Physics 1C Chapter 31 Problems

31.13) $R = 160\Omega$, $L = 0.450H$, $C = 5.70\mu F$, $\mathcal{E}_{max} = 27V$, $\omega = 270 \frac{rad}{s}$

a) $Z = \sqrt{R^2 + (\frac{1}{\omega C} - \omega L)^2}$

$\boxed{Z = 551.97\Omega}$

b) $\mathcal{E}_{max} = I_{max} Z$

$\boxed{I_{max} = 0.0489A}$

c) $\tan \phi = \frac{R}{\frac{1}{\omega C} - \omega L}$

$\boxed{\phi = -73.15°}$

d) $\boxed{\text{lags}}$

e) $V_{max} = I_{max} R$

$\boxed{V_{max} = 7.8V}$

f) $V_{max} = I_{max} X_L = I_{max}(\omega L)$

$\boxed{V_{max} = 5.94V}$

g) $V_{max} = I_{max} X_C = I_{max}(\frac{1}{\omega C})$

$\boxed{V_{max} = 31.77V}$

c) $V_L = I_{max}(X_L)\cos(\omega t + \frac{\pi}{2})$

$V_L = I_{max}(\omega L)\cos(\omega t + \frac{\pi}{2})$

$\boxed{V_L = 8.77V}$

d) $V_C = I_{max}(X_C)\cos(\omega t - \frac{\pi}{2})$

$V_C = I_{max}(\frac{1}{\omega C})\cos(\omega t - \frac{\pi}{2})$

$\boxed{V_C = -77.08V}$

e) $\boxed{V_C + V_R + V_L = V}$

f) $V_{R_{max}} = I_{max} R$

$\boxed{V_{R_{max}} = 12.67V}$

g) $V_{C_{max}} = I_{max} X_C$

$V_{C_{max}} = I_{max}(\frac{1}{\omega C})$

$\boxed{V_{C_{max}} = 36.92V}$

h) $V_{L_{max}} = I_{max} X_L$

$V_{L_{max}} = I_{max}(\omega L)$

$\boxed{V_{L_{max}} = 11.98V}$

i) $\boxed{V_{L_{max}} + V_{C_{max}} + V_{R_{max}} > V_{max}}$

31.14) $R = 220\Omega$, $L = 0.8H$, $C = 6.00\mu F$, $\mathcal{E}_{max} = 28V$, $\omega = 260 \frac{rad}{s}$

a) $i = I_{max}\cos(\phi)$

$\phi = 0$

$\tan\phi = \frac{\frac{1}{\omega C} - \omega L}{R}$

$\phi = -63.07°$

$V = \mathcal{E}_{max}(\omega t - 63.07°)$

$\boxed{V = -9.66V}$

b) $V_R = I(0.0716)R$

$V_R = I_{max}(\cos(\omega t))R$

$Z = \sqrt{R^2 + (\frac{1}{\omega C} - \omega L)^2}$

$Z = 485.7\Omega$

$I_{max} = \frac{\mathcal{E}_{max}}{Z}$

$I_{max} = 0.0576A$

$\boxed{V_R = 8.62V}$

31.15) $V_{R_{rms}} = 35V$

$V_{C_{rms}} = 90V$

$V_{L_{rms}} = 55V$

$\mathcal{E}_{max} = \sqrt{V_x^2 + V_y^2}$

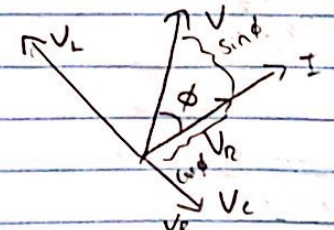
$V_y = 90V - 55V = 35V$

$V_x = 35V$

$\mathcal{E}_{max} = \sqrt{35^2 + 35^2}$

$\boxed{\mathcal{E}_{max} = 49.5V}$

31.21)



