ $\rightarrow \frac{2}{2\pi(15)} = L$

a) $\boxed{2.12\times10^{-2}\ H = L}$

$X_L = 2\pi f L$

$X_L = 2\pi(60)(2.12\times10^{-2})$ $\rightarrow$ b) $\boxed{X_L = 8.00\ \Omega}$

13



a) acts as a low pass filter b/c in RC circuit capacitor reactance ↓ as frequency of input ↑ so @ ↑ frequency capacitor becomes short circuit and lets the signal bypass so that output voltage ↓ for ↑ frequencies

b) $V_{in} - V_{out} - I_R \cdot R = 0$

c) $V_{out} - V_C - V_{in} = 0$

d) $V_{in} - V_{out} - I_R \cdot R = 0$

$V_{in} - V_{out} - \frac{V_{out}}{R} \cdot R = 0$

$V_{in} - V_{out} - V_{out} = 0$

$V_{in} = 2V_{out}$

$V_{out} - V_C - V_{in} = 0$

$V_{out} - V_{in} = 0$

$V_{out} = V_{in}$

e) $f = 100(2\pi RC)^{-1}$ $\quad$ $f = 0.1(2\pi RC)^{-1}$

$V_{out}/V_{in} = 1/2$ $\quad$ $V_{out}/V_{in} = 1$

14 $R = 0.1 k\Omega = 100\Omega$

$C = 1\mu F = 1 \times 10^{-6} F$

$L = 10mH = 10 \times 10^{-3} H$

$\Delta f = \frac{R}{L} = \frac{100}{10 \times 10^{-3}}$

$\boxed{\Delta f = 10000 Hz}$

$f_0 = \frac{1}{2\pi\sqrt{LC}} = \frac{1}{2\pi\sqrt{(10 \times 10^{-3})(1 \times 10^{-6})}}$

$f_0 = \frac{1}{2\pi \times 10^{-4}}$

$f_0 \approx \frac{10^4}{2\pi}$

$f_0 = \frac{10^4}{6.28}$

$\boxed{f_0 = 1591.5 Hz}$

$\frac{\Delta f}{\Delta f_0} = \frac{10000}{1591.5}$

$\approx \boxed{6.28}$

$X_L = 2\pi f L = 2\pi(0.1)(10 \times 10^{-3}) = 0.02\Omega$

$X_C = \frac{1}{2\pi f C} = \frac{1}{2\pi(0.1)(1 \times 10^{-6})}$

$X_C = \frac{1}{2\pi \times 10^{-4}} = 10^4 \Omega$

$Z_{total} = \sqrt{R^2 + (X_L - X_C)^2} = \sqrt{100^2 + (0.02 - 10^4)^2}$

$f = 0.1 f_0$

≈ 10000.47

$X_L = 2\pi f L = 2\pi(10)(10 \times 10^{-3}) = 0.628\Omega$

$X_C = \frac{1}{2\pi f C} = \frac{1}{2\pi(10)(1 \times 10^{-6})}$

$X_C = \frac{1}{2\pi \times 10^{-4}} = 100\Omega$

$Z_{tot} = \sqrt{R^2 + (X_L - X_C)^2} = \sqrt{(100)^2 + (0.628 - 100)^2}$

$f = 10 f_0$

$\approx \boxed{140.97}$

θ 10fo

(15) $R = 100\,\Omega$
$L = 10mH = 0.01H$
$C = 1\mu F = 10^{-6}F$
$V_{rms} = 120V$

$Z_{tot} = \sqrt{R^2 + (X_L - X_C)^2} = \sqrt{100^2 + (0.628 - 100)^2}$
$Z_{tot} = \sqrt{10000 + 99.372} \approx \sqrt{10099.372} \approx 100.5\,\Omega$
$I_{rms} = \frac{V_{rms}}{Z_{tot}} = \frac{120}{100.5} = \boxed{1.195A}$

θ 0.1fo
$Z_{tot} = \sqrt{R^2 + (X_L - X_C)^2} = \sqrt{100^2 + (0.02 - 10000)^2}$
$Z_{tot} = \sqrt{10000 + 10000.0004} = \sqrt{20000.0004} = 141\,\Omega$
$I_{rms} = \frac{V_{rms}}{Z_{tot}} = \frac{120}{141.4} \approx 0.848A$

10fo $(\theta) \approx -83.25^\circ \rightarrow P_{rms} = I^2_{rms} \times R = (1.195)^2 \times 100 \approx 143.29W$
0.1fo $(\theta) \approx -89.995^\circ \rightarrow P_{rms} = I^2_{rms} \times R = (0.848)^2 \times 100 \approx 72.07W$

(16) a) carrier frequency $(f_c) = 1.4MHz$
upper sideband frequency $(f_c + f_m) = 1.4MHz + 10kHz = 1.41MHz$
lower sideband frequency $(f_c - f_m) = 1.4MHz - 10kHz = 1.3999 MHz$
b) if that happens → could be that bandwidth is too narrow to capture sideband effectively → would need to widen by increasing the resistance of the receiver circuit

