《Fundamentals of Electric Circuits》 homework CH.16

16.20 Find i(t) for t > 0 in the circuit of Fig. 16.43. (15')

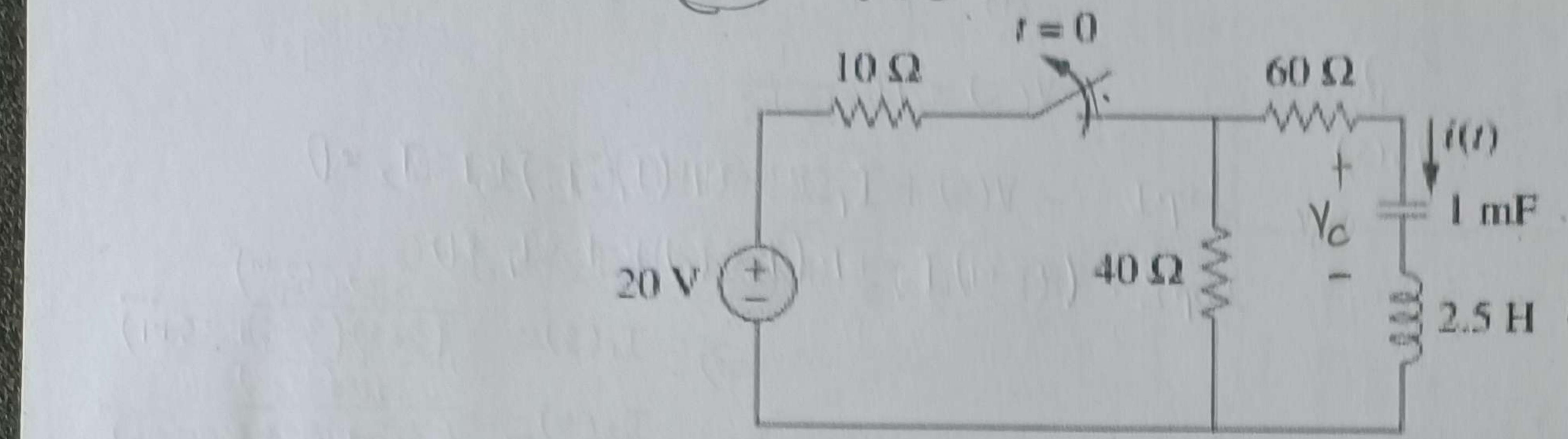
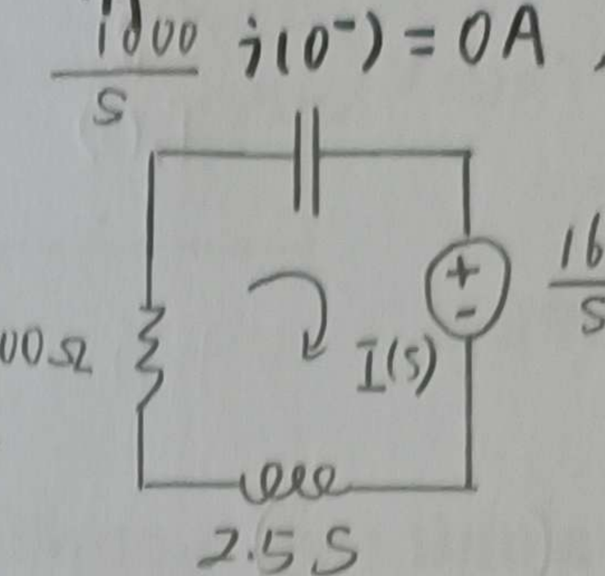