a) $\cos\phi = \frac{V_R}{V}$

$\boxed{\cos\phi = \frac{IR}{V}}$

b) $P_{av} = \frac{1}{2} V I \cos\phi$

$P_{av} = \frac{1}{2} V I \left(\frac{I R}{V}\right)$

$\boxed{P_{av} = \frac{1}{2} I^2 R}$

c) $\mathcal{E}_{max} = 120V$

$\phi = 53.1°$

$P_{av} = 80W$

$P_{av} = \frac{1}{2} V I \cos\phi$

$\langle P \rangle = I_{rms} \mathcal{E}_{rms} \cos\phi$

$\mathcal{E}_{rms} = \frac{\mathcal{E}}{\sqrt{2}}$

$\mathcal{E}_{rms} = 84.85V$

$I_{rms} = 1.57A$

$\langle P \rangle = I_{rms}^2 R$

$\boxed{R = 32.4\Omega}$

31.23) $L = 0.115H$, $R = 240\Omega$

$C = 7.31\mu F$, $I_{rms} = 0.446A$

$f = 400Hz$

a) $\omega = 2\pi f = 2513.27 Hz$

$\tan\phi = \frac{\left(\frac{1}{\omega C} - \omega L\right)}{R}$

$\boxed{\phi = 0.774 rads}$

b) $\cos\phi$ = power factor

$\boxed{0.715}$

c) $Z = \sqrt{R^2 + \left(\frac{1}{\omega C} + \omega L\right)^2}$

$\boxed{Z = 335.61\Omega}$

d) $\mathcal{E}_{rms} = \frac{\mathcal{E}_{max}}{\sqrt{2}}$

$I_{max} = \frac{\mathcal{E}_{max}}{Z}$

$I_{rms} = \frac{\mathcal{E}_{rms}}{Z}$

$\boxed{\mathcal{E}_{rms} = 150.75V}$

e) $\langle P \rangle = I_{rms} \mathcal{E}_{rms} \cos\phi$

$\boxed{\langle P \rangle = 48.16W}$

f) $P = I^2 R$

$\langle P \rangle = I_{rms}^2 R$

$\boxed{\langle P \rangle = 48.16W}$

g) $\boxed{0W}$

h) $\boxed{0W}$

31.27) $R = 205\Omega$, $L = 0.406H$,

$C = 5.09\mu F$, $\mathcal{E}_{max} = 2.93V$

a) $\omega = \frac{1}{\sqrt{LC}}$

$\boxed{\omega = 695.63 rad/s}$

b) $I_{max} = \frac{\mathcal{E}_{max}}{\sqrt{R^2 + \left(\frac{1}{\omega C} - \omega L\right)^2}}$

$\boxed{I_{max} = 0.0147A}$

c) $\boxed{I_{max} = 0.0074A}$

d) $X_C > X_L$

$\boxed{\text{lags}}$

31.30) $\mathcal{E}_{max} = 120V$, $\omega = 50 \frac{rad}{s}$

$R = 400\Omega$, $L = 3H$

a) $\frac{1}{\omega C} = \omega L$

$C = \frac{1}{\omega^2 L}$

$\boxed{C = 1.33 \times 10^{-4} F}$

b) $V_L = X_L I$

$I_{max} = 0.3A$

$X_L = \omega L$

$V_L = 45V$

31.35) $\mathcal{E}_{rms1} = 150V$, $\mathcal{E}_{rms2} = 15V$

$R = 5.10\Omega$

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

$\boxed{\frac{N_1}{N_2} = 10}$

b) $I_2 = \frac{V_2}{R}$

$\boxed{I_2 = 2.94A}$

c) $\langle P \rangle = I_{rms}^2 R$

$\boxed{\langle P \rangle = 44.12W}$

d) $I_{rms} = \frac{V_{rms}}{R}$

$R = \frac{V_{rms}}{I_{rms}}$

$I_{rms} = \frac{\langle P \rangle}{\mathcal{E}_{rms}}$

$R = \frac{\mathcal{E}_{rms}^2}{\langle P \rangle} = \boxed{510\Omega}$

31.40) $R = 200\Omega$, $L = 0.4H$

$C = 6\mu F$, $V = 30V$

a) $\omega = 200\ rad/s$

$I_{rms} = \frac{\mathcal{E}_{rms}}{\sqrt{R^2 + (\frac{1}{\omega C} - \omega L)^2}}$

