Midterm 2

Unit 4

1) a. if it increases counter-clockwise
if it decreases clockwise

b. if it increases counter-clockwise
if it decreases clockwise

2) a. 1st closed: counter-clockwise
closed: no direction
opened: clockwise

b. 1st closed: counter-clockwise
closed: no direction
opened: clockwise

c. 1st closed: no direction
closed: no direction
opened: no direction

3) $\frac{\Delta \Phi}{\Delta t} = \frac{\Delta(BA)}{\Delta t} \rightarrow \frac{T/m^2}{s} = \frac{(N/A \cdot m)\, m^2}{s}$ $\quad N \cdot m = J$

$\frac{T}{m^2 \cdot s} = \frac{N \cdot m}{A \cdot s} \rightarrow \frac{T}{m^2 \cdot s} = \frac{J}{C} = V$

$A \cdot s = C$

4) a. $\varepsilon = -N \frac{\Delta \Phi}{\Delta t}$ $\quad \varepsilon = -1\left(\frac{2(\pi \cdot .011^2)}{.250}\right)$

$\Phi = BA\cos\theta$ $\quad \varepsilon = -.00304\ V$

b. $I = \frac{V}{R}$ $\quad I = \frac{-.00304}{.0100}$

$I = .304\ A$

c. $P = IV$ $\quad P = .304(.00304$

$P = 9.24 \times 10^{-4}\ W$

6) a. $\varepsilon = N\omega BA$ $\quad 18.0 = N(1875)(.640)(3 \times 10^{-4})$

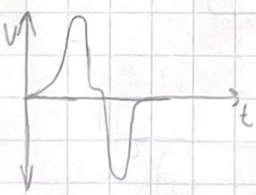
$N = 50$ turns

7) a. $\frac{V_L}{V_R} = \frac{N_L}{N_R}$ $\quad \frac{120}{240} = \frac{1}{2}$ $\quad$ 1:2 ratio

b. 1:2 ratio also

c. They would use the same ratios in a step-up transformer

8) a.



c. $0 = 120\sin(240\pi t)$

$t = .0083$ sec

9) $\varepsilon = -L\frac{\Delta I}{\Delta t}$ $\quad 500 = .002\left(\frac{.1}{\Delta t}\right)$

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

10) $\mathcal{E} = L\frac{\Delta I}{\Delta t}$ a. $\mathcal{E} = 25\left(\frac{100}{.08}\right)$

$\mathcal{E} = 31250$ V

b. $U = \frac{1}{2}LI^2$ $U = \frac{1}{2}(25)(100^2)$

$U = 1.25\times10^5$ J

c. $P = \frac{J}{s}$ $P = \frac{1.25\times10^5}{.08}$

$P = 1.56\times10^6$ W

d. $L = \frac{\mu_0 N^2 A}{l}$ $25 =$

11) a. $\tau = \frac{L}{R}$ $2\times10^{-8} = \frac{L}{5\times10^6}$

$L = .1$ H

b. $1\times10^{-9} = \frac{.1}{R}$

$R = 1.0\times10^8$

c. $I = I_0\left(1 - e^{-t/\tau}\right)$ $\frac{I}{I_0} = 1 - e^{-3\tau/\tau}$

$\frac{I}{I_0} = 1 - e^{-3} = .95 = 95\%$

d. $X_L = 2\pi f L$ $X_L = 2\pi(10000)(.1)$

$X_L = 6283.19\ \Omega$

12) a. $X_L = 2\pi f L$ $2000 = 2\pi(15000)L$

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

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

$X_L = 8\ \Omega$

14) a. $f = \frac{1}{2\pi\sqrt{LC}}$ $f = \frac{1}{2\pi\sqrt{(1\times10^{-6})(.01)}}$ $L = .01$ $C = 1\times10^{-6}$ $R = 100$

$f = 1591.55$ Hz

b. $Z = \sqrt{R^2 + (X_L - X_C)^2}$

$X_L = 2\pi f L$

$X_C = \frac{1}{2\pi f C}$

$Z = \sqrt{100^2 + \left[(2\pi(.1)(.01)) - \left(\frac{1}{2\pi(.1)(1\times10^{-6})}\right)\right]^2}$

$Z = \sqrt{100^2 + [.00628 - 1591549.431]^2}$

$Z = 1.59\times10^6\ \Omega$

$Z = \sqrt{100^2 + \left[(2\pi(10)(.01)) - \left(\frac{1}{2\pi(10)(1\times10^{-6})}\right)\right]^2}$

