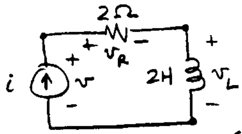
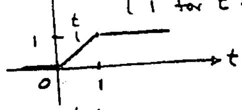
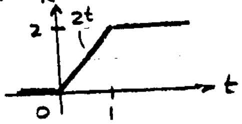
3.5



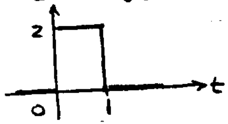
$i(t) = \begin{cases} 0 & \text{for } t \le 0\,s \\ t & \text{for } 0 < t \le 1\,s \\ 1 & \text{for } t > 1\,s \end{cases}$



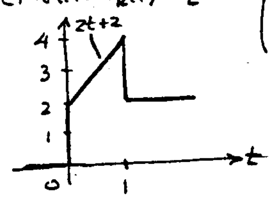
(a) $v_R(t) = R\,i(t) = 2i(t) = \begin{cases} 0 & \text{for } t \le 0\,s \\ 2t & \text{for } 0 < t \le 1\,s \\ 2 & \text{for } t > 1\,s \end{cases}$



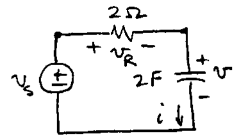
(b) $v_L(t) = L\dfrac{di(t)}{dt} = 2\dfrac{di(t)}{dt} = \begin{cases} 0 & \text{for } t \le 0\,s \\ 2 & \text{for } 0 < t \le 1\,s \\ 0 & \text{for } t > 1\,s \end{cases}$



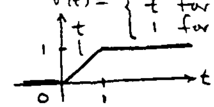
(c) $v(t) = v_R(t) + v_L(t) = \begin{cases} 0 & \text{for } t \le 0\,s \\ 2t+2 & \text{for } 0 < t \le 1\,s \\ 2 & \text{for } t > 1\,s \end{cases}$



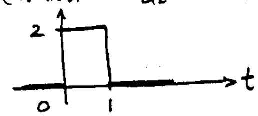
3.7



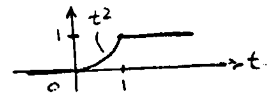
$v(t) = \begin{cases} 0 & \text{for } t \le 0\,s \\ t & \text{for } 0 < t \le 1\,s \\ 1 & \text{for } t > 1\,s \end{cases}$



(a) $i(t) = C\dfrac{dv(t)}{dt} = 2\dfrac{dv(t)}{dt} = \begin{cases} 0 & \text{for } t \le 0\,s \\ 2 & \text{for } 0 < t \le 1\,s \\ 0 & \text{for } t \ge 1\,s \end{cases}$

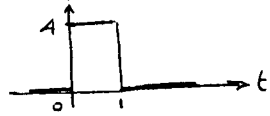


(b) $w_C(t) = \frac{1}{2}Cv^2(t) = v^2(t) = \begin{cases} 0 & \text{for } t \le 0\,s \\ t^2 & \text{for } 0 < t \le 1\,s \\ 1 & \text{for } t > 1\,s \end{cases}$

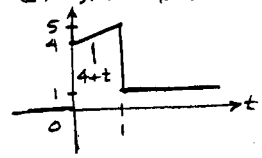


(c) $p_R(t) = R\,i^2(t) = 2i^2(t) = \begin{cases} 0 & \text{for } t \le 0\,s \\ 8 & \text{for } 0 < t \le 1\,s \\ 0 & \text{for } t > 1\,s \end{cases}$

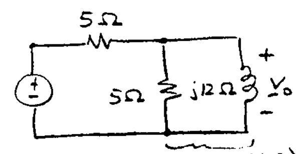
(d) $v_R(t) = R\,i(t) = 2i(t) = \begin{cases} 0 & \text{for } t \le 0\,s \\ 4 & \text{for } 0 < t \le 1\,s \\ 0 & \text{for } t > 1\,s \end{cases}$