$I_{rms} = 0.0269A$

$V_1 = I_{rms} R$

$\boxed{V_1 = 5.44V}$

b) $V_2 = I_{rms} X_L$

$V_2 = I_{rms} \omega L$

$\boxed{V_2 = 2.15V}$

c) $V_3 = I_{rms} X_C$

$V_3 = I_{rms} \frac{1}{\omega C}$

$\boxed{V_3 = 22.42V}$

d) $V_4 = I_{rms}(Z)$

$V_4 = I_{rms}\left(\sqrt{\frac{1}{\omega C} - \omega L)^2}\right)$

$\boxed{V_4 = 20.27V}$

e) $V_5 = I_{rms}(Z)$

$V_5 = I_{rms}\left(\sqrt{R^2 + (\frac{1}{\omega C} - \omega L)^2}\right)$

$\boxed{V_5 = 20.97V}$

f) $\omega = 1000 rad/s$

$\mathcal{E}_{rms} = 21.21V$

$Z = 307.32\Omega$

$I_{rms} = 0.069A$

$\boxed{V_1 = 13.8V}$

g) $\boxed{V_2 = 27.6V}$

h) $\boxed{V_3 = 11.5V}$

i) $\boxed{V_4 = 16.1V}$

j) $\boxed{V_5 = 21.2}$

31.47) a) $I_s = \frac{V_s}{Z}$

$V_s = I_s Z$

$V_{out} = I_s Z$

$I_s = \frac{V_s}{\sqrt{R^2 + (\frac{1}{\omega C} - \omega L)^2}}$

$\frac{V_s}{\sqrt{R^2 + (\frac{1}{\omega C} - \omega L)^2}} \cdot \left(\sqrt{R^2 + \omega^2 L^2}\right) = V_{out}$

$\boxed{\frac{V_{out}}{V_s} = \frac{\sqrt{R^2 + \omega^2 L^2}}{\sqrt{R^2 + (\frac{1}{\omega C} - \omega L)^2}}}$

b) $\frac{V_{out}}{V_s} = \frac{\sqrt{R^2 + \omega^2 L^2}}{\sqrt{R^2 + (\frac{1}{\omega C} - \omega L)^2}}$

$= \frac{R}{\sqrt{R^2 + \frac{1}{\omega^2 C^2} + \omega^2 L^2 - \frac{2L}{C}}}$

$\frac{V_{out}}{V_s} = \frac{R}{\sqrt{R^2 + \frac{1}{\omega^2 C^2} - \frac{2L}{C}}} \cdot \frac{C\omega}{C\omega}$

$\boxed{\frac{V_{out}}{V_s} = RC\omega}$

c) $\frac{V_{out}}{V_s} = \frac{\sqrt{R^2 + \omega^2 L^2}}{\sqrt{R^2 + (\frac{1}{\omega C} + \omega L)^2}}$

$\frac{V_{out}}{V_s} = \frac{\sqrt{R^2 + \omega^2 L^2}}{\sqrt{R^2 + \omega^2 L^2}}$

$\boxed{\frac{V_{out}}{V_s} = 1}$

31.48) $V_{out} = I_s X_C = I_s \frac{1}{\omega C}$

a) $I_s = \frac{V_s}{\sqrt{R^2 + (\frac{1}{\omega C} - \omega L)^2}}$

$\boxed{\frac{V_{out}}{V_s} = \frac{1}{\omega C \sqrt{R^2 + (\frac{1}{\omega C} - \omega L)^2}}}$

b) $\frac{V_{out}}{V_s} = \frac{1}{\omega C \sqrt{R^2 + (-\omega L)^2}}$

$\boxed{\frac{V_{out}}{V_s} = \frac{1}{\omega^2 CL}}$

c) $\frac{V_{out}}{V_s} = \frac{1}{\omega C \sqrt{R^2 (\frac{1}{\omega^2 C^2} - \omega^2 L^2 - \frac{2L}{C})}}$

$\frac{V_{out}}{V_s} = \frac{1}{\omega C (\frac{1}{\omega C})} = \boxed{1}$

31.49) a) $\boxed{I = \frac{V}{\sqrt{R^2 + (\frac{1}{\omega C} - \omega L)^2}}}$

b) $\langle P \rangle = I_{rms} \mathcal{E}_{rms}$

$I_{rms} = \frac{1}{\sqrt{2}} \frac{V}{\sqrt{R^2 + (\frac{1}{\omega C} - \omega L)^2}}$

