Riana Barrett

Unit 4

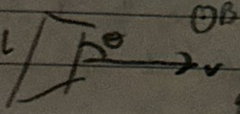
1. a) clockwise decreasing: counterclockwise
   b) increase: counter clockwise decreasing: clockwise

2. a) closed: counterclockwise left closed: None opened: clockwise
   b) closed: counterclockwise left closed: None opened: clockwise
   c) closed: None left closed: None opened: None

3. $V = \frac{\Delta\Phi}{\Delta t} = \frac{T(m^2)}{s} = V$ $\frac{\Delta\Phi}{\Delta t} = \frac{V}{S} =$ amps

4. a) $\Delta B = 2.00T$ $emf_i = -\frac{N\Delta\Phi}{\Delta t} = -N\frac{\Delta BA\cos\theta}{\Delta t} = -\frac{1 \cdot 2(\pi(\frac{2.20}{2}\times10^{-2})^2\cos 0}{0.25}$
   $\boxed{\mathcal{E}_{mf} = -3.04\times10^{-3}V}$
   b) $V = IR$ $I = \frac{V}{R} = \frac{3.04\times10^{-3}}{0.01}$
   $\boxed{I = 0.304A}$
   c) $P = IV = 0.304(3.04\times10^{-3})$
   $= \boxed{9.29\times10^{-4}W}$

5. B perpendicular to v

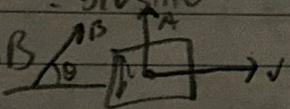


$\Phi = A(B\cos(90+\theta)) = BA\sin\theta$ $A = lx$

$\mathcal{E} = \frac{\Delta\Phi}{\Delta t} = \frac{\Delta(BA\sin\theta)}{\Delta t} = \frac{\Delta x(Bl\sin\theta)}{\Delta t}$

$v = \frac{\Delta x}{\Delta t}$ $= Blv\sin\theta$

l perpendicular to B

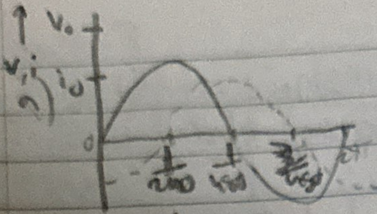


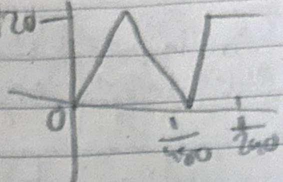
$\Phi = B(A\cos(90-\theta)) = BA\sin\theta$

$\mathcal{E} = \frac{\Delta\Phi}{\Delta t} = \frac{\Delta B(A\sin\theta)}{\Delta t} = \frac{\Delta x(Bl\sin\theta)}{\Delta t}$
$= Blv\sin\theta$

6. a) $V = NAB\omega$ $N = \frac{V}{AB\omega} = \frac{14}{3\times10^{-4}(.1)(1875)} = \boxed{50}$
   b) $T = \frac{1}{f}$ $f = \frac{\omega}{2\pi}$ $\frac{1875}{2\pi} = 298.41 Hz$ $T = \frac{1}{298.41} = \boxed{3.35\times10^{-3}s}$

7. a) $\frac{V_P}{V_S} = \frac{N_P}{N_S}$ $\frac{240}{120} = \boxed{2}$ b) $\frac{I_P}{I_S} = \frac{N_S}{N_P}$ $\frac{I_P}{I_S} = \frac{120}{240} = \boxed{\frac{1}{2}}$ c) plug in output of one to become the new input, or switch coils

8. a) 

b) 

c) $V(t) = V_0 \sin(\omega t)$ $\quad 0 = 120 \sin(240\pi t)$ $\quad \frac{240\pi t}{240\pi} = \frac{n\pi}{240\pi}$ $\quad \boxed{t = \frac{n}{240}}$

9. $emf = L\frac{\Delta I}{\Delta t}$ $\quad \Delta t = L\frac{\Delta I}{emf} = \frac{2\times10^{-3}(.1)}{500} = \boxed{4\times10^{-7}\ s}$

