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Final Exam

1) $P = 2.5$ hp $= 1865$ watts $\quad V = 120$

a) $P = IV \Rightarrow I = \frac{P}{V}$

$I = \frac{1865}{120} = 15.5$ A

b) $E = P * t \qquad t = 3$ hours $= 10800$ s

$E = 1865 * 10800$ s $= 2.0 \times 10^7$ Joules

c) $c = \$.11 * \frac{2.0 \times 10^7}{3.6 \times 10^6} = \$.61$

3) $N = 100. \quad L = 10$ cm $= .10$ m $\quad I = .5$ A

a) $B = \mu_0 n I \qquad n = \frac{N}{L} = \frac{100}{.10} = 1000 \qquad \mu_0 = 4\pi \times 10^{-7}\ H_m^{-1}$

$B = 4\pi \times 10^{-7}(1000)(.5) =$ 6.2×10^{-4} Tesla

b) ~~$F = qVB\sin\theta \qquad F_c = mV^2/R$~~ $B = mV/qr \Rightarrow mV = qBr$

~~$mV^2/R = qVB \Rightarrow mV = qBR$~~ $\qquad q = 1.6 \times 10^{-19}$ C

$P = qBR = 1.6 \times 10^{-19}\,C\,(6.2 \times 10^{-4}\,T)(.02) = 1.9 \times 10^{-24}$ kg m/s

4) a) $U = \frac{1}{2} L I^2$ $\quad P = IV = I^2 R$

$\Rightarrow IV = I^2 R \Rightarrow I = \frac{V}{R} = \frac{24V}{8\Omega} = 3A$

$U = \frac{1}{2}(4)(3)^2 = 18\,J$

b) $I(t) = \mathcal{E}/R(1-e^{-t/\tau})$ $\quad I = \frac{\mathcal{E}}{Rt}$

$\Rightarrow I = I(1-e^{-t/\tau}) \quad t = \tau$

$\Rightarrow I = 3(1-e^{-1}) = 1.9A$

$U = \frac{1}{2} L I^2 = \frac{1}{2}(4)(1.9)^2 = 7.22\,J$

5) $X_L = \omega L = 2\pi f L = 2\pi(60)(.6) = 226.2\,\Omega$

$X_C = \frac{1}{C\omega} = \frac{1}{C 2\pi f} = \frac{1}{(3.5\times10^{-6})2\pi(60)} = 757.9\,\Omega$ $\quad C = 3.5\,\mu F = 3.5 \times 10^{-6} F$

a) $Z = \sqrt{R^2 + (X_L - X_C)^2} = \sqrt{(2.5\times10^2)^2 + (226.2 - 757.9)^2}$

$= 587.5\,\Omega$

b) $P = IV = I^2 R \Rightarrow IV = I^2 R \Rightarrow I = \frac{V}{R} = \frac{150}{2.5\times10^2} = .6A$

c) $V_m = I_m Z \Rightarrow I_m = \frac{V_m}{Z} = \frac{150}{587.5} = .255\,A$

$V_r = IR = (.255)(2.5\times10^2) = 63.8\,V$
$V_c = IX_c = (.255)(757.9) = 193.3\,V$
$V_L = IX_L = (.255)(226.2) = 57.7\,V$

6) $s' = -20\text{cm}$ $f = 8\text{cm}$

$-.2\text{m}$ $.08\text{m}$

a) $\frac{1}{s} + \frac{1}{s'} = \frac{1}{f} \Rightarrow \frac{1}{s} = \frac{1}{f} - \frac{1}{s'}$

$= \frac{1}{.08\text{m}} + \frac{1}{.2\text{m}} = \frac{(20)\,1}{(20)\,8} + \frac{1\,(8)}{20\,(8)} = \frac{20}{160} + \frac{8}{160} = \frac{28}{160} = \frac{7}{40}$

$\frac{1}{s} = \frac{7}{40} \Rightarrow s = \frac{40}{7} \approx 5.7\text{cm} \approx .057\text{m}$

b) $m = \frac{-s'}{s} = \frac{-(-20)}{5.7} = 3.5\text{cm} = .035\text{m}$

c) $m = \frac{h'}{h}$ $h' = m\,(3) = 3.5\text{cm}\,(3) = 10.5\text{cm}$

$= .105\text{m}$

$\Rightarrow hm = h'$

2) $F = qVB\sin\theta$ $\quad F = mV^2/R$

$$\frac{mV^2}{R} = qVB$$

$$E_K = \tfrac{1}{2}mv^2 \Rightarrow \quad V = \sqrt{\frac{2qE_K}{m}} = \sqrt{\frac{2(1.6\times10^{-19})(400)eV)}{9.1\times10^{-31}kg}}$$

$$= 1.18\times10^{7}\ m/s$$

$$\frac{mV^2}{R} = qVB \Rightarrow B = \frac{mV}{qR} =$$

$$\frac{(9.1\times10^{-31})(1.18\times10^{7})}{(1.6\times10^{-19})(.8)} = 8.5\times10^{-5}\ T$$