$Z = \sqrt{100^2 + (.62832 - 15915.49)^2}$

$Z = 15915.18\ \Omega$

15) $L=.01$ a. $V_{rms}=I_{rms}Z$ $120=I_{rms}(1.59\times10^{6})$
$C=1\times10^{-6}$ $I_{rms}=7.547\times10^{-5}$ A
$R=100$

$120=I_{rms}(1.59\times10^{4})$
$I_{rms}=.00755A$

b. $P_{rms}=V_{rms}\times I_{rms}$ $P_{rms}=(120)(7.547\times10^{-5})$
$P_{rms}=.0090564$ W

$P_{rms}=(120)(.00755)$
$P_{rms}=.906$ W

16) $f=1.4\times10^{6}$ Hz   a. 1.4 MHz and 100 kHz   b. gradually increase
$f_A=10000$ Hz   10 kHz

Unit 5

1) $B=\frac{\mu_0 I}{2\pi r}$ a. $B=\frac{(4\pi\times10^{-7})(2\times10^{-7})}{2\pi(.01)}$ b. The changing E-field is responsible for this.
$B=4\times10^{-12}$ T

2) a. $c=\frac{d}{t}$ $3\times10^{8}=\frac{2d}{1\times10^{-5}}$ b. $c=f\lambda$ $3\times10^{8}=(1\times10^{8})\lambda$
$d=1500$ $3m=\lambda$

c. $\theta_i=\theta_r$
$R=\left|\frac{n_1-n_2}{n_1+n_2}\right|^2$ $R=\left|\frac{1.000368-1.78}{1.78+1.000368}\right|^2$
$R=.0796$

3) $I=\frac{P}{A}$ a. $I=\frac{1000}{.001}$ c. $I=\frac{1}{2}\varepsilon_0 c E_0^2$ $1\times10^{6}=\frac{1}{2}(8.85\times10^{-12})(3\times10^{8})E_0^2$
$I=1\times10^{6}\ \frac{W}{m^2}$ $E_0=27446\ \frac{V}{m}$

b.

4) a. $\theta_3=\theta_1$ because $n_1=n_3$. The refraction that happens from n_1 to n_2 is the same one that happens from n_2 to n_3. The transition from n_2 to n_3 "undoes" the refraction from n_1 to n_2.

b. $\frac{1}{d_o}+\frac{1}{d_i}=\frac{1}{f}$ c. $\frac{1}{d_o}+\frac{1}{.135}=\frac{1}{.15}$ d. $m=-\frac{d_i}{d_o}$ $m=-\frac{-1.35}{.135}$
$d_o=-1.35m$ $m=10$

e. $.01\times10=.1m$ or 10 cm

5) $n = \frac{c}{V}$

a. ice: $1.309 = \frac{3\times10^8}{V}$

$V = 2.29\times10^8$ m/s

snow: $1.333 = \frac{3\times10^8}{V}$

$V = 2.25\times10^8$ m/s

b. $n_1 \sin\theta_i = n_2 \sin\theta_t$ (n_1: snow, n_2: ice)

$1.333\sin(30) = 1.309 \sin\theta_t$

$\theta_t = 30.61°$

6) a. $\frac{1}{d_o} + \frac{1}{d_i} = \frac{1}{f}$

$m = -\frac{d_i}{d_o}$

$d_i = -md_o \rightarrow \frac{1}{d_o} + \frac{1}{-md_o} = \frac{1}{f} \rightarrow \frac{1}{d_o} - \frac{1}{f} = \frac{1}{md_o}$

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

$\frac{f\cancel{d_o}}{(f-d_o)(\cancel{d_o})} = m$

$\boxed{\frac{f}{f-d_o} = m}$

b. The focal length increasing causes $m \rightarrow \infty$.

c. The image location gets farther away

9) After one hour $\frac{1}{2199600}$ of the neutrons remain

10) a. $\frac{.25\text{ J}}{60\text{ kg}} = .00417 \frac{\text{J}}{\text{kg}} = .417$ rad

b. $\frac{.25\text{ J}}{2\text{ kg}} = .125 \frac{\text{J}}{\text{kg}} = 12.5$ rad

c. $Sv = x\,Gy \times 1$ $\qquad Sv = .125\,Gy \cdot 1$

$.125\ Sv$

d. There is no serious health risk.