Unit 5: Waves, Optics, Medical Physics

(1) $I_{avg} = \frac{Q}{\Delta t} = \frac{200 \times 10^{-9}C}{2 \times 10^{-6}s} = \boxed{100mA}$ ← displacement current responsible for generating the magnetic field

$B = \frac{\mu_0 I_d}{2\pi r} = \frac{4 \times 10^{-7} \cdot 100 \times 10^{-3}}{2\pi \times 0.01} = \boxed{2 \times 10^{-4}T}$

(2) $s = d/t$ $3 \times 10^8 = \frac{2d}{10 \times 10^{-6}}$
$2d = \frac{3000}{2}$ $\boxed{d = 1500m}$

$w = c/f = \frac{3 \times 10^8}{100 \times 10^6} = 3/2 = \boxed{1.5m}$

$P_r = \frac{P_{tot}}{4\pi R^2} = ?$

(3) $I = P/A = \frac{1 \times 10^3}{10 \times 10^{-4}} = \boxed{10^7 W/m^2}$ $t = r/c = 1/3 \times 10^8 = \boxed{3.33 \times 10^{-7}s}$

$I = 1/2\, c\, \epsilon E^2 \rightarrow E = \sqrt{\frac{2I}{\epsilon c}} = \sqrt{\frac{2(10^7)}{8.85 \times 10^{-12}(3 \times 10^8)}} = \boxed{86802\, V/m}$

$I_2 = \frac{I_1}{2(2)} = \frac{10^7}{4} = \boxed{25 \times 10^6 W/m^2}$

(4) $n_1 \sin(\theta_1) = n_3 \sin(\theta)_3$ $n_1 \sin(\theta_1) = n_1 \sin(\theta_3)$

$\sin(\theta_1) = \sin(\theta_3)$ $\boxed{\theta_1 = \theta_3}$

$1/f = 1/d_i + 1/d_o$ $1/d_i = 1/f - 1/d_i = 1/15 - 1/13.5 = \boxed{-13.5\text{cm}}$

$m = \frac{d_i}{d_i} = \frac{-13.5}{13.5} = \boxed{1}$

(5) $\frac{n_i}{n_s} = \frac{c_v}{c_i} / \frac{c_v}{c_s}$ $\frac{n_i}{n_s} = \frac{c_s}{c_i}$ $\frac{1.31}{1.33} = \boxed{0.982}$

$n_s \sin(\theta_s) = n_i \sin(\theta_i)$ $1.33 \sin 30 = 1.31 \sin(\theta_1) = 30.5^\circ$

(6) $\frac{1}{d_o} + \frac{1}{d_i} = 1/f$ $\frac{(f)}{(f)}\frac{1}{d_o} - \frac{(d)}{(d)}\frac{1}{f} = \frac{1}{md_o}$ $\frac{f}{fd_o} - \frac{d}{fd_o} = \frac{1}{md_o}$

$\frac{f-d_o}{fd_o} = \frac{1}{md_o}$ $md_o = \frac{fd_o}{fd_o}$ $\boxed{m = \frac{f}{fd_o}}$

as (f-do) approaches zero m approaches ∞
the image height gets larger and laterally goes towards ∞

(7) $N = \rho n$ $N_A = \frac{11.35}{202.2}(6.02 \times 10^{23}) = \boxed{3.30 \times 10^{22}}$

$\mu = \varepsilon_A N$ $M + 200\ (3.3 \times 10^{22}) = \boxed{6.595 \times 10^{24}}$

$\frac{I}{I_0} = \boxed{1/2}$

(8) $\frac{\mu_y}{\mu_y} = \frac{\varepsilon_y}{\varepsilon_x} = \frac{1}{200}$ $e^{\mu y^{xy}} = \frac{1}{2}e^{-\mu_x x_{1/2}}$

$e^{-1/200\, xy} = \frac{1}{2}e^{-1/200}$

$xy = -200 \ln(\frac{1}{2}e^{-1/200})$ $e^{-1/200\, xy} = \frac{1}{2}e^{-\mu x}$ $\boxed{xy = 0.693\text{cm}}$

(9) $\lambda = \frac{\ln 2}{611 s} = 1.13 \times 10^{-3}$ $mT_1 = \frac{\ln 2}{1.13 \times 10^3} = 613.45$

$N(t) = N_0 e^{-\lambda t}$ $N(3600) = 1e^{-1.13 \times 10^{-3} \cdot 3600}$ $N(3600) = e^{-4.94}$

$N(3600) = 1.607 \times 10^{-7}$ $\boxed{0.1607\%\ \text{remaining neutrons}}$

(10) $D = E/m = \frac{250 \times 10^{3}}{60 \times 10^{3}} = 4.167 \times 10^{-6}\ J/g$

$D = E/m = \frac{250 \times 10^{-3}}{2 \times 10^{3}} = 1.25 \times 10^{-4}\ J/g$

$H = D \times RBE$

$H = D(1)$ $H = D$

125 J/g = 0.125 SV below the doseage limit so there is no health risk