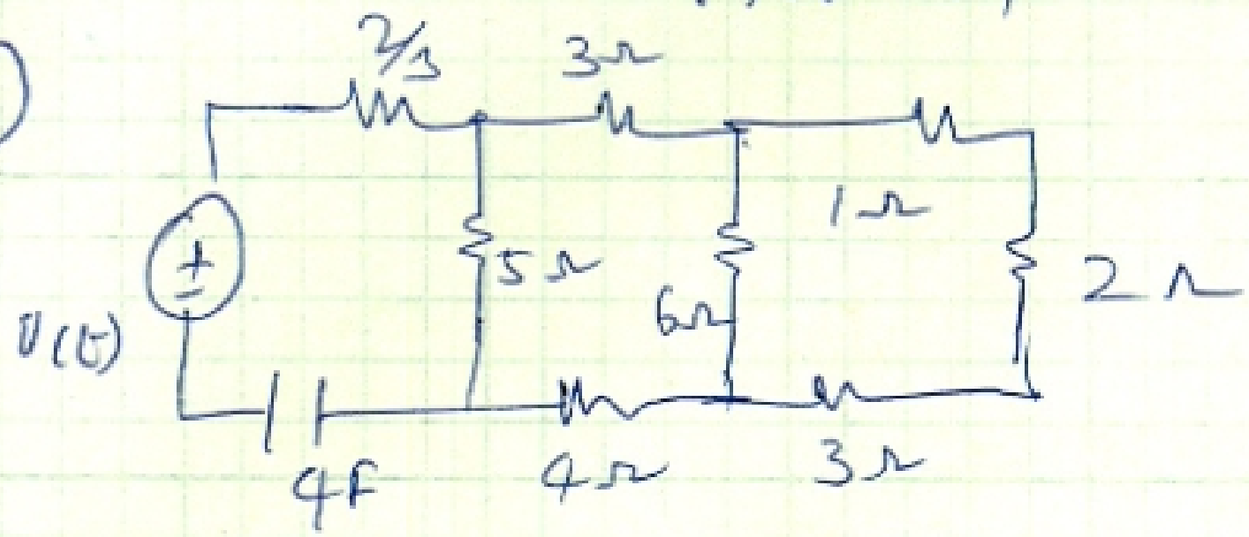
HW - 19

(1)



(a) R_{eff} seen by capacitor $= \frac{2}{3} + \left(5 \,||\, [3+4+[6\,||\,(1+2+3)]]\right)$

$= \frac{2}{3} + 5 \,||\, (3+4+3)$

$= \frac{2}{3} + 5 \,||\, 10 = 4\Omega$

(b) Time constant $\tau = RC = 4 \times 4 = 16$ sec

(c) $V_c(0) = 0 \quad V_c(\infty) = 10\,V$ (as cap becomes open)

$\Rightarrow V_c(t) = (\text{final value}) + (\text{initial value} - \text{final value})\, e^{-t/\tau}$