(e) $v_s(t) = v_R(t) + v(t) = \begin{cases} 0 & \text{for } t \le 0\,s \\ 4+t & \text{for } 0 < t \le 1\,s \\ 1 & \text{for } t > 1\,s \end{cases}$



4.7



$V_s = 13\angle -22.6^\circ$

$\omega = 2$ rad/s

$$Z = \frac{5(j12)}{5+j12} = \frac{j60}{5+j12}\cdot\frac{5-j12}{5-j12}$$

$$Z = \frac{j300+720}{25+144} = \frac{720}{169} + j\frac{300}{169}$$

$$Z = 4.26 + j1.78$$

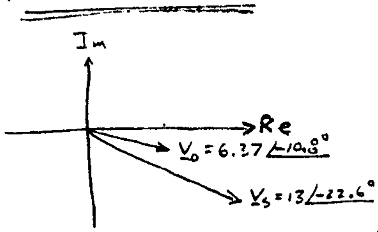
By voltage division,

$$V_o = \frac{Z}{5+Z}V_s = \frac{4.26+j1.78}{5+(4.26+j1.78)}(13\angle -22.6^\circ)$$

$$V_o = \frac{4.62\angle 22.7^\circ}{9.43\angle 10.9^\circ}(13\angle -22.6^\circ) = 6.37\angle -10.8^\circ$$

Thus,

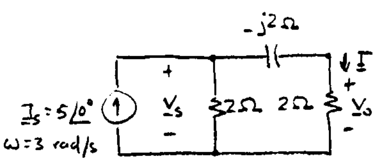
$v_o(t) = 6.37\cos(2t - 10.8^\circ)$ V



Since ang $V_o = -10.8^\circ >$ ang $V_s = -22.6^\circ$, $v_o(t)$ leads $v_s(t)$ by $-10.8^\circ + 22.6^\circ = 11.8^\circ$

Hence, the circuit is a **lead network**.

4.9



$\omega = 3$ rad/s

$Z_C = \dfrac{1}{j\omega C} = \dfrac{6}{j3}$

$Z_c = \dfrac{2}{j} = -j2\,\Omega$

By current division,

$$I = \frac{2}{2+(2-j2)}I_s = \frac{2}{4-j2}I_s = \frac{1}{2-j}I_s = \frac{1}{\sqrt{5}\angle -26.6^\circ}(5\angle 0^\circ)$$

$$I = \sqrt{5}\angle 26.6^\circ$$

$\therefore V_o = 2I = 2(\sqrt{5}\angle 26.6^\circ) = 4.47\angle 26.6^\circ$

Hence,

$v_o(t) = 4.47\cos(3t + 26.6^\circ)$ V

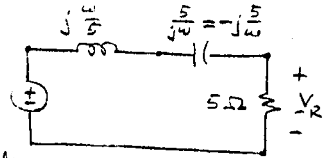
Also, $V_s = (2-j2)I = (2\sqrt{2}\angle -45^\circ)(\sqrt{5}\angle 26.6^\circ) = 2\sqrt{10}\angle -18.4^\circ$

$V_s = 6.32\angle -18.4^\circ$

Hence,

$v_s(t) = 6.32\cos(3t - 18.4^\circ)$ V

4.12



$V_s = 10\angle 0°$

ω rad/s

By voltage division,

$$V_R = \frac{5}{5 + j\frac{\omega}{5} - j\frac{5}{\omega}} V_s = \frac{5}{5 + j\left(\frac{\omega}{5} - \frac{5}{\omega}\right)}(10\angle 0°)$$

(a) $\omega = 1$ rad/s

$$V_R = \frac{5}{5 + j\left(\frac{1}{5} - 5\right)}(10) = \frac{50}{5 - j4.8} = \frac{50}{6.93\angle -43.8°}$$

