Physics 135-B Midterm 2

1) (a) counterclockwise
(b) clockwise
(c) no change in magnetic flux = no induced current

2) (a) coil 1 & 3 are counterclockwise & coil 2 is clockwise
(b) when closed too long there are no currents

3) $\Delta\phi / \Delta t = V$
$= 1 T \cdot m^2/s$
$= (1 N/A \cdot m) * m^2/s$
$= 1 N \cdot m/s * (1/A)$
$= 1 J/s \cdot (1/C)$
$= V$

4) $\Delta B = 2 - 0 = 2$
$$EMF_i = \frac{-N\Delta\phi}{\Delta t}$$
$EMF_i = -N \Delta B A \cos\theta / \Delta t$
$$= \frac{(-1)(2(\pi)\, 2.20/2)^2 \cos 10)}{0.25}$$
$\boxed{EMF = -3.04 \times 10^{-3}\ V}$

5) $\varepsilon = \Delta\phi / \Delta t$
top down view w/ all mutually perpendicular ($\perp$)

x x x
x x x
x x x

emf now when $v \perp B$, but l is not $\perp$ to B

6) (a) $N = V_p / A \cdot B \cdot w$
$N = 18 / (3 \times 10^{-4})(0.64)(1875)$
$\boxed{N = 50 \text{ turns}}$

7) a) $V_p / V_s = N_p / N_s$

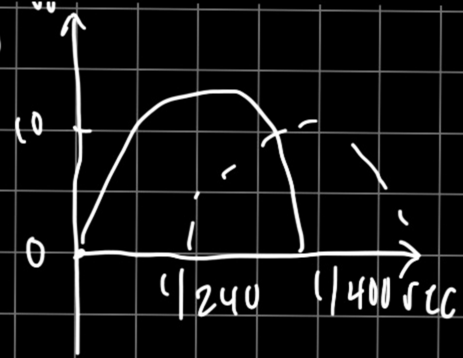
$240 / 120 = N_p / N_s = \boxed{2}$

(b) $I_p / I_s = N_s / N_p$

$I_p / I_s = \boxed{1/2}$

(c) They would need to switch the coils or transformer to become a new input of the other

8)



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

9) $EMF = L \, \Delta I / \Delta t$

$\Delta t = L \, \Delta I / EMF$

$\Delta t = \dfrac{(2\times10^{-3})(0.01)}{500}$

$\boxed{\Delta t = 4\times10^{-7} \text{ s}}$

10) (a) $EMF = L \, \Delta I / \Delta t$

$EMF = (25)(100 / 80\times10^{-3})$

$\boxed{EMF = 3.13\times10^{4} \text{ V}}$

(b) $E = 1/2 \, L I^2$

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

$= \boxed{1.25\times10^{5} \text{ J}}$

(c) $P = J/s$

$P = 1.25\times10^{5} / 80\times10^{-3}$

$\boxed{P = 1.56\times10^{6} \text{ W}}$

11) (a) $R \times \tau = L$

$(5\times10^{6})(20\times10^{-9}) = L$

$\boxed{L = 0.100 \text{ H}}$

(b) $R = L / \tau$

$R = 0.1 / 1\times10^{-9}$

$\boxed{R = 1\times10^{8} \, \Omega}$

$X_L = 2\pi f L$

$X_L = 2\pi (10{,}000 \times 1$

$\boxed{X_L = 62{,}832 \, \Omega}$

12) (a) $L = X_L / 2\pi f$

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

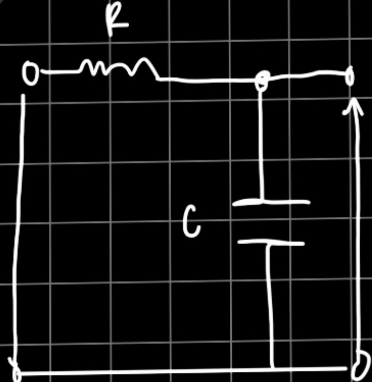
$\boxed{L = 2.12\times10^{-3} \text{ H}}$

(b) $X_L = 2\pi f L$

$X_L = 2\pi (60)(2.12\times10^{-3})$

$\boxed{X_L = 8.00 \, \Omega}$

R



13)

(a) RC circuit capacitor reactance ↓ as frequency of input ↑ so at higher frequency, the capacitor becomes a short circuit and lets the signal pass so the output (V) ↓ for higher frequencies

