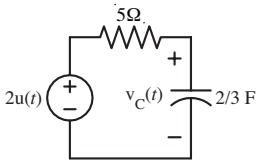
Chapter 15 Solutions to Assigned Homework

4. (a) $\mathrm{v}(t)=\left[4.531e^{-2.454t}-1.031e^{-t}\right]\mathrm{u}(t)$

(b) $\mathrm{v}(t)=-\left(1.031e^{-t}+3.569e^{-2.4545t}\right)\mathrm{u}(t)$

5. $\mathrm{V}_C(s)=\dfrac{2}{s}+\dfrac{1}{s+0.3}\Rightarrow \mathrm{v}(t)=\left(2+e^{-0.3t}\right)\mathrm{u}(t)$

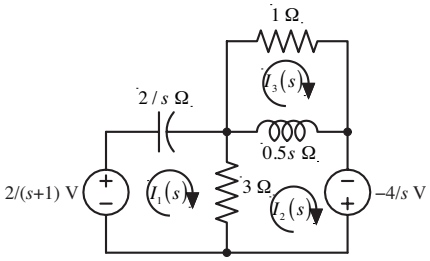


$\mathrm{v}_C\left(0^-\right)=3\ \mathrm{V}$

7. $Z_{in}(s)=0.5\dfrac{s^2+1.2121s+8}{s+1.2121}$

8. $\mathrm{Y}(s)=0.667\dfrac{s^2+3.6453s+1.7632}{s^2+4.736s+5.5278}$

11. (a)



(b) $$\begin{bmatrix} \dfrac{2}{s}+3 & -3 & 0 \\ -3 & 3+0.5s & -0.5s \\ 0 & -0.5s & 1+0.5s \end{bmatrix}\begin{bmatrix} I_1(s) \\ I_2(s) \\ I_3(s) \end{bmatrix}=\begin{bmatrix} \dfrac{2}{s+1} \\ -\dfrac{4}{s} \\ 0 \end{bmatrix}$$

(c) $\mathrm{i}_1(t)=\left[-0.5714e^{-t}+3.243e^{-1.333t}\cos\left(1.4907t+103.6°\right)\right]\mathrm{u}(t)$

$\mathrm{i}_2(t)=\left[-0.8572e^{-t}-1.333+2.648e^{-1.333t}\cos\left(1.4907t+85.875°\right)\right]\mathrm{u}(t)$

$\mathrm{i}_3(t)=\left[0.8571e^{-t}+3.243e^{-1.333t}\cos\left(1.4907t+151.78°\right)\right]\mathrm{u}(t)$

13. $\left(\frac{1}{0.8}+\frac{s}{5}+\frac{s^2}{4}\right)\mathrm{V}_x(s)=-\frac{2}{0.8s}+\frac{3s}{4}$

$$\mathrm{v}_x(t)=\left[-2+5e^{-0.4t}\cos(2.2t+42.27°)\right]\mathrm{u}(t)$$

15. $$p_1(t)=\frac{\mathrm{v}_1^2(t)}{1}=\left[4.667e^{-t}+5.669e^{-t/4}\cos(1.5612t+178.38°)\right]^2\mathrm{u}(t)$$

16. $$p_3(t)=\frac{\mathrm{v}_2^2(t)}{3}=\frac{\left(4.65-1.05e^{-t}\right)^2}{3}\mathrm{u}(t)$$

20. $\mathrm{v}_2(1\mathrm{ms})=0.0001938\left(e^{-0.02882}-e^{0.21276}\right)=-51.45\ \mu\mathrm{V}$

$$\mathrm{v}_2(100\mathrm{ms})=0.0001938\left(e^{-2.882}-e^{21.276}\right)=-336.82\ \mathrm{kV}$$

$\mathrm{v}_2(10\mathrm{s})=0.0001938\left(e^{-288.2}-e^{2127.6}\right)=-0.0001938e^{2127.6}$ (as a practical matter, negative infinity)

21. $$V_{Th}=\frac{6}{17}\frac{s^2}{(s+1)(s+2)\left(s^2+(47/34)s+15/17\right)}$$

$$Z_{Th}=12\frac{s+35/34}{s^2+(47/34)s+15/17}$$

25. (a) $Z_{Th}=6.5\dfrac{s}{s+1.3}$.