Figure 16.43

解: At $t=0^-$

$i(0^-) = 0A$, $V_c(0^-) = \frac{20}{10+40} \times 40 = 16V$



$\frac{16}{s} + (2.5s + 100 + \frac{1000}{s}) I(s) = 0$

$I(s) = \frac{-16}{2.5s^2+100s+1000}$

$= \frac{-16}{2.5(s^2+40s+400)}$

$= \frac{-16}{2.5} \cdot \frac{1}{(s+20)^2}$

$i(t) = \frac{-16}{2.5} \times e^{-20t} \cdot t\, u(t)$

$= -6.4 e^{-20t} t\, u(t)$ A

$= -6.4 e^{-20t} t$ A $t>0$

16.44 For the circuit in Fig.16.67, find i(t) for t > 0. (15')

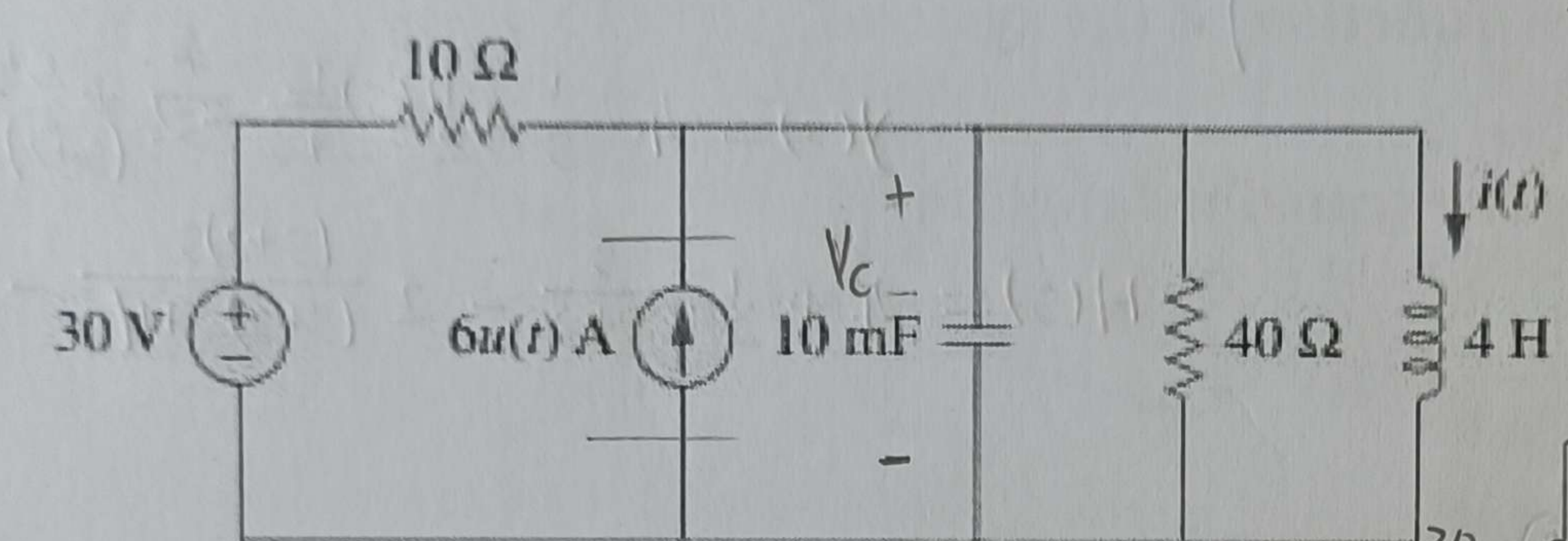
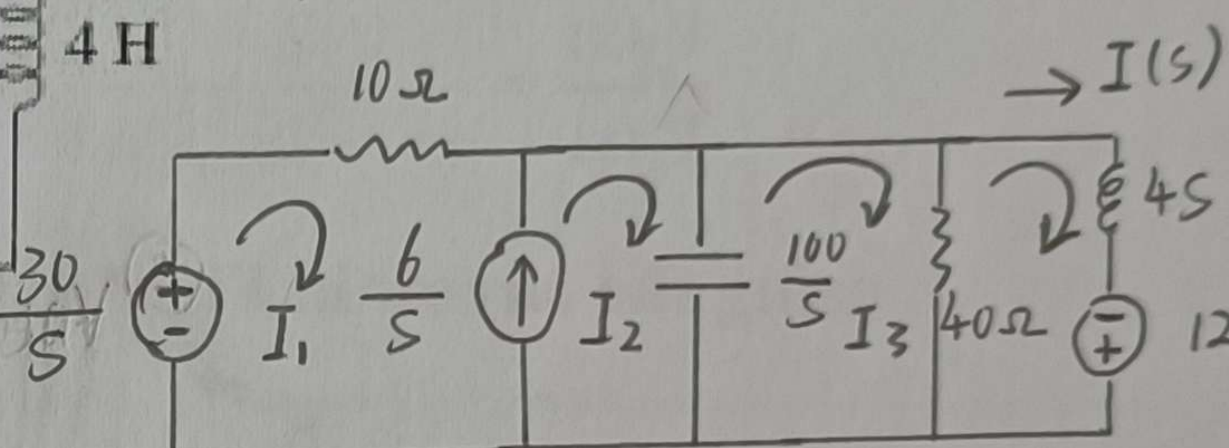