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

(c) $V_{out} - V_c - V_m = 0$

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

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

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

$V_{out}/V_m = 1/2$

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

$V_{out}/V_m = 1$

14) $R = 0.1\,k\Omega = 1000\,\Omega$

$C = 1\,\mu F = 1\times10^{-6}\,F$

$L = 10\,mH = 10\times10^{-3}\,H$

$\Delta F = 10000\,Hz$

$F_0 = 1/2\pi\sqrt{LC}$

$F_0 = 1/2\pi\times10^{-4}$

$\boxed{F_0 = 1591.5\,Hz}$

$\Delta f/\Delta F_0 = 1000/1591.5 \approx \boxed{6.28}$

$X_L = 2\pi fL = 2\pi(0.1)(10\times10^{-3}) = 0.02\,\Omega$

$X_C = 1/2\pi\times10^{-4} = 10^4\,\Omega$

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

$= \sqrt{(100)^2 + (0.02 - 10^4)^2} \approx \boxed{1000.47}$

$X_L = 2\pi fL = 2\pi(10)(10\times10^{-3}) = 0.628\,\Omega$

$X_C = 1/2\pi fL = 1/2\pi(10)(1\times10^{-6}) = 100\,\Omega$

$Z_{tot} = \sqrt{(100)^2 + (0.628 - 100)^2} = \boxed{140.97}$

15) $Z_{tot} = \sqrt{(100)^2 + (0.628 - 100)^2} = 100.5\,\Omega$

$I_{rms} = V_{rms}/Z_{tot}$

$I_{rms} = 120/100.5 = \boxed{1.195\,A}$ @ $10F_0$

$Z_{tot} = \sqrt{110^2 + (0.02 - 10000)^2} = 141.4\,\Omega$

$I_{rms} = 120/141.4 = \boxed{0.8\,A}$

$10F_0 \rightarrow P_{rms} = I^2_{rms} \times R = (1.195)^2 \times 100 \approx \boxed{143.29\,W}$

$0.1F_0 \rightarrow P_{rms} = (0.848)^2 \times 100 \approx \boxed{72.07\,W}$

16) (a) carrier $f = 1.4\,MHz$

$(f_c + f_m) = 1.4\,MHz + 10\,kHz = 1.41\,MHz$

$(f_c - f_m) = 1.4\,MHz - 10\,kHz = 1.399\,MHz$

(b) could be from a narrow band → would need to widen the band

Unit 5:

1) $I_{avg} = Q/\Delta t$

$= 200\times10^{-9} / 2\times10^{-6} = \boxed{100\,mA}$

$B = \mu_0 I_a / 2\pi r = \dfrac{4\times10^{-7} \cdot 0.100\times10^{-3}}{2 \times 0.01} = \boxed{2\times10^{-4}\,T}$

2) $s = d/t$

$2d = 3000/2$

$d = \boxed{1500\,m}$

$w = c/f = 3\times10^{8} / 100\times10^{6} = \boxed{1.5\,m}$

3) $I = P/A = 1\times10^{3} / 1\times10^{-4} = \boxed{10\ W/m^2}$

$t = r/c = 1/3\times10^{3} = \boxed{3.33\times10^{-9}\,s}$

$E = \sqrt{2\pi/c} = \sqrt{2(10)/(8.85\times10^{-12})(3\times10^{8})} =$

$\boxed{88302\,V/m}$

$I_2 = 10\pi/4 = \boxed{2.5\times10^{6}\ W/m^2}$

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

$\theta_1 = \theta_3$

$1/f = 1/d_i + 1/d_o = 1/15 - 1/15.5 = \boxed{-13.5\,cm}$

$m = d_i/d_o = -13.5/13.5 = \boxed{1}$

5) $n_1/n_2 = c_0/c_i$

$1.31/1.33 = 0.982$

$1.33 \sin(30) = 1.31 \sin(\theta_i) = \boxed{30.5°}$

6) $1/d_i + 1/d_o = 1/f$

$f - d_o / f d_o = 1/m d_o$

$m = f/d_o$

as $(f - d_o) \to 0$, $m \to \infty$

7) $N_A = 11.35/202.2(6.02\times10^{23}) = \boxed{3.30\times10^{23}}$

$M + 200(3.3\times10^{23}) = \boxed{6.595\times10^{24}}$

10) $D = E/m = 150\times10^{3} / 60\times10^{3} = 4.167\times10^{-6}\,J/c$

$D = 250\times10^{-3} / 2\times10^{3} = 1.25\times10^{-4}\,J/g$

There is no health risk since below 50