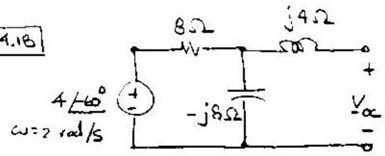
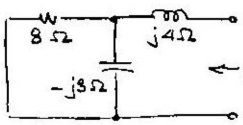
4.18




$$\underline{V}_{oc} = \frac{-j8}{8-j8}(4\angle -60^\circ)$$

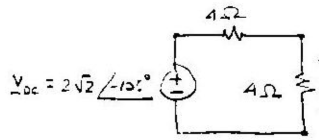
$$\underline{V}_{oc} = \frac{-j}{1-j}(4\angle -60^\circ) = \frac{1\angle -90^\circ}{\sqrt{2}\angle -45^\circ}(4\angle -60^\circ) = 2\sqrt{2}\angle -105^\circ$$




$$Z_o = j4 + \frac{8(-j8)}{8-j8} = j4 - \frac{j8}{1-j}\cdot\frac{1+j}{1+j}$$

$$Z_o = j4 - \frac{j8-8}{1+1} = j4 - (j4-4)$$

$$Z_o = 4\,\Omega$$

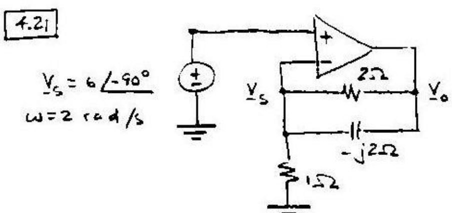



$$\underline{V}_o = \frac{4}{4+4}\underline{V}_{oc} = \frac{1}{2}(2\sqrt{2}\angle -105^\circ)$$

$$\underline{V}_o = \sqrt{2}\angle -105^\circ = 1.414\angle -105^\circ$$

$$\therefore v_o(t) = \sqrt{2}\cos(2t - 105^\circ) = \underline{\underline{1.41\cos(2t-105^\circ)\ V}}$$

4.21




By KCL at the inverting input of the op amp,

$$\frac{\underline{V}_s}{1} + \frac{\underline{V}_s - \underline{V}_o}{2} + \frac{\underline{V}_s - \underline{V}_o}{-j2} = 0$$

$$\underline{V}_s + \frac{1}{2}\underline{V}_s - \frac{1}{2}\underline{V}_o + j\frac{1}{2}\underline{V}_s - j\frac{1}{2}\underline{V}_o = 0$$

$$\left(\frac{3}{2} + j\frac{1}{2}\right)\underline{V}_s = \left(\frac{1}{2} + j\frac{1}{2}\right)\underline{V}_o$$

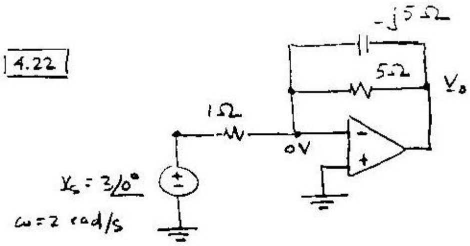
$$(3+j)\underline{V}_s = (1+j)\underline{V}_o$$

$$\underline{V}_o = \frac{(3+j)\underline{V}_s}{1+j} = \frac{(\sqrt{10}\angle 18.4^\circ)(6\angle -90^\circ)}{\sqrt{2}\angle 45^\circ}$$

$$\underline{V}_o = 6\sqrt{5}\angle -117^\circ = 13.4\angle -117^\circ\ V$$

$$\therefore v_o(t) = \underline{\underline{13.4\cos(2t-117^\circ)\ V}}$$

4.22




By KCL at the inverting input of the op amp,

$$\frac{\underline{V}_s}{1} + \frac{\underline{V}_o}{5} + \frac{\underline{V}_o}{-j5} = 0$$

$$\frac{1}{5}(\underline{V}_o + j\underline{V}_o) = -\underline{V}_s = -3\angle 0^\circ = 3\angle 180^\circ$$

