7. A system is described by the following differential equation:

$$\frac{d^3y}{dt^3}+3\frac{d^2y}{dt^2}+5\frac{dy}{dt}+y=\frac{d^3x}{dt^3}+4\frac{d^2x}{dt^2}+6\frac{dx}{dt}+8x$$

Find the expression for the transfer function of the system, $Y(s)/X(s)$. [Section: 2.3]

16. Find the transfer function, $G(s)=V_o(s)/V_i(s)$, for each network shown in Figure P2.3. [Section: 2.4]

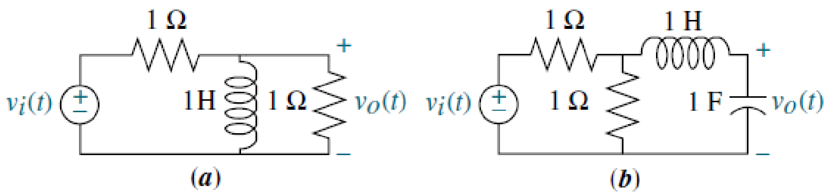


FIGURE P2.3

17. Find the transfer function, $G(s)=V_L(s)/V(s)$, for each network shown in Figure P2.4. [Section: 2.4]

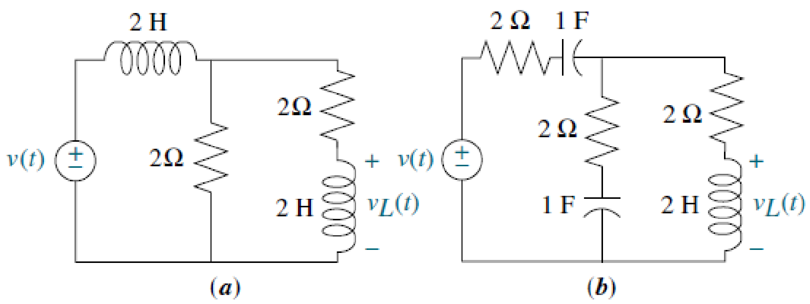
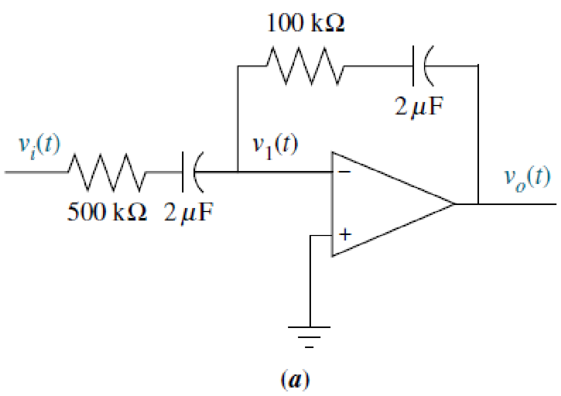


FIGURE P2.4

21. Find the transfer function, $G(s)=V_o(s)/V_i(s)$, for each operational amplifier circuit shown in Figure P2.7. [Section: 2.4]



22. Find the transfer function, $G(s) = V_o(s)/V_i(s)$, for each operational amplifier circuit shown in Figure P2.8. [Section: 2.4]

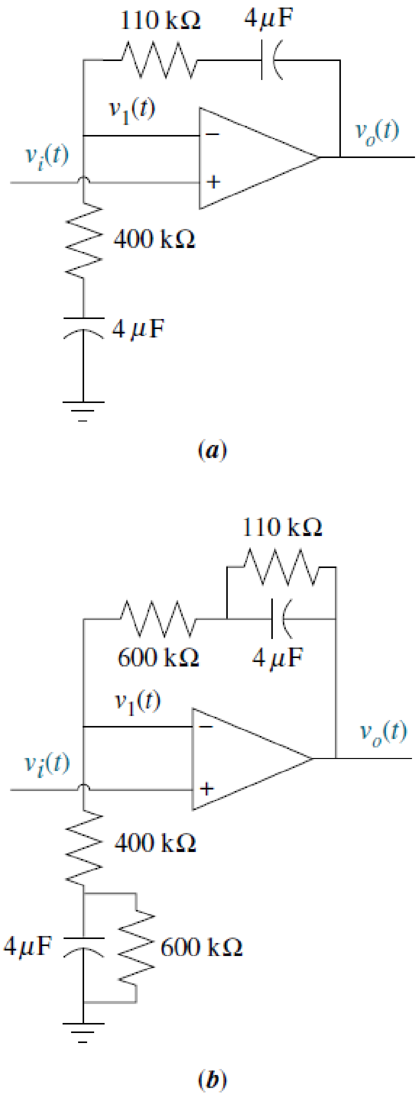


FIGURE P2.8

7.

The Laplace transform of the differential equation, assuming zero initial conditions, is,

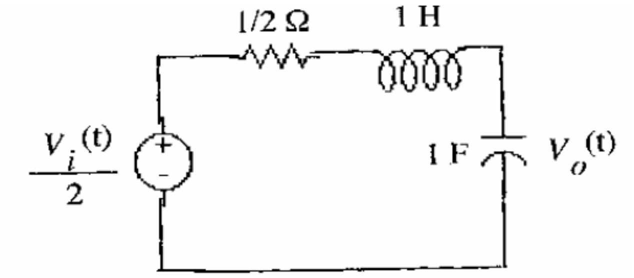
$(s^3+3s^2+5s+1)Y(s) = (s^3+4s^2+6s+8)X(s)$.