$V_R = 7.22\angle 43.8°$ => $v_R(t)$ leads $v_s(t)$ by 43.8°

(b) $\omega = 5$ rad/s

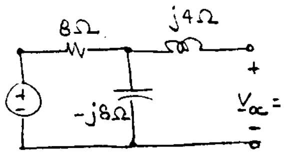
$V_R = \frac{5}{5 + j(1-1)}(10) = 10\angle 0°$ => $v_R(t)$ is in phase with $v_s(t)$

(c) $\omega = 10$ rad/s

$$V_R = \frac{5}{5 + j\left(2 - \frac{1}{2}\right)}(10) = \frac{50}{5 + j1.5} = \frac{50}{5.22\angle 16.7°}$$

$V_R = 9.58\angle -16.7°$ => $v_R(t)$ lags $v_s(t)$ by 16.7°

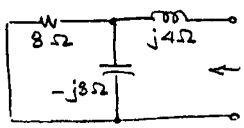
4.18



$\omega = 2$ rad/s

$$V_{oc} = \frac{-j8}{8 - j8}(4\angle -60°)$$

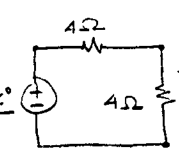
$$V_{oc} = \frac{-j}{1 - j}(4\angle -60°) = \frac{1\angle -90°}{\sqrt{2}\angle -45°}(4\angle -60°) = 2\sqrt{2}\angle -105°$$



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

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

$$Z_o = 4\Omega$$



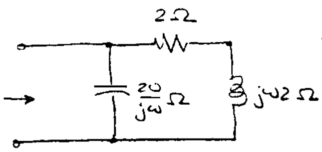
$V_{oc} = 2\sqrt{2}\angle -105°$

$$V_o = \frac{4}{4+4}V_{oc} = \frac{1}{2}(2\sqrt{2}\angle -105°)$$

$$V_o = \sqrt{2}\angle -105° = 1.414\angle -105°$$

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

4.16



$$Y = \frac{j\omega}{20} + \frac{1}{2 + j\omega 2}$$

$$Y = \frac{j\omega}{20} + \frac{1}{2 + j\omega 2}\cdot\frac{2 - j\omega 2}{2 - j\omega 2}$$

$$= \frac{j\omega}{20} + \frac{2 - j\omega 2}{4 + 4\omega^2} = \frac{j\omega}{20} + \frac{1 - j\omega}{2 + 2\omega^2}$$

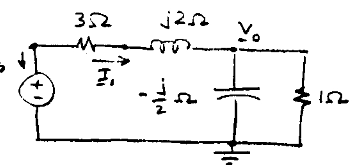
$$= \frac{(2 + 2\omega^2)j\omega + 20(1 - j\omega)}{20(2 + 2\omega^2)} = \frac{j\omega 2 + j\omega^3 2 + 20 - j\omega 20}{20(2 + 2\omega^2)}$$

$$= \frac{20 + j\omega^3 2 - j\omega 18}{20(2 + 2\omega^2)} = \frac{10 + j\omega^3 - j\omega 9}{20(1 + \omega^2)}$$

$$= \frac{10}{20(1 + \omega^2)} + \frac{j\omega(\omega^2 - 9)}{20(1 + \omega^2)}$$

$$= \frac{1}{2(\omega^2 + 1)} + j\frac{\omega(\omega^2 - 9)}{20(\omega^2 + 1)}$$

4.29



$V_s = 8\angle 0°$

$\omega = 2$ rad/s

By KCL at node V_o,

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

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

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

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

$$j8V_o = 8$$

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

$$I_1 = \sqrt{5}\angle -26.6°$$

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

$$I_s = \sqrt{5}\angle -153.4°$$

For 3-Ω resistor,

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

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

For inductor, $P_L = 0$ W

For capacitor, $P_C = 0$ W

} by inspection

For voltage source,

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

$$P_s = \frac{1}{2}(8)(\sqrt{5})\cos(0° + 153.4°) = -8.0\text{ W}$$