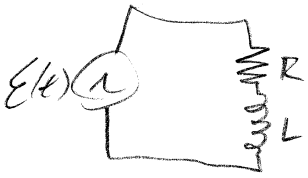
Homework #10
Tipler 28-62,66,75, 2 others

28-62



$\mathcal{E}_{rms} = 120\,V \qquad \omega = 2\pi \cdot 60\,Hz$

$P_{ave} = 60\,W$

$I_{rms} = 1.5\,A$

a) Power factor $= \cos\delta = \dfrac{P_{av}}{\mathcal{E}_{rms} I_{rms}} = \dfrac{1}{3}$

b) $I_{rms} Z_T = \mathcal{E}_{rms} \qquad Z_T = \dfrac{\mathcal{E}_{rms}}{I_{rms}} = \dfrac{120}{1.5} = 80\,\Omega$

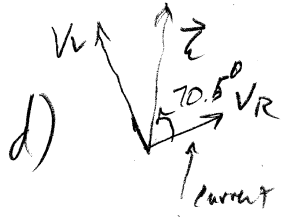
$R = Z_T \cos\delta = 80\,\Omega \cdot \dfrac{1}{3} \approx 26.7\,\Omega$

c) $Z_T^2 = R^2 + \omega^2 L^2 \Rightarrow L^2 = \dfrac{Z_T^2 - R^2}{\omega^2}$

$= \dfrac{80^2\left(1 - \frac{1}{3^2}\right)}{(7\pi)^2 60^2}$

$L = 0.2\,H$

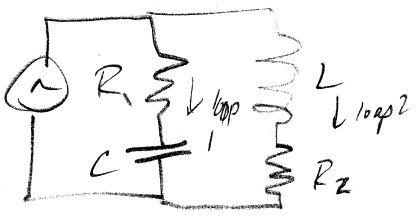
d)



Current lags voltage

$\delta = \cos^{-1}\frac{1}{3} = 70.5^\circ$

28.66



$X_C = 10\,\Omega$

$X_L = 30\,\Omega$

$R_1 = 10\,\Omega$

$R_2 = 40\,\Omega$

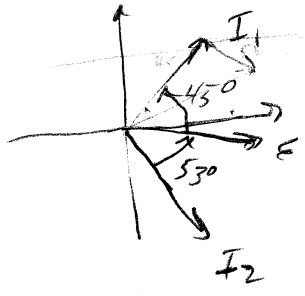
a) $Z_1 = \sqrt{R_1^2 + X_C^2} = \sqrt{10^2 + 10^2} = 10\sqrt{2}\,\Omega = 14.14\,\Omega$

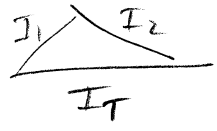
$Z_2 = \sqrt{R_2^2 + X_L^2} = \sqrt{40^2 + 30^2} = 50\,\Omega$

b) $I_1 = \frac{\mathcal{E}}{Z_1} = \frac{\mathcal{E}}{14.14\,\Omega}$ $\quad \cos\delta_1 = \frac{R_1}{Z_1} = \frac{10}{14.14} = \frac{1}{\sqrt{2}}$ $\quad \delta_1 = 45^\circ$ lead V

$I_2 = \frac{\mathcal{E}}{Z_2} = \frac{\mathcal{E}}{50\,\Omega}$ $\quad \cos\delta_2 = \frac{R_2}{Z_2} = \frac{40}{50} \Rightarrow$ $\delta_2 \approx 36.87^\circ$ lag V

c)



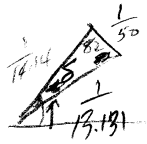


$\vec{I}_T = \vec{I}_1 + \vec{I}_2$

$= I_1\left(\frac{1}{\sqrt{2}}\hat{i} + \frac{1}{\sqrt{2}}\hat{j}\right) + I_2\left(\cos\delta_2\,\hat{i} - \sin\delta_2\,\hat{j}\right)$

$= \left(\frac{I_1}{\sqrt{2}} + I_2\cos\delta_2\right)\hat{i} + \left(\frac{I_1}{\sqrt{2}} - I_2\sin\delta_2\right)\hat{j}$

$|I_T| = \frac{\mathcal{E}}{13.131}$



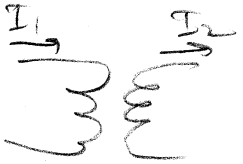
$\delta_2 = 16.26^\circ$

$\frac{\sin\delta}{1/50} = \frac{\sin(180^\circ - 45^\circ - 36.87^\circ)}{1/13.131}$

$= .26$ $\quad \delta = 15.06^\circ$

phase angle $= 45^\circ - \delta \approx 29.9^\circ$

28.75.



$P: I_1 \mathcal{E}_1 = I_2 \mathcal{E}_2$

$\frac{\mathcal{E}_2}{N_2} = \frac{\mathcal{E}_1}{N_1}$

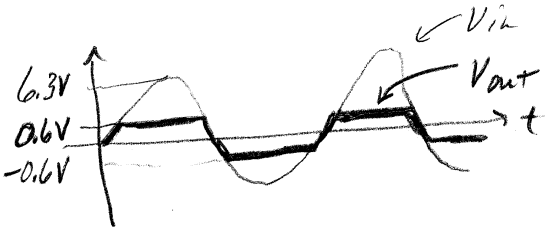
$N_1 I_1 = N_2 I_2$

$I_1 = I_2 \frac{\mathcal{E}_2}{\mathcal{E}_1}$

$= \frac{\mathcal{E}_2}{Z} \cdot \frac{\mathcal{E}_2}{\mathcal{E}_1} = \frac{\mathcal{E}_1^2 \cdot \left(\frac{N_2}{N_1}\right)^2}{Z\,\mathcal{E}_1} = \frac{\mathcal{E}_1}{\left(N_1/N_2\right)^2 Z}$

$\Rightarrow Z_{eff} = \left(\frac{N_1}{N_2}\right)^2 Z$

4. The diodes limit the output to a diode drop 0.6 V, neglecting other diode effects. The transformer is just an AC source, and the resistor is just to limit current. So we have



5. The current gain is $\beta = \frac{I_{collector}}{I_{base}} = \frac{0.5\ mA}{10\ \mu A} = 50.$

So the voltage gain is $\frac{v_L}{v_s} = \beta \cdot \frac{R_L}{R_b} = 50 \cdot \frac{10\ k\Omega}{2\ k\Omega}$

$= 250.$