

Problem 5.65

For the network in Figure P5.65,  $v_s(t)=120\cos 377t$  V. Find  $v_o(t)$

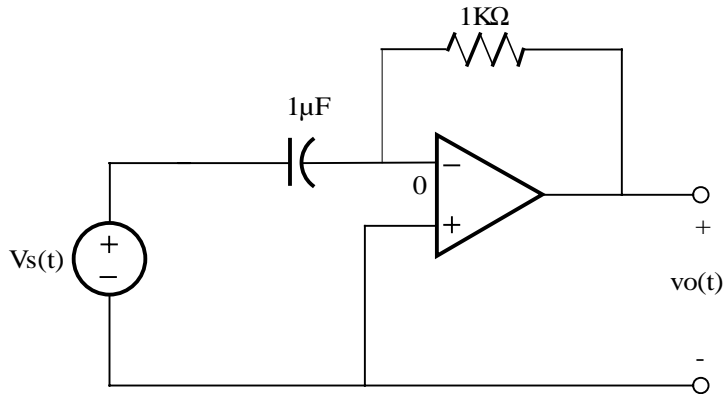
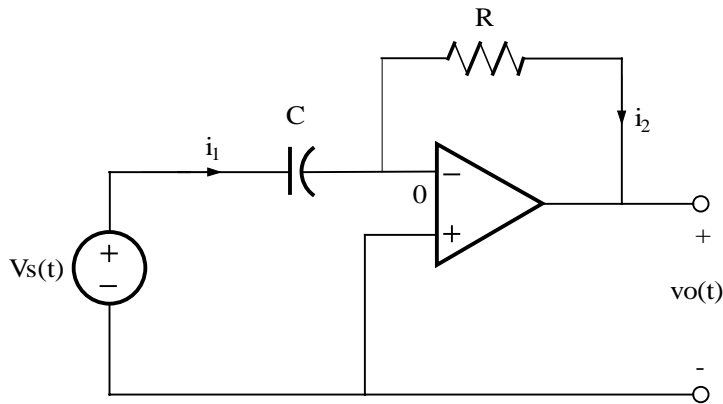


Figure P5.65

Suggested Solution



$$C = 1\mu F \quad R = 1K\Omega$$

$$v_s = 120\cos 377t \text{ V}$$

$$i_1 = i_2 \text{ (ideal op-amp assumptions)}$$

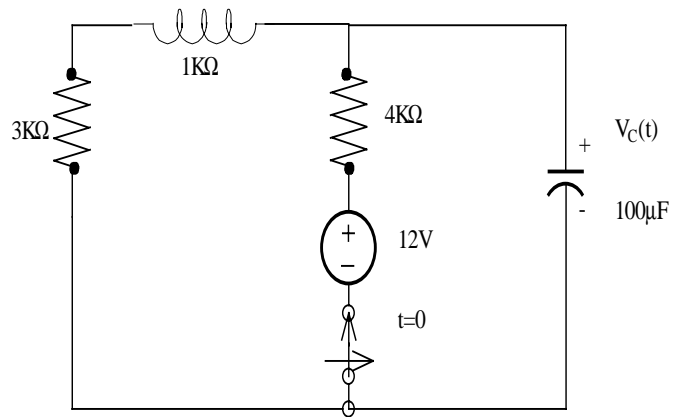
$$C \frac{dv_s}{dt} = -\frac{v_o}{R} \Rightarrow v_o = -RC \frac{dv_s}{dt}$$

$$v_o(t) = +(1k)(1\mu)(120)(377) \sin(377)t$$

$$v_o(t) = 45.24 \sin(377t) \text{ V}$$

Problem 6.3

Use the differential equation approach to find  $v_C(t)$  for  $t>0$  in the circuit in Fig. P6.3



### Suggested Solution

$$V_C(0^-) = 12 \left( \frac{4K}{8K} \right) = 6V$$

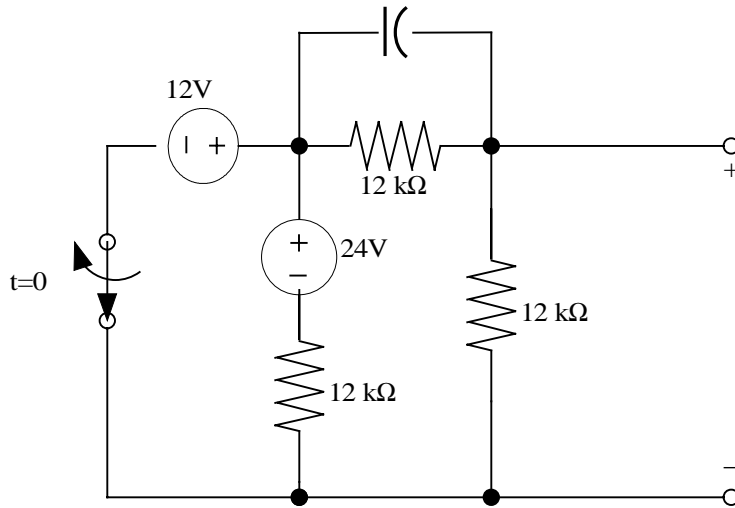
$$\frac{V_C(t)}{4K} + Cd \frac{V_C(t)}{dt} = 0 \Rightarrow d \frac{V_C(t)}{dt} + \frac{V_C(t)}{0.4} = 0$$