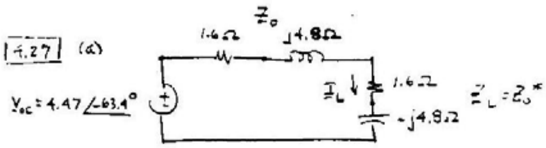
$$\frac{1}{5}(1+j)\underline{V}_o = 3\angle 180^\circ$$

$$\underline{V}_o = \frac{5(3\angle 180^\circ)}{1+j} = \frac{15\angle 180^\circ}{\sqrt{2}\angle 45^\circ}$$

$$\underline{V}_o = \frac{15}{\sqrt{2}}\angle 135^\circ = 10.6\angle 135^\circ$$

$\therefore v_o(t) = \underline{\underline{10.6\cos(2t + 135^\circ)\ \text{V}}}$

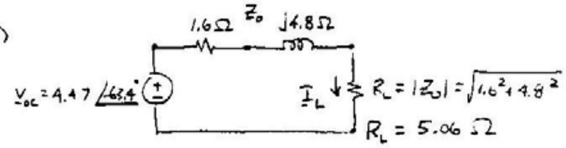
**4.27** (a)




$$I_L = \frac{V_{oc}}{Z_o + Z_L} = \frac{4.47\angle -63.4^\circ}{3.2} = 1.40\angle -63.4^\circ$$

$$\therefore P_L = \tfrac{1}{2} R_L |I_L|^2 = \tfrac{1}{2}(1.6)(1.4)^2 = \underline{1.57\text{ W}}$$

(b)

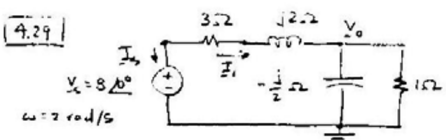



$$I_L = \frac{V_{oc}}{Z_o + R_L} = \frac{4.47\angle -63.4^\circ}{1.6 + j4.8 + 5.06} = \frac{4.47\angle -63.4^\circ}{6.66 + j4.8}$$

$$I_L = \frac{4.47\angle -63.4^\circ}{8.21\angle 35.8^\circ} = 0.544\angle -99.2 \ \ A$$

$$\therefore P_L = \tfrac{1}{2} R_L |I_L|^2 = \tfrac{1}{2}(5.06)(0.544)^2 = \underline{\underline{0.749\text{ W}}}$$

**4.29**




By KCL at node $V_o$,

$$\frac{V_o - 8}{3 + j2} + \frac{V_o}{-j/2} + \frac{V_o}{1} = 0$$

$$\frac{V_o - 8}{3 + j2} + j2V_o + V_o = 0$$

$$V_o - 8 + (3 + j2)(j2V_o) + (3 + j2)V_o = 0$$

$$V_o - 8 - 4V_o + j6V_o + 3V_o + j2V_o = 0$$

$$j8V_o = 8$$

$$V_o = \frac{1}{j1} = -j1 = 1\angle -90^\circ \Rightarrow I_1 = \frac{V_s - V_o}{3 + j2} = \frac{8 + j}{3 + j2} = \frac{\sqrt{65}\angle 7.13^\circ}{\sqrt{13}\angle 33.7^\circ}$$

$$I_1 = \sqrt{5}\angle -26.6^\circ$$

$$I_s = -I_1 = (-1)I_1 = (1\angle 180^\circ)(\sqrt{5}\angle -26.6^\circ)$$

$$I_s = \sqrt{5}\angle -153.4^\circ$$

For 3-Ω resistor,

$$P_3 = \tfrac{1}{2} R_3 |I_1|^2 = \tfrac{1}{2}(3)(\sqrt{5})^2 = \underline{\underline{7.5\text{ W}}}$$

For 1-Ω resistor, $P_1 = \frac{1}{2}\frac{|V_o|^2}{R_1} = \frac{1}{2}\frac{(1)^2}{1} = \underline{\underline{0.5\text{ W}}}$

For inductor, $P_L = \underline{\underline{0\text{ W}}}$
For capacitor, $P_C = \underline{\underline{0\text{ W}}}$
} by inspection

For voltage source,

$$P_s = \tfrac{1}{2}|V_s||I_s| \cos[\text{ang}(V_s) - \text{ang}(I_s)]$$

$$P_s = \tfrac{1}{2}(8)(\sqrt{5})\cos(0^\circ + 153.4^\circ) = \underline{\underline{-8.0\text{ W}}}$$