Figure 16.67

解: At $t=0^-$

$V_c(0^-) = 0$ V

$i(0^-) = 3$A



$$\left.\begin{aligned} &\frac{-30}{s} + 10I_1 + \frac{100}{s}(I_2 - I_3) = 0 \\ &I_2 - I_1 = \frac{6}{s} \\ &40(I_3 - I) + \frac{100}{s}(I_3 - I_2) = 0 \\ &4s \cdot I - 12 + 40(I - I_3) = 0 \end{aligned}\right\} \Rightarrow$$

$I = \frac{9}{s} + \frac{-16}{2s+5} + \frac{2}{s+10}$

$i(t) = (9 - 8 \cdot e^{-2.5t} + 2e^{-10t})u(t)$ A

16.57 (a) Find the Laplace transform of the voltage shown in Fig. 16.80(a).
(b) Using that value of $u_s(t)$ in the circuit shown in Fig. 16.80(b), find the value of $v_o(t)$.
(20')

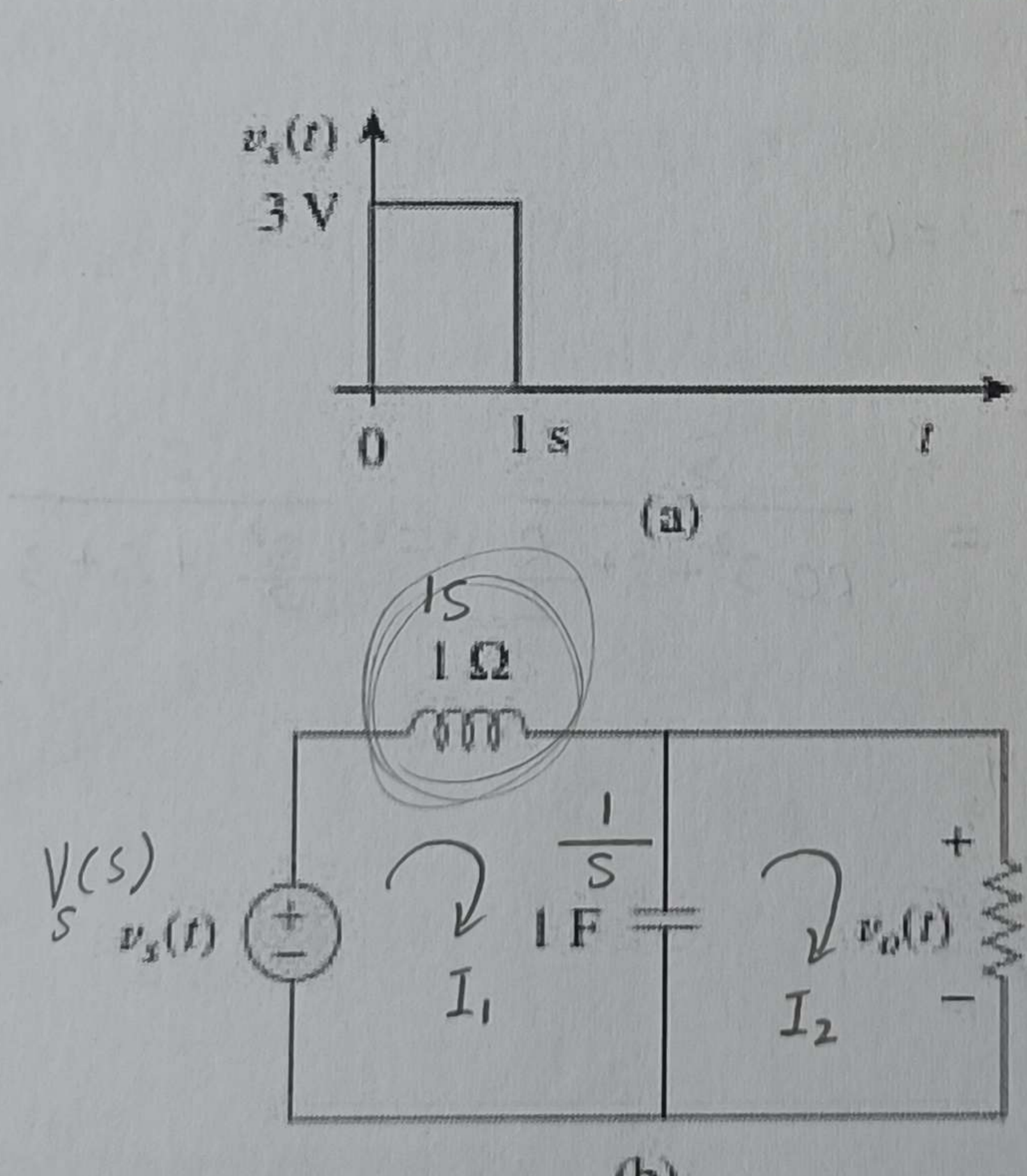


Figure 16.80

16.57解: a) $V_s(t) = 3[u(t) - u(t-1)]$

$V_s(s) = 3(\frac{1}{s} - \frac{e^{-s}}{s}) = \frac{3}{s}(1 - e^{-s})$

b) At $t=0^-$

$V_c(0^-) = 0$

$-V_s(s) + 1 \cdot I_1 + \frac{1}{s}(I_1 - I_2) = 0$

$2I_2 + \frac{1}{s}(I_2 - I_1) = 0$

$V_o(s) = 2I_2 = \frac{2(1-e^{-s}) \cdot \frac{3}{s}}{2s+3}$

$= \frac{3(1-e^{-s})}{s^2 + \frac{3}{2}s}$

$= \frac{2}{s} - \frac{2e^{-s}}{s} + \frac{-2}{s+\frac{3}{2}} + \frac{2e^{-s}}{s+\frac{3}{2}}$

$v_o(t) = 2u(t) - 2u(t-1) - 2 \cdot e^{-\frac{3}{2}t} u(t)$
$+ 2 \cdot u(t-1) \cdot e^{-\frac{3}{2}(t-1)}$ V