Solving for the transfer function, $\dfrac{Y(s)}{X(s)} = \dfrac{s^3 + 4s^2 + 6s + 8}{s^3 + 3s^2 + 5s + 1}$.

16.

a. Writing the node equations, $\frac{V_o - V_i}{s} + \frac{V_o}{s} + V_o = 0$. Solve for $\frac{V_o}{V_i} = \frac{1}{s+2}$.

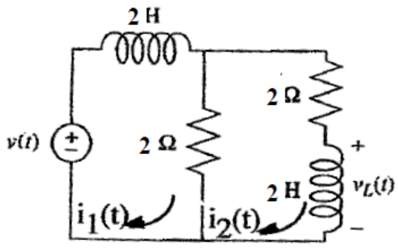
b. Thevenizing,



Using voltage division, $V_o(s) = \frac{V_i(s)}{2}\frac{\frac{1}{s}}{\frac{1}{2}+s+\frac{1}{s}}$. Thus, $\frac{V_o(s)}{V_i(s)} = \frac{1}{2s^2+s+2}$

17.

a.



Writing mesh equations

$$(2s+2)I_1(s) - 2\,I_2(s) = V_i(s)$$

$$-2I_1(s) + (2s+4)I_2(s) = 0$$

But from the second equation, $I_1(s) = (s+2)I_2(s)$. Substituting this in the first equation yields,

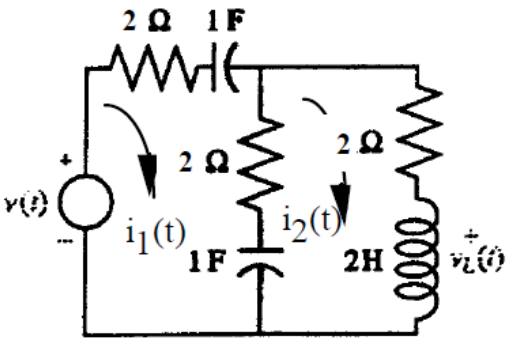
$$(2s+2)(s+2)I_2(s) - 2\,I_2(s) = V_i(s)$$

or

$$I_2(s)/V_i(s) = 1/(2s^2 + 4s + 2)$$

But, $V_L(s) = sI_2(s)$. Therefore, $V_L(s)/V_i(s) = s/(2s^2 + 4s + 2)$.

b.



$$(4+\frac{2}{s})I_1(s)-(2+\frac{1}{s})I_2(s)=V(s)$$

$$-(2+\frac{1}{s})I_1(s)+(4+\frac{1}{s}+2s)=0$$

Solving for $I_2(s)$:

$$I_2(s)=\frac{\begin{vmatrix}\frac{4s+2}{s} & V(s)\\ \frac{-(2s+1)}{s} & 0\end{vmatrix}}{\begin{vmatrix}\frac{4s+2}{s} & \frac{-(2s+1)}{s}\\ \frac{-(2s+1)}{s} & \frac{(2s^2+4s+1)}{s}\end{vmatrix}}=\frac{sV(s)}{4s^2+6s+1}$$

Therefore, $\frac{V_L(s)}{V(s)}=\frac{2sI_2(s)}{V(s)}=\frac{2s^2}{4s^2+6s+1}$

21.

a.

$$Z_1(s) = 5x10^5 + \frac{1}{2x10^{-6}s}$$

$$Z_2(s) = 10^5 + \frac{1}{2x10^{-6}s}$$

Therefore,

$$-\frac{Z_2(s)}{Z_1(s)} = -\frac{1}{5}\frac{(s+5)}{(s+1)}$$

b.

$$Z_1(s) = 10^5\left(\frac{5}{s}+1\right) = 10^5\,\frac{(s+5)}{s}$$

$$Z_2(s) = 10^5\left(1+\frac{5}{s+5}\right) = 10^5\,\frac{(s+10)}{(s+5)}$$

Therefore,

$$-\frac{Z_2(s)}{Z_1(s)} = -\frac{s(s+10)}{(s+5)^2}$$

22.

a.

$$Z_1(s) = 4x10^5 + \frac{1}{4x10^{-6}s}$$

$$Z_2(s) = 1.1x10^5 + \frac{1}{4x10^{-6}s}$$

Therefore,

$$G(s) = \frac{Z_1(s) + Z_2(s)}{Z_1(s)} = 1.275\frac{(s+0.98)}{(s+0.625)}$$

b.

$$Z_1(s) = 4x10^5 + \frac{\frac{10^{11}}{s}}{4x10^5 + \frac{0.25x10^6}{s}}$$

$$Z_2(s) = 6x10^5 + \frac{27.5\frac{10^9}{s}}{110x10^3 + \frac{0.25x10^6}{s}}$$

Therefore,

$$\frac{Z_1(s) + Z_2(s)}{Z_1(s)} = \frac{2640s^2 + 8420s + 4275}{1056s^2 + 3500s + 2500}$$