(b) $\mathrm{i}_L(t)2.6907\left(1-e^{-0.7879t}\right)\mathrm{u}(t)$

27. $V_{Th}=0\ \mathrm{V}$, $R_{Th}=5/6\ \Omega$

28. $$\mathrm{v}_1(t)=\begin{bmatrix}-0.0205e^{-1.0123t}+0.1491e^{-0.2051t}+0.2982\cos(2t-86.06°)\\+0.0283e^{-0.41352t}\cos(0.89t-96.09°)\end{bmatrix}\mathrm{u}(t)$$

31. (a) Zero at $s=0$, Pole at $s=-12.5$
(b) Zeros at $s=0$ and $s=-1$, Poles at $s=-5$ and $s=-3$
(c) Zero at $s=-4$ and $s\to\infty$, Poles at $s=-1$ and $s=-7$
(d) Zeros at $s=2$ and $s=-1$, Poles at $s=0$, $s=-7$ and $s=-1$

33. (a) Zero at $s=-0.2$, Pole at $s=0$

(b) Zeros at $s = 0,\ s = -1$ and $s = -4$, Poles at $s = -5$ and $s = -3$ and $s = -3$

(c) No finite zeros, Poles at $s = \pm j2$

(d) Zeros at $s = \pm 6$, Poles at $s = \pm j$

34. (a) $\mathrm{H}(s) = \dfrac{s}{s + 1/RC}$

(b) Zero at $s = 0$, Pole at $s = -1/RC$

35. $(\mathrm{a})\quad \mathrm{H}(s) = \dfrac{R}{L}\dfrac{1}{s + R/L} \Rightarrow (\mathrm{b})$ No finite zeros, Pole at $s = -R/L$

$(\mathrm{a})\quad \mathrm{H}(s) = \dfrac{s}{s + R/L} \Rightarrow (\mathrm{b})$ Zero at $s = 0$, Pole at $s = -R/L$

38. (a) $\mathrm{V}_{out}(s) = \dfrac{3}{s^2 + 8s + 7}$

(b) $\mathrm{V}_{out}(s) = \dfrac{25s}{(s^2 + 8s + 7)(s + 2)}$

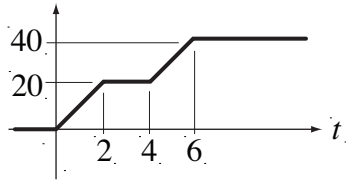
(c) $\mathrm{V}_{out}(s) = \dfrac{4e^{s}}{s^2 + 8s + 7}$

(d) $\mathrm{V}_{out}(s) = \dfrac{10s}{(s^2 + 8s + 7)(s^2 + 25)}$

40. Zeros at $s = -2$ and $s = -1/3$, Poles at $s = -3.351$ and $s = -0.149$

41. $\mathrm{x}(t) * \mathrm{y}(t) = 3(t-1)\mathrm{u}(t-1)$

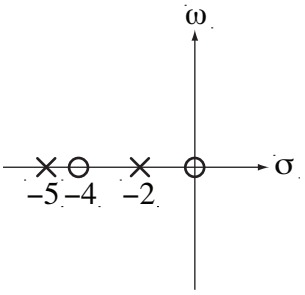
43. $\mathrm{f}(t) * \mathrm{g}(t)$



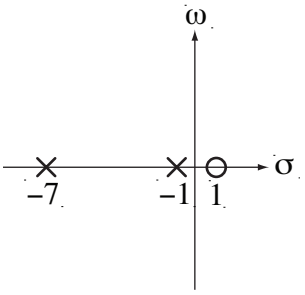
44. $\mathrm{y}(t) = \dfrac{2}{3}\left(1 - 4e^{-3t}\right)\mathrm{u}(t)$

48.

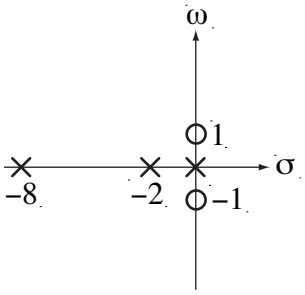
(a)



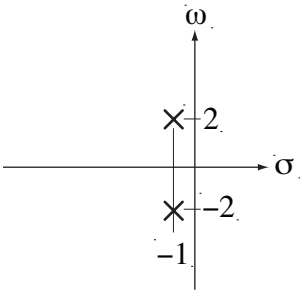
(b)



(c)



(d)