16.69 Find $I_1(s)$ and $I_2(s)$ in the circuit of Fig. 16.92. (20')

$-V + (2s+1)i_1 - i_2 + s i_2 = 0.$

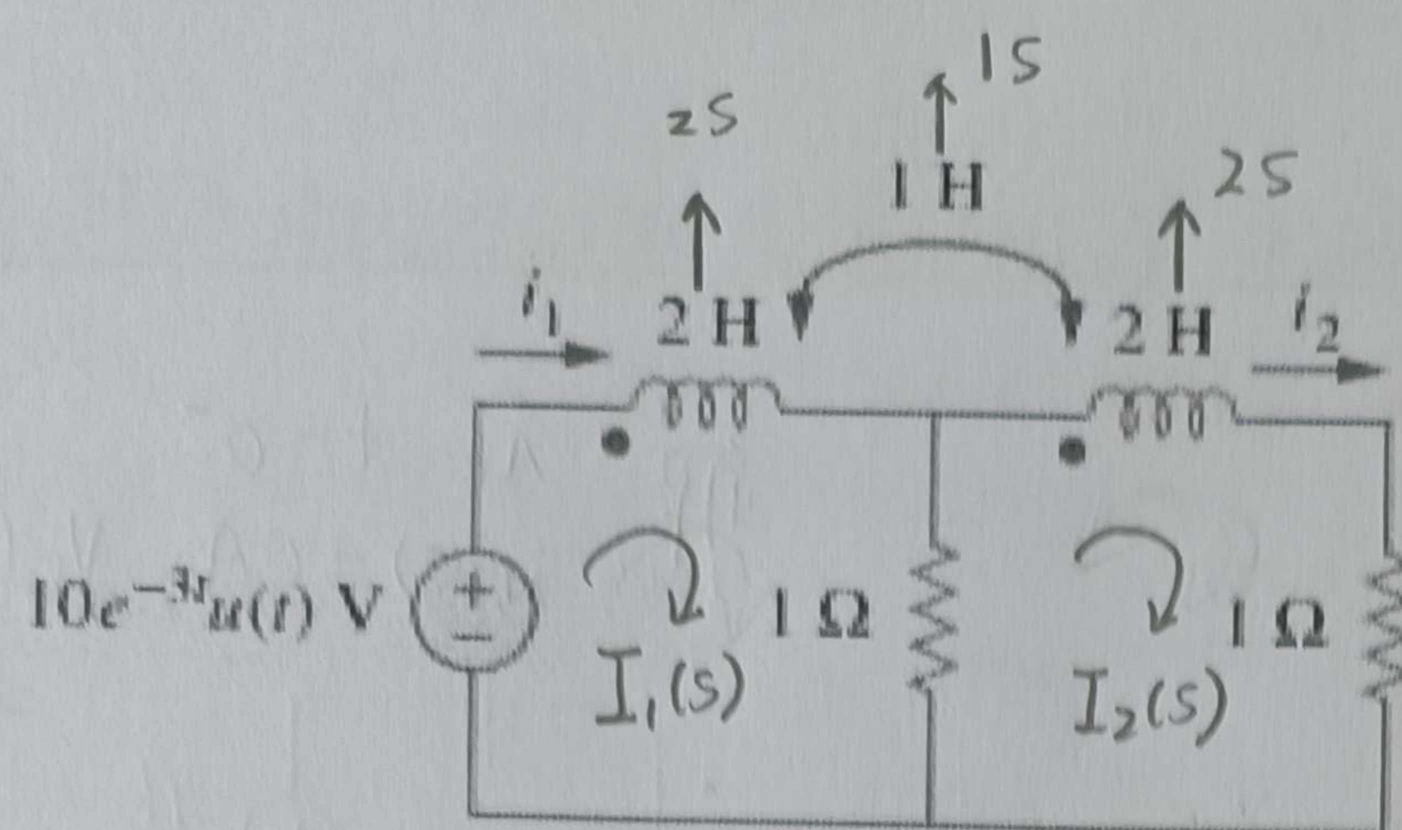


Figure 16.92

解:

At $t=0^-$, $i_2(0^-)=0$

$V(s) = 10\,\frac{1}{s+3}$

Loop1: $-V(s) + I_1\cdot 2s + 1\cdot(I_1 - I_2) + 1s\cdot I_2 = 0$

Loop2: $(2s+1)I_2 + 1\cdot(I_2 - I_1) + 1s\cdot I_1 = 0$

$\Rightarrow I_1(s) = \frac{20(s+1)}{(s+3)(3s^2+8s+1)}$

$I_2(s) = \frac{10(1-s)}{(s+3)(3s^2+8s+1)}$

16.75 When a unit step is applied to a system at t = 0, its response is

$$y(t) = \left[4 + \frac{1}{2}e^{-3t} - e^{-2t}(2\cos 4t + 3\sin 4t)\right]u(t)$$

$e^{-2t}\cdot\cos 4t \quad e^{-2t}\sin 4t$

What is the transfer function of the system? (15')

