8.125 Calculate the Thévenin equivalent impedance $\mathbf{Z}_{Th}$ in the circuit shown in Fig. P8.125.

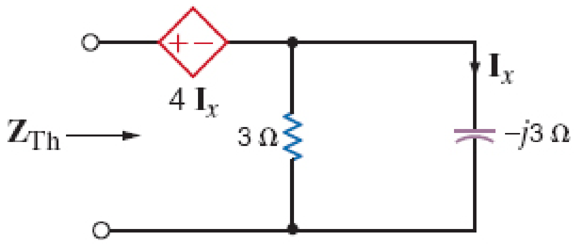
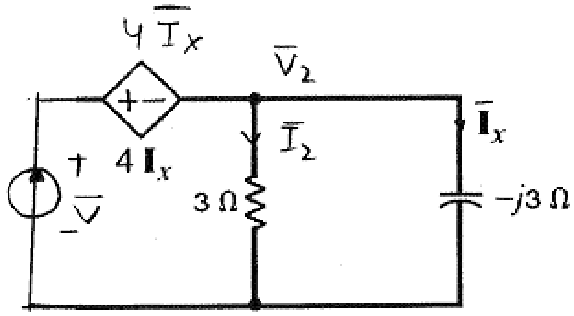


Figure P8.125

SOLUTION:

$\bar{I} = 1\angle 0°$A



KCL at ② : $1\angle 0° = \bar{I}_2 + \bar{I}_x$

$$\frac{\bar{V}_2}{3} + \frac{\bar{V}_2}{-j3} = 1\angle 0°$$

$$-j1\bar{V}_2 + \bar{V}_2 = -j3(1\angle 0°)$$

$$\bar{V}_2(1-j1) = 3\angle -90°$$

$$\bar{V}_2 = 2.12\angle -45°\ \text{V}$$

$$\bar{I}_2 = \frac{\bar{V}_2}{3} = \frac{2.12\angle -45°}{3} = 0.707\angle -45°\text{A}$$

$$\bar{I}_x = \frac{\bar{V}_2}{-j3} = \frac{2.12\angle -45°}{-j3} = 0.707\angle 45°\text{A}$$

KVL: $\bar{V} = 4\bar{I}_x + 3\bar{I}_2$

$$\bar{V} = 4(0.707\angle 45^\circ) + 3(7.07\angle -45^\circ)$$

$$\bar{V} = 3.54\angle 8.13^\circ \text{ V}$$

$$\bar{Z}_{TH} = \frac{\bar{V}}{\bar{I}} = \frac{3.54\angle 8.13^\circ}{1\angle 0^\circ}$$

$$\bar{Z}_{TH} = 3.54\angle 8.13^\circ\ \Omega$$

9.57 The current waveform in Fig. P9.57 is flowing through a 5-Ω resistor. Find the average power absorbed by the resistor.

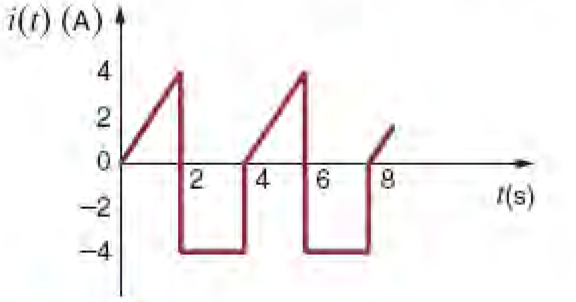


Figure P9.57

SOLUTION:

$$i_1(t) = 2t$$
$$i_1^2(t) = 4t^2$$

$$i_2(t) = -4$$
$$i_2^2(t) = 16$$

$$\int_0^2 i_1^2(t)dt = \int_0^2 4t^2\,dt = \frac{4t^3}{3}\Big]_0^2 = \frac{32}{3}$$

$$\int_2^4 i_2^2(t)\,dt = \int_2^4 16\,dt = 16t\Big]_2^4 = 32$$

$$I_{rms} = \sqrt{\frac{1}{T}\int_0^T i^2(t)dt}$$

$$I_{rms} = \sqrt{\frac{1}{4}\left[\frac{32}{3} + 32\right]}$$

$$I_{rms} = 3.27\text{A}$$

$$P_{5\Omega} = I_{rms}^2\,R$$

$$P_{5\Omega} = (3.27)^2(5)$$

$$P_{5\Omega} = 53.46\,\text{W}$$

14.64 Determine the transfer function for the network shown in Fig. P14.64. If a step function is applied to the network, what type of damping will the network exhibit?