10. a) $emf = L\frac{\Delta I}{\Delta t} = 25\left(\frac{100}{80\times10^{-3}}\right) = \boxed{3.13\times10^{4}\ V}$ $\quad$ b) $E = \frac{1}{2}LI^2 = \frac{1}{2}(25)(100)^2$
$= \boxed{1.25\times10^{5}\ J}$

c) $P = \frac{J}{s} = \frac{1.25\times10^{5}}{80\times10^{-3}} = \boxed{1.56\times10^{6}\ W}$

d) Since it is large it makes sense

d) $L = \frac{BA\cos\theta}{NI}$ need more information to create

11. a) $\tau = \frac{L}{R}$ $\quad L = R\tau = 5\times10^{6}(20\times10^{-9}) = \boxed{0.1\ H}$ $\quad$ b) $R = \frac{L}{\tau} = \frac{0.1}{1\times10^{-9}} = \boxed{1\times10^{8}\ \Omega}$

c) $I(t) = I_0(1-e^{-t/\tau})$ $\quad I(3ns) = I_0(1-e^{-3/1})$ $\quad I(3ns) = I_0(1-e^{-3})$

$I(3ns) = I_0(0.95) = \boxed{95\%}$

d) $X_L = 2\pi fL$ $\quad X_L = 2\pi\times10^{7}(100\times10^{-9}) = \boxed{6.28\ \Omega}$

12. a) $X_L = 2\pi fL$ $\quad L = \frac{X_L}{2\pi f} = \frac{2\times10^{3}}{2\pi(15\times10^{3})} = \boxed{0.0212\ H}$

b) $X_L = 2\pi fL = 2\pi(60)(0.0212) = \boxed{8\ \Omega}$

13. a) High frequency signals encounter high reactance from the capacitor, which blocks them.

b) $v_{in} - i(t)R - v_{out} = 0$ $\quad v_{out} - i(t)R - 0 = 0$ $\quad v_{out} - i(t)R = 0$

c) $v_{out} - i(t)R - 0 = 0$ $\quad v_{out} - i(t)R$

d) from (b) $v_{in} = i(t)R + v_{out}$ $\quad$ from (c) $v_{out} = i(t)R$

$v_{in} = v_{out} + v_{out}$ $\quad v_{in} = 2v_{out}$ $\quad v_{out}/v_{in} = \frac{1}{2}$

e) $f = 100(2\pi RC)^{-1}$ $\quad v_{out}/v_{in} = \frac{1}{\sqrt{1+(100)^2}}$

$f = 0.1(2\pi RC)^{-1}$ $\quad v_{out}/v_{in} = \frac{1}{\sqrt{1+(0.1)^2}}$

14. a) $f_0 = \frac{1}{2\pi\sqrt{LC}} = \frac{1}{2\pi\sqrt{(10\times10^{-3})(1\times10^{-6})}} = \frac{1}{2\pi\sqrt{10^{-8}}} = \frac{1}{6.28\times10^{-4}} = \boxed{15.915\,kHz}$

$\Delta f = \frac{f_0}{Q}$ $Q = \frac{1}{R}\sqrt{\frac{L}{C}} = \frac{1}{100}\sqrt{\frac{10\times10^{-3}}{1\times10^{-6}}} = \frac{1}{100}\times\sqrt{10^4} = 1$ $\boxed{\Delta f / f_0 = 1}$

b) $f = 0.1 f_0$ - $Z = \sqrt{R^2 + (X_L - X_C)^2} = \sqrt{(100)^2 + (2\pi f L - \frac{1}{2\pi f C})^2}$

$= \sqrt{(100)^2 + (2\pi(0.1f_0)(10\times10^{-3}) - \frac{1}{2\pi(0.1f_0)(1\times10^{-6})})^2} = \sqrt{100^2 + (10 - 1000)^2} = \sqrt{990100} = \boxed{995\Omega}$

$f = 10 f_0$ $Z = \sqrt{(100)^2 + (2\pi f L - \frac{1}{2\pi f C})^2} = \sqrt{(100)^2 + (2\pi(10)(15.9)(10\times10^{-3}) - \frac{1}{2\pi(10)(15.9)(1\times10^{-6})})^2}$

$= \sqrt{100^2 + (318 - 1000)^2} = \sqrt{475124} = \boxed{689\Omega}$

15. a) $I_{rms} = \frac{V_{rms}}{Z} = \frac{120}{995} = \boxed{0.121A}$ for $f_{0.1}$ $\frac{120}{689} = \boxed{0.174A}$ for $10f_0$

b. $P = I^2R$ for $0.1f_0$ $P = (0.121)^2\,100 = \boxed{1.46\,W}$

for $10f_0$ $P = (0.174)^2\,100 = \boxed{3.03\,W}$

16. a) Carrier Frequency, lower sideband, upper sideband

b) Decrease gradually to increase bandwidth

Unit 5

1. a) $B = \frac{\mu_0 I}{2\pi r} = \frac{4\pi\times10^{-7}(1\times10^{-4})}{2\pi(0.01)} = \boxed{3.18\times10^{-10}\,T}$

b) The transient charging current

02. a) $s = \frac{d}{t}$ $3\times10^8 = \frac{2d}{10\times10^{-6}}$ $2d = 3000$ $\boxed{d = 1500\,m}$

b) $W = \frac{c}{f} = \frac{3\times10^8}{100\times10^6} = \frac{3}{2} = \boxed{1.5m}$

c) $P_r = \frac{P_t\,\sigma}{4\pi R^2} =$ not given transmitted power radar cross section