16.75 解: $H(s) = \frac{Y(s)}{X(s)}$

$X(s) = \frac{1}{s}$

$Y(s) = 4\cdot\frac{1}{s} + \frac{1}{2}\cdot\frac{1}{s+3} - 2\,\frac{s+2}{(s+2)^2+16} - 3\cdot\frac{4}{(s+2)^2+16}$

$H(s) = 4 + \frac{1}{2}\cdot\frac{s}{s+3} - 2\,\frac{(s+2)s}{(s+2)^2+16} - 3\,\frac{4s}{(s+2)^2+16}$

16.99 It is desired to realize the transfer function

$$\frac{V_2(s)}{V_1(s)} = \frac{2s}{s^2 + 2s + 6}$$

using the circuit in Fig. 16. 108. Choose R = 1 kΩ and find L and C. (15')

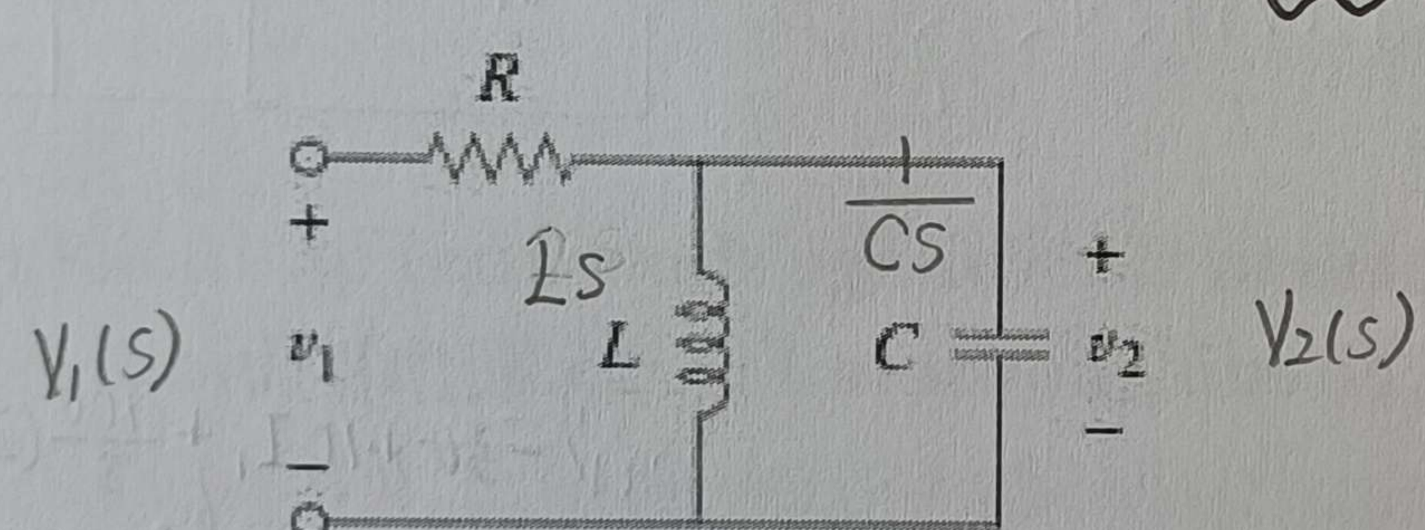


Figure 16.108

解: $-V_1(s) + V_2(s) + R\cdot\frac{V_2(s)}{\frac{\frac{L}{C}}{Ls+\frac{1}{Cs}}} = 0$

$\frac{V_2(s)}{V_1(s)} = \frac{Ls}{RCLs^2 + Ls + R} = \frac{s}{RCs^2 + s + \frac{R}{L}} = \frac{s}{\frac{s^2}{2} + s + 3}$

$\left.\begin{array}{l}\frac{R}{L} = 3\\ RC = \frac{1}{2}\end{array}\right\} \Rightarrow \left\{\begin{array}{l} L = \frac{1000}{3}\text{ H}\\ C = \frac{1}{2000}\text{ F}\end{array}\right.$