$\Rightarrow V_c(t) = 10 - 10e^{-t/16} = \boxed{10(1 - e^{-t/16}) = V_c(t)}$

(d) $V_c(0) = 4V \quad V_c(\infty) = 10\,V$

$\therefore V_c(t) = 10 - e^{-t/16}(4-10)$

$\Rightarrow \boxed{V_c(t) = 10 - 6e^{-t/16}}$

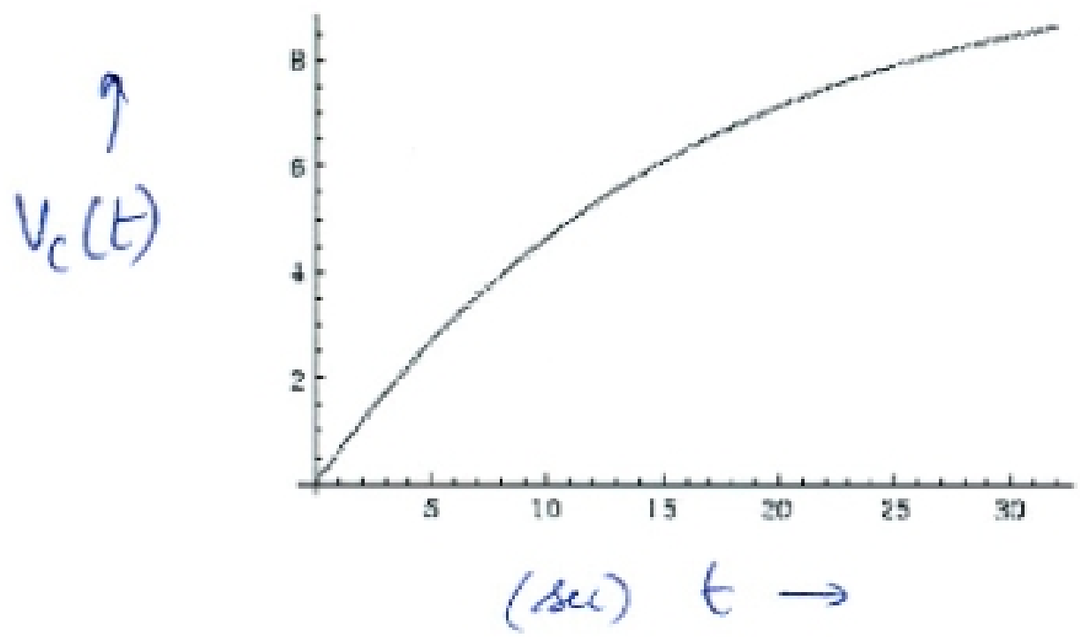
(e) $V_c(0) = -2V \quad V_c(\infty) = 10V$

$\Rightarrow V_c(t) = 10 - 12e^{-t/16}$

$\therefore i_c(t) = C\frac{dV_c}{dt} \Rightarrow \boxed{i_c(t) = 3e^{-t/16}}$

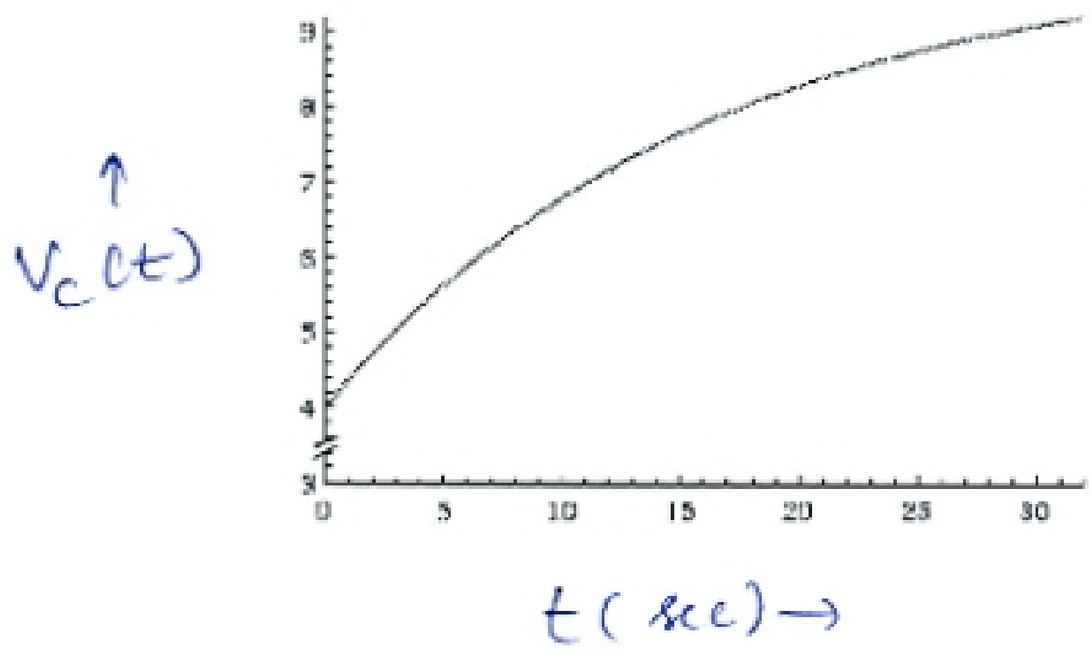
(1)

(c)