3. a) $I = \frac{P}{A} = \frac{1\times10^3\,W}{10\times10^{-4}\,m^2} = \boxed{10^7\,\frac{W}{m^2}}$ b) $t = \frac{d}{c} = \frac{1m}{3\times10^8\,m/s} = \boxed{3.33\times10^{-9}\,s}$

c) $I = \frac{1}{2}\varepsilon_0 c E^2$ $E = \sqrt{\frac{2I}{\varepsilon_0 c}} = \sqrt{\frac{2(10^7)}{8.85\times10^{-12}(3\times10^8)}} = \boxed{86802\,\frac{V}{m}}$

d) $I_2 = \frac{I_1}{2(2)} = \frac{10^7}{4} = \boxed{2.5\times10^6\,\frac{W}{m^2}}$

4. a) $n_1 \sin(\theta_1) = n_3 \sin(\theta_3)$ $n_1 \sin(\theta_1) = n_1 \sin(\theta_3)$ $\sin(\theta_1) = \sin(\theta_3)$ $\boxed{\theta_1 = \theta_3}$

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

d) $M = \frac{d_i}{d_o} = \frac{-13.5}{13.5} = \boxed{1}$

e) $M = \frac{d_i}{d_o} = \frac{-13.5}{13.5} = \boxed{1}$

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

b) $n_s \sin(\theta_s) = n_i \sin(\theta_i)$ $1.33 \sin 30 = 1.31 \sin(\theta_i) = \boxed{30.5°}$

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

$\frac{f - d_o}{f d_o} = \frac{1}{M d_o}$ $M d_o = \frac{f d_o}{f - d_o}$ $M = \frac{f}{f d_o}$

b) as $(f - d_o)$ approaches 0, M approaches ∞

c) image height becomes bigger, image located at infinity

7. a) $N = \frac{\rho}{m} \cdot N_A = \frac{11.35}{207.2}(6.02\times10^{23}) = 3.30\times10^{22}$

$M = \Sigma \cdot N$ $M = 200(3.3\times10^{22}) = 6.595\times10^{24}$

b) $\frac{I}{I_0} = \boxed{\frac{1}{2}}$

8. $\frac{\mu_y}{\mu_x} = \frac{\Sigma_y}{\Sigma_x} = \frac{1\text{ barn}}{200\text{ barn}} = \frac{1}{200}$ $e^{-\mu_y x_y} = \frac{1}{2} e^{-\mu_x x_x}$

$e^{-\frac{1}{200} x_y} = \frac{1}{2} e^{-\mu_x x_x}$ $e^{-\frac{1}{200} x_y} = \frac{1}{2} e^{-\frac{1}{200}}$

$x_y = -200 \ln\left(\frac{1}{2} e^{-\frac{1}{200}}\right)$ $\boxed{x_y = 0.693\text{ cm}}$

9. $\lambda = \frac{\ln 2}{614\text{ s}} = 1.13\times10^{-3}$ m $T_{\frac{1}{2}} = \frac{\ln(2)}{1.13\times10^{-3}} = 613.4\text{ s}$

$N(t) = N_0 \cdot e^{-\lambda t}$ $N(3600) = 1e^{-1.13\times10^{-3} \cdot 3600}$ $N(3600) = e^{-6.94}$

$N(3600) = 1.607\times10^{-3}$ $\boxed{0.16076\text{ remain after 1 hour}}$

10. a) $D = \frac{E}{m} = \frac{250\times10^{-3}}{60\times10^{3}} = 4.167\times10^{-6}\ \frac{J}{g}$

b) $D = \frac{E}{m} = \frac{250\times10^{-3}}{2\times10^{-3}} = 1.25\times10^{-4}\ \frac{J}{g}$

c) $H = D \times RBE$ $H = D(1)$ $H = 0$

d) $125\ \frac{J}{g} = 0.125$ Sv below dose limit no health risk