$$\therefore V_C(t) = K_2 e^{-t/0.4} V \text{ and since } V_C(0) = 6 = K_2$$

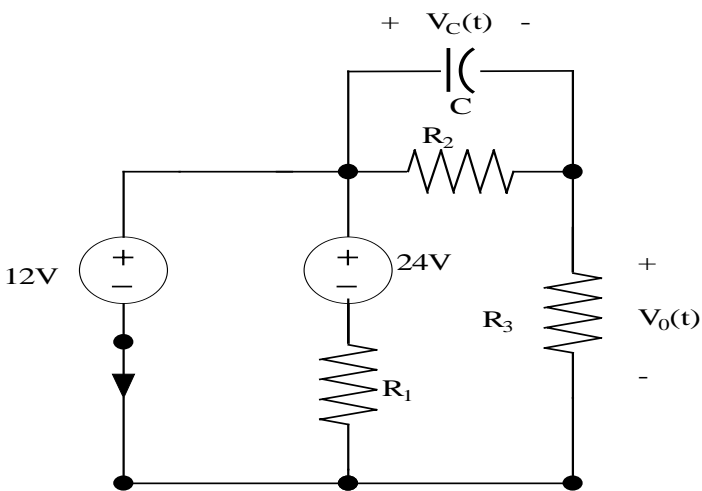
$$V_C(t) = 6e^{-t/0.4} V \quad t > 0$$

### Problem 6.24

Use the differential equation approach to find  $V_C(t)$  for  $t > 0$  in the circuit in Fig. P.24 and plot the response including the time interval just prior to opening the switch.



Suggested Solution



All  $R=12\text{ k}\Omega$   $C=0.1\text{ mF}$

For  $t < 0$

$$V_c(0^-) = V_c(0^+) = 12 \left( \frac{R_2}{R_2 + R_3} \right) = 6V$$

$$V_0(0^-) = 12 - V_c(0^-) = 6V$$

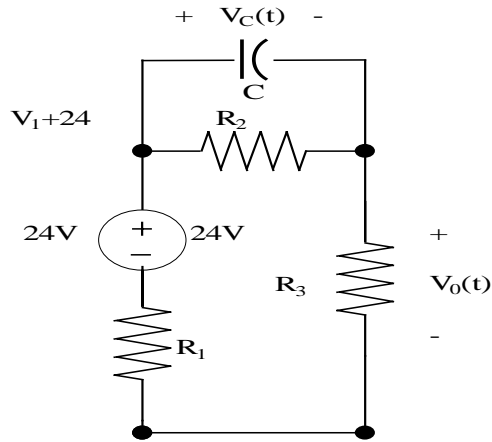
For  $t > 0$

KCL:

$$C \frac{d(V_1 + 24)}{dt} + 1(V_1 + 24) = \frac{V_0}{R_3}$$

$$\text{or, } \frac{dV_1}{dt} + \frac{V_1}{1.2} + 20 = \frac{V_0}{1.2}$$

$$\text{Also, } \frac{V_1}{R_1} + \frac{V_0}{R_3} = 0 \Rightarrow V_1 = -V_0$$



Now,  $\frac{dV_0}{dt} + \frac{V_0}{0.6} = 20$  Assume  $V_0(t) = K_1 + K_2 e^{-\frac{t}{\tau}}$

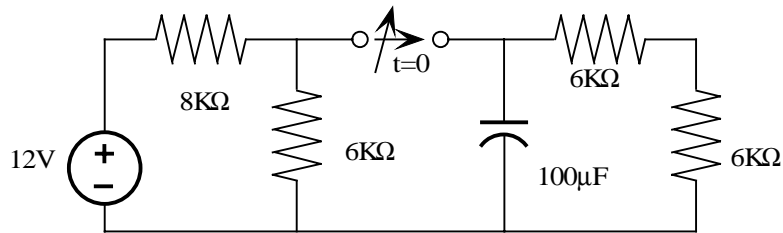
substitute,  $-K_2 e^{-\frac{t}{\tau}} + \frac{K_1}{0.6} + \frac{K_2 e^{-\frac{t}{\tau}}}{0.6} = 20 \Rightarrow \tau = 0.65$  and  $K_1 = 12$

$$V_0(0^+) = \frac{24-6}{2} = 9V = K_1 + K_2 \Rightarrow K_2 = -3$$

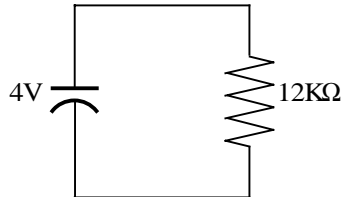
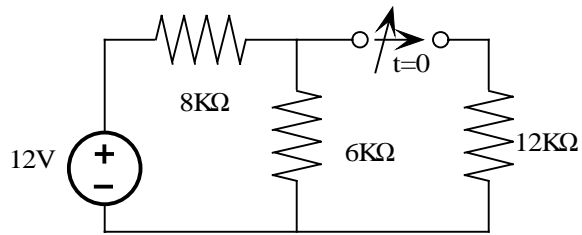
$$V_0(t) = 12 - 3e^{-\frac{5t}{3}} \text{ V } t > 0 \quad V_0(t) = 6 \text{ V } t < 0$$

Problem 6FE-1

In the circuit in Fig the switch, which has been closed for a long time, opens at  $t=0$ . Find the value of the capacitor voltage  $V_c(t)$  at  $t=2s$ .



Suggested Solution



FOR  $t < 0$

$$6K \parallel 12K = 4K$$

$$V_c(0) = 12 \left( \frac{4K}{4K + 12K} \right) = 4V$$

$t > 0$  SWITCH OPENS

$$V_c(t) = 4e^{\frac{-t}{\tau}} V$$

$$\tau = 100 * 10^{-6} * 12 * 10^3 = 1.2 \text{ SEC.}$$

$$V_c(t) = 4e^{\frac{-t}{1.2}} V$$

AT  $t = 2 \text{ SEC}$

$$V_c(t) = 4e^{\frac{-2}{1.2}} V = 0.76V$$