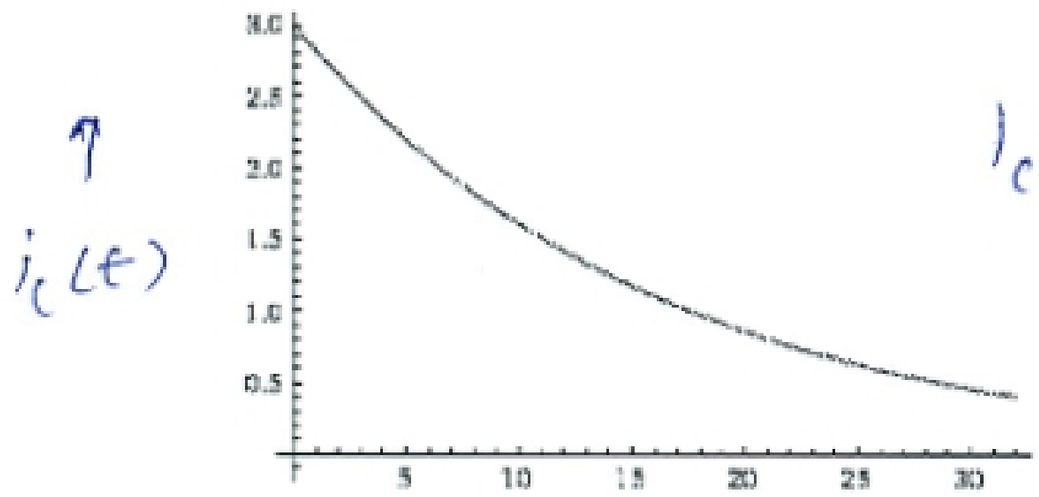
$V_c(t) = 10(1 - e^{-t/16})$

(d)



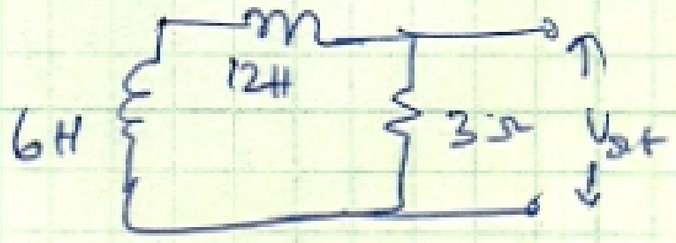
$V_c(t) = 10 - 6e^{-t/16}$

(e)



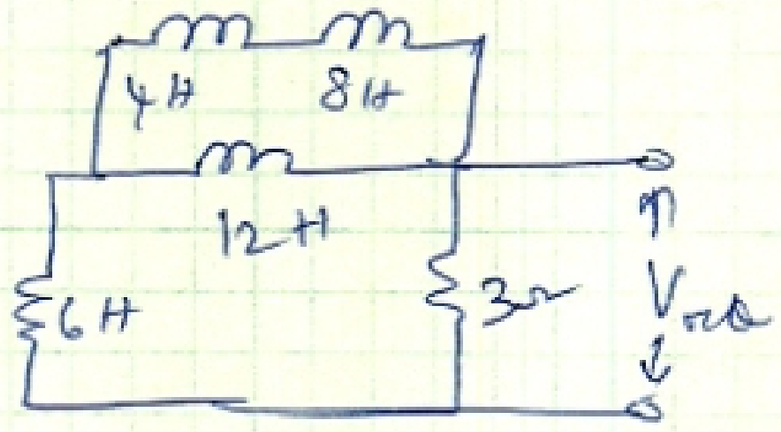
$i_c(t) = 3e^{-t/16}$

(2) (a) When the switch is open, the circuit is



$$\Rightarrow \tau_1 = \frac{L_{eq}}{R} = \frac{18}{3} = 6 \text{ sec}$$

(b) When switch is closed



$$\Rightarrow \tau_2 = \frac{L_{eq}}{R} = \frac{((4+8)\|12)+6}{3}$$

$$= \frac{12}{3} = 4 \text{ sec}$$

(c) $i(0) = 2A$ & circuit is not driven so the current decays to 0A $i(\infty) = 0A$

$$\therefore i(t) = (\text{final value}) + (\text{initial value} - \text{final value})\, e^{-t/\tau}$$

$$i_L(t) = 2e^{-t/6}$$

$$\boxed{V_{out} = i_L R = 6e^{-t/6} \quad 0 < t < 6}$$

(d) @ $t = 6$ $i_L(6) = 2e^{-1}$ @ $t = \infty$ $i_L(\infty) = 0$

$$\boxed{\begin{aligned} i_L(t) &= \frac{2}{e} e^{-\frac{(t-6)}{4}} \quad \text{for } 6 < t < 10 \\ \& \; i_L(t) &= 2e^{-t/6} \quad \text{for } 0 < t < 6 \end{aligned}}$$

$$\Rightarrow V_{out} = \begin{cases} 6e^{-t/6} & 0 \le t \le 6 \\ \frac{6}{e} e^{-\frac{(t-6)}{4}} & 6 < t \le 10 \end{cases}$$