$\mathcal{E}_{rms} = \frac{V}{\sqrt{2}}$

$\langle P \rangle = \frac{1}{2} \left(\frac{V^2}{\sqrt{R^2 + (\frac{1}{\omega C} - \omega L)^2}} \right) X$

$\langle P \rangle = I_{rms}^2 R$

$\boxed{\langle P \rangle = \frac{1}{2} \left(\frac{V^2}{R^2 + (\frac{1}{\omega C} - \omega L)^2} \right) R}$

c) $\frac{1}{\omega C} = \omega L$

$\boxed{\omega = \sqrt{\frac{1}{LC}}}$

31.50) a) $V_L = I(\omega) * L$

$I(\omega) = \frac{V}{\sqrt{R^2 + (\frac{1}{\omega C} - \omega L)^2}}$

$\boxed{V_L = \frac{V \omega L}{\sqrt{R^2 + (\frac{1}{\omega C} - \omega L)^2}}}$

b) $V_C = I(\omega) * C$

$\boxed{V_C = \frac{V}{\omega C \sqrt{R^2 + (\frac{1}{\omega C} - \omega L)^2}}}$

d) $V_L = V_C$

$\omega L = \frac{1}{\omega C}$

$\boxed{\omega = \sqrt{\frac{1}{LC}}}$

31.54) $v = V \cos \omega t$

a) $\boxed{V = V_R = V_L = V_C}$

b) $\boxed{i = i_R + V_L + i_C}$

c) $\boxed{i_R \rightarrow \phi = 0°}$

d) $\boxed{i_L \rightarrow \phi = -90°}$

e) $\boxed{i_C \rightarrow \phi = 90°}$

g) $\boxed{I = \sqrt{I_R^2 + (I_C - I_L)^2}}$

31.57) $C = 2.4\,\mu F$, $L = 6\,mH$, $R = 65\,\Omega$

$\mathcal{E}_{max} = 20\,V$

a) $\langle P \rangle = \frac{1}{2} V_{rms} I_{rms}$

$\langle P \rangle = I_{rms}^2 R$

$\frac{1}{2} \frac{\mathcal{E}_{max}}{\sqrt{2}} \left(\frac{\mathcal{E}_{max}}{\sqrt{2} \sqrt{R^2 + (\frac{1}{\omega C} - \omega L)^2}} \right) =$

$\frac{1}{2} \left(\frac{\mathcal{E}_{max}}{\sqrt{R^2 + (\frac{1}{\omega C} - \omega L)^2}} \right)^2 R$

$\frac{\mathcal{E}_{max}}{\sqrt{2}} = \frac{\mathcal{E}_{max} R}{\sqrt{R^2 + (\frac{1}{\omega C} - \omega L)^2}}$

