EE 220