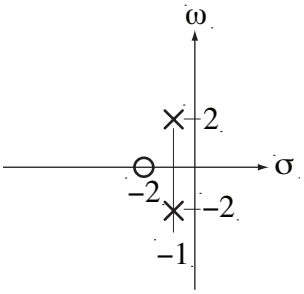


49. (a) $\mathrm{H}(s) = \dfrac{5}{2}\dfrac{s+2}{s^2+2s+5}$

(b) $\mathrm{H}(s) = -\dfrac{25}{2}\dfrac{s+2}{s^2+2s+5}$

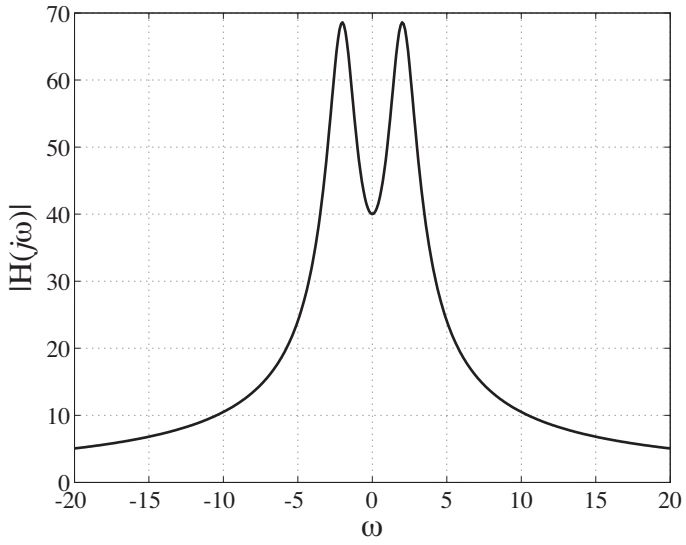
(c) Stable.

51. (a)



(b) $\mathrm{H}(j\omega) = 100\dfrac{j\omega+2}{-\omega^2+j2\omega+5}$

(c) $\left|\mathrm{H}(j\omega)\right| = 100\sqrt{\dfrac{4+\omega^2}{\left(5-\omega^2\right)^2+4\omega^2}}$

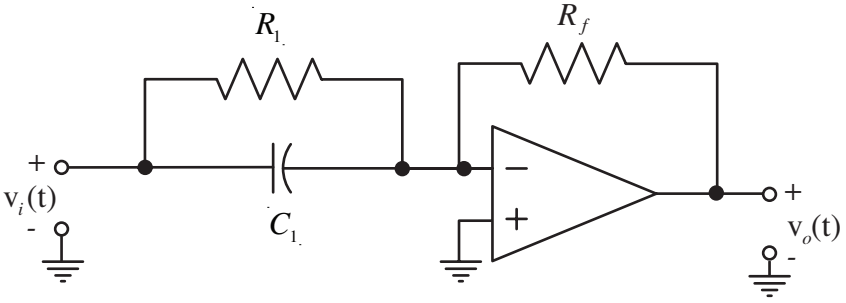


(d)

(e) $\omega_{\max} = 2.0155$.

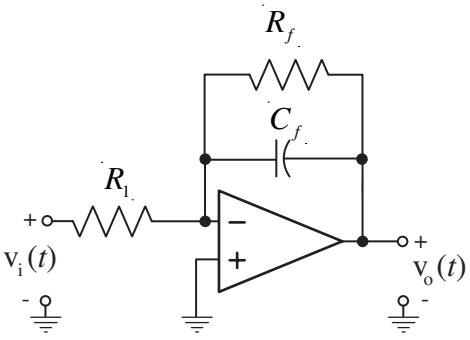
54. Pole at $s = -\dfrac{1}{(R_1 + R_2)C}$

56. (a)



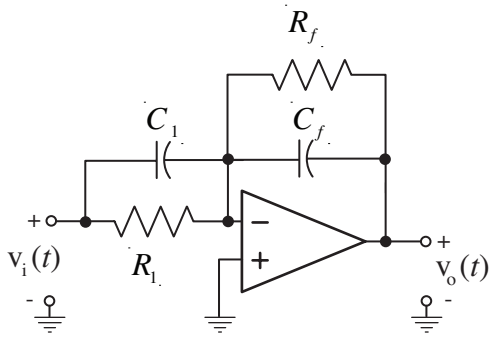
Choose $R_f = 5R_1$ and $R_1C_1 = 1$. (Complete except for the minus sign.)

(b)



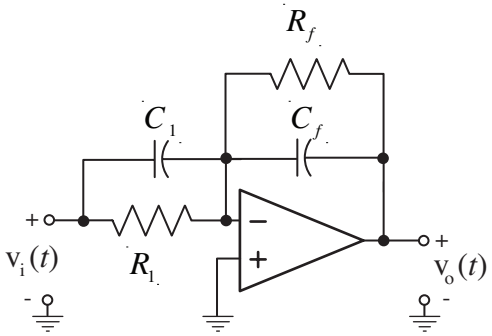
Choose $R_f = 5R_1$ and $R_fC_f = 1$. (Complete except for the minus sign.)

(c)



Choose $C_1 = 5C_f$ and $R_1C_1 = 1$ and $R_fC_f = 1/2$. (Complete except for the minus sign.)

58.



Let $C_f = 1\text{nF}$. Then $C_1 = 5\text{nF}$, $R_1 = 20\ \text{k}\Omega$ and $R_f = 5\text{k}\Omega$. (Complete except for the minus sign.)

60. (a) $\mathrm{H}(s) = -5\dfrac{s}{s+10^5}$

(b) $\mathrm{H}(s) = -0.2\dfrac{s+10^5}{s}$

(c) $\mathrm{H}(s) = -10\dfrac{s+10^4}{s+10^5}$