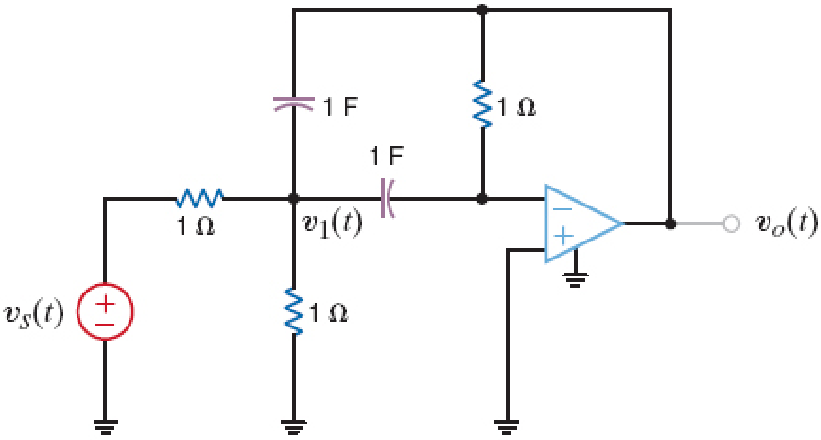
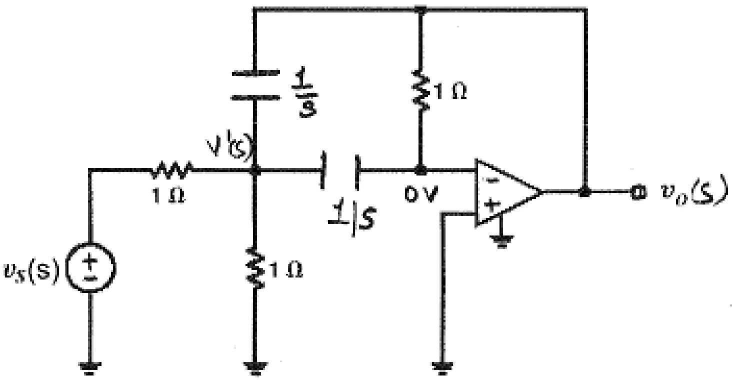


Figure P14.64

SOLUTION:



$$\frac{V_S(s) - V'(s)}{1} = \frac{V'(s)}{1} + V_1(s)S + \left(V_1(s) - V_o(s)\right)S$$

$$\frac{V_o(s)}{1} + V_1(s)S = 0$$

$$V_1(s) = \frac{-V_o(s)}{S}$$

$$V_S(s) = (2s+2)V_1(s) - SV_o(s)$$

$$V_S(s) = -\left(\frac{s^2+2s+2}{s}\right)V_o(s)$$

$$\frac{V_o(s)}{V_S(s)} = \frac{-s}{s^2+2s+2}$$

The roots are:

$$s = \frac{-2 \pm \sqrt{2^2 - 4(1)(2)}}{2(1)} = -1 \pm j1$$

Complex conjugate poles. Therefore, the network is underdamped.

16.15 Find the Z parameters of the two-port network in Fig. P16.15.

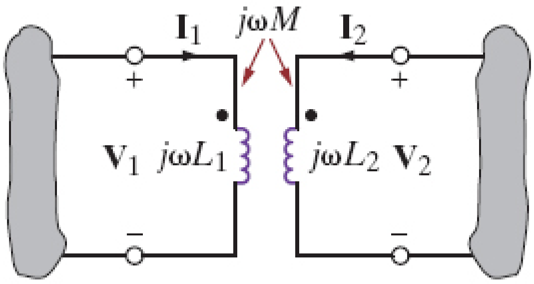
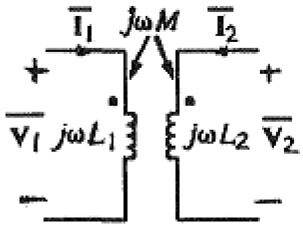


Figure P16.15

SOLUTION:



$$\overline{V}_1 = \overline{I}_1(j\omega L_1) + \overline{I}_2(j\omega M)$$

$$\overline{V}_2 = \overline{I}_1(j\omega M) + \overline{I}_2(j\omega L_2)$$

$$\overline{Z}_{11} = j\omega L_1$$

$$\overline{Z}_{12} = j\omega M$$

$$\overline{Z}_{21} = j\omega M$$

$$\overline{Z}_{22} = j\omega L_2$$

15.29 Determine the steady-state voltage $v_o(t)$ in the network in Fig. P15.29a if the input current is given in Fig. P15.29b.