$R^2 + (\frac{1}{\omega C} - \omega L)^2 = 2R^2$

$(\frac{1}{\omega C} - \omega L)^2 = R^2$

$\frac{1}{\omega C} - \omega L = R$

$1 - \omega^2 LC = R \omega C$

$\omega^2 LC + R \omega C = 1$ Y

$\cos \phi = \frac{1}{2}$

$\phi = \frac{\pi}{3}$

$\tan \phi = \frac{\frac{1}{\omega L} - \omega C}{R}$

$\boxed{\omega = 21929.78\ rad/s}$

b) $\langle P \rangle = I_{max}^2 R (1/2)$

$I_{max} = \frac{V}{\sqrt{R^2 + (\frac{1}{\omega C} - \omega L)^2}}$

$I_{max} = 0.154\,A$

$\boxed{P_R = 0.77\,W}$

$\boxed{P_C = 0\,W}$

$\boxed{P_L = 0\,W}$

c) $\boxed{I_{max} = 0.154\,A}$

31.61) a) $I_{max} = \frac{\mathcal{E}_{max}}{R}$

$\boxed{I_{max} = \frac{V}{R}}$

b) $\omega_0 = \frac{1}{\sqrt{LC}}$

$V_{Cmax} = I_{max} * X_C$

$X_C = \frac{1}{\omega C} = \frac{\sqrt{LC}}{C}$

$\boxed{V_{Cmax} = \frac{V\sqrt{LC}}{RC}}$

c) $V_{Lmax} = I_{max} X_L$

$X_L = \omega L = \frac{L}{\sqrt{LC}}$

$\boxed{V_{Lmax} = \frac{VL}{R\sqrt{LC}}}$

d) $U = \frac{1}{2}CV^2$

$U = \frac{1}{2}C\left(\frac{V^2LC}{R^2C^2}\right)$

$\boxed{U = \frac{1}{2}\frac{V^2L}{R^2}}$

e) $U = \frac{1}{2}LI^2$

$\boxed{U = \frac{1}{2}\frac{LV^2}{R^2}}$

31.60) a) $\mathcal{E}_{max} = \frac{I_{max}}{R}$

I_{max} @ ω_0

$\boxed{\omega_0 = \frac{1}{\sqrt{LC}}}$

b) $V_L = I_{max} X_L$

$V_L = I_{max}(\omega L)$

$V_L = \frac{V\omega L}{\sqrt{R^2 + (\frac{1}{\omega C} - \omega L)^2}}$

$\frac{\partial V_L}{\partial \omega} = 0$ @ max

$0 = \frac{\partial}{\partial \omega}\left(\frac{\omega}{\sqrt{R^2 + (\frac{1}{\omega C} - \omega L)^2}}\right)$

$f(x) = \omega$, $f'(x) = 1$

$g(x) = \sqrt{R^2 + (\frac{1}{\omega C} - \omega L)^2}$

$g'(x) = \frac{(\frac{1}{\omega C} - \omega L)(-\frac{1}{\omega^2 C} - L)}{(R^2 + (\frac{1}{\omega C} - \omega L)^2)^{1/2}}$

$\frac{(R^2 + (\frac{1}{\omega C} - \omega L)^2)^{1/2} - (\frac{1}{\omega C} - \omega L)(-\frac{1}{\omega C} - \omega L)}{(R^2 + (\frac{1}{\omega C} + \omega L)^2)^{1/2}}$

$(R^2 + (\frac{1}{\omega C} - \omega L)^2)^{1/2} = (\frac{1}{\omega C} - \omega L)^2$

$R^2 + (\frac{1}{\omega C} - \omega L)^2 = (\frac{1}{\omega C} - \omega L)^4$

$R^2 = (\frac{1}{\omega C} - \omega L)^2$

$\boxed{\omega = \frac{1}{\sqrt{LC - R^2C^2}^{1/2}}}$

c) $V_C = I_{max} X_C$

$V_C = \frac{I_{max}}{\omega L}$

$V_C = \frac{V}{\omega L\sqrt{R^2 + (\frac{1}{\omega C} - \omega L)^2}}$

$\frac{\partial V_C}{\partial \omega} = 0$ @ max

$0 = \frac{\partial}{\partial \omega}\left(\frac{V}{\omega L\sqrt{R^2 + (\frac{1}{\omega C} - \omega L)^2}}\right)$

$\boxed{\omega = \sqrt{\frac{1}{LC} - \frac{R^2}{2L^2}}}$

31.67) $i = I\cos\omega t$

a) $P = I\mathcal{E}\cos^2\omega t$

$\boxed{P = IV_R\cos^2\omega t}$

b) $\langle P \rangle = IV_R\langle\cos^2\omega t\rangle$

$\boxed{\langle P \rangle = \frac{1}{2}IV_R}$

c) $P_L = V_L I\cos(\omega t)\cos(\omega t + \frac{\pi}{2})$

$\boxed{P_L = -V_L I\cos(\omega t)\sin(\omega t)}$

d) $\langle P_L \rangle = -V_L I\langle\cos(\omega t)\sin(\omega t)\rangle$

$\boxed{\langle P_L \rangle = 0W}$

e) $\boxed{P_C = V_C I\cos(\omega t)\sin(\omega t)}$

f) $\boxed{\langle P_C \rangle = 0}$

g) $\boxed{P = P_R + P_L + P_C}$