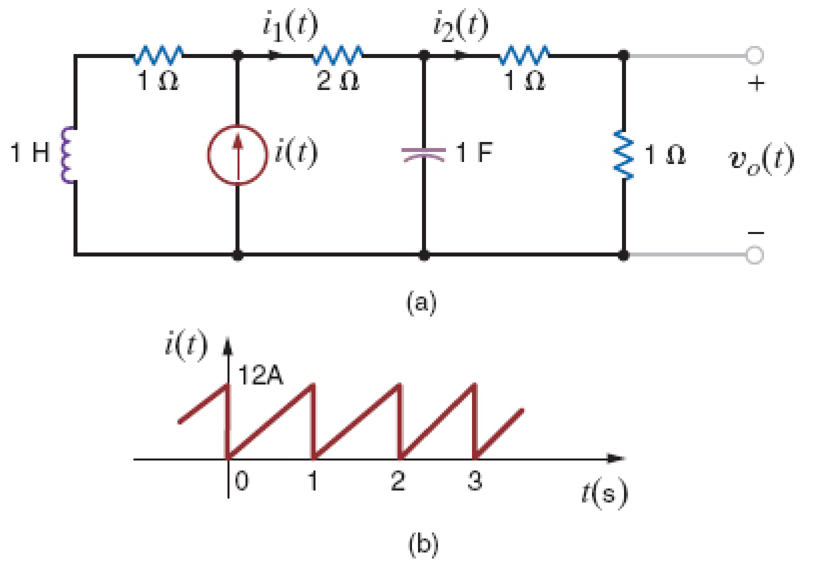


Figure P15.29

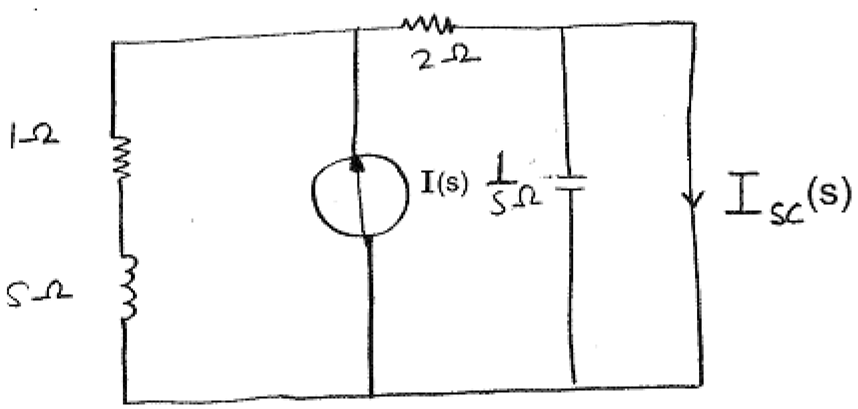
SOLUTION:

$T_0 = 1\text{s}$ and $\omega_0 = 2\pi$ rad/s

$i(t)$ can be found from Table 15.2:

$$i(t) = 6 + \sum_{n=1}^{\infty} \frac{-12}{n\pi} \sin 2n\pi t \quad \text{A}$$

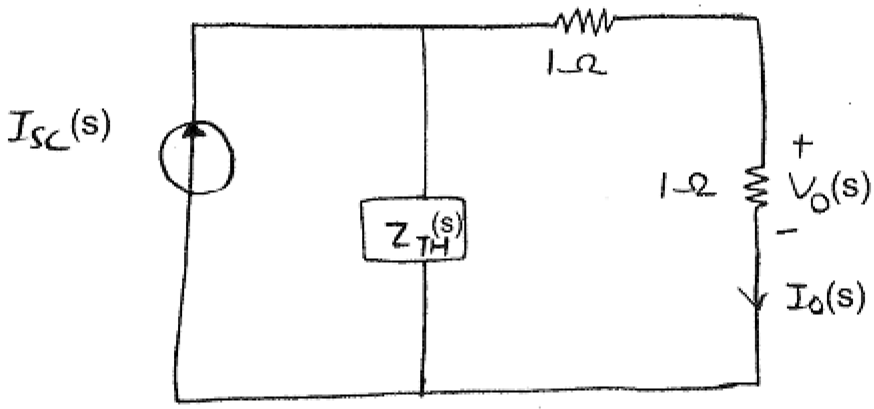
$$i(t) = 6 + \sum_{n=1}^{\infty} \frac{-12}{n\pi} \cos(2\pi n t - 90°) \quad \text{A}$$



$$I_{sc}(s) = \left(\frac{s+1}{s+3}\right) \bar{I}$$

$$Z_{TH}(s) = \frac{\frac{1}{s}(s+3)}{s+3+1/s}$$

$$Z_{TH}(s) = \frac{s+3}{s^2+3s+1}$$



$V_o(s) = 1\, I_o(s)$

$$\frac{I_o(s)}{I_{sc}(s)} = \frac{Z_{TH}(s)}{2+Z_{TH}(s)}$$

$$\frac{V_o(s)}{I_{sc}(s)} = \frac{s+3}{s+3+2s^2+6s+2}$$

$$\frac{V_o(s)}{I_{sc}(s)} = \frac{s+3}{(2s+5)(s+1)}$$

$$\frac{V_o(s)}{I(s)} = \frac{s+3}{(2s+5)(s+1)}\left(\frac{s+1}{s+3}\right)$$

$$\frac{V_o(s)}{I(s)} = \frac{1}{2s+5}$$

$$S = j2\pi n$$

$$\frac{\bar{V}_o}{\bar{I}} = \frac{1}{5+j4\pi n}$$

let

$$A(n) = \frac{1}{5+j4\pi n}$$

$$A(n) = |A(n)| \angle \theta_{A(n)}$$

$n=0$, $i(t) = 6A$ and $A(0) = 1/5$

$$V_o(t) = \frac{6}{5} + \sum_{n=1}^{\infty} \frac{-12}{n\pi} |A(n)| \cos(2\pi nt - 90^\circ + \theta_{A(n)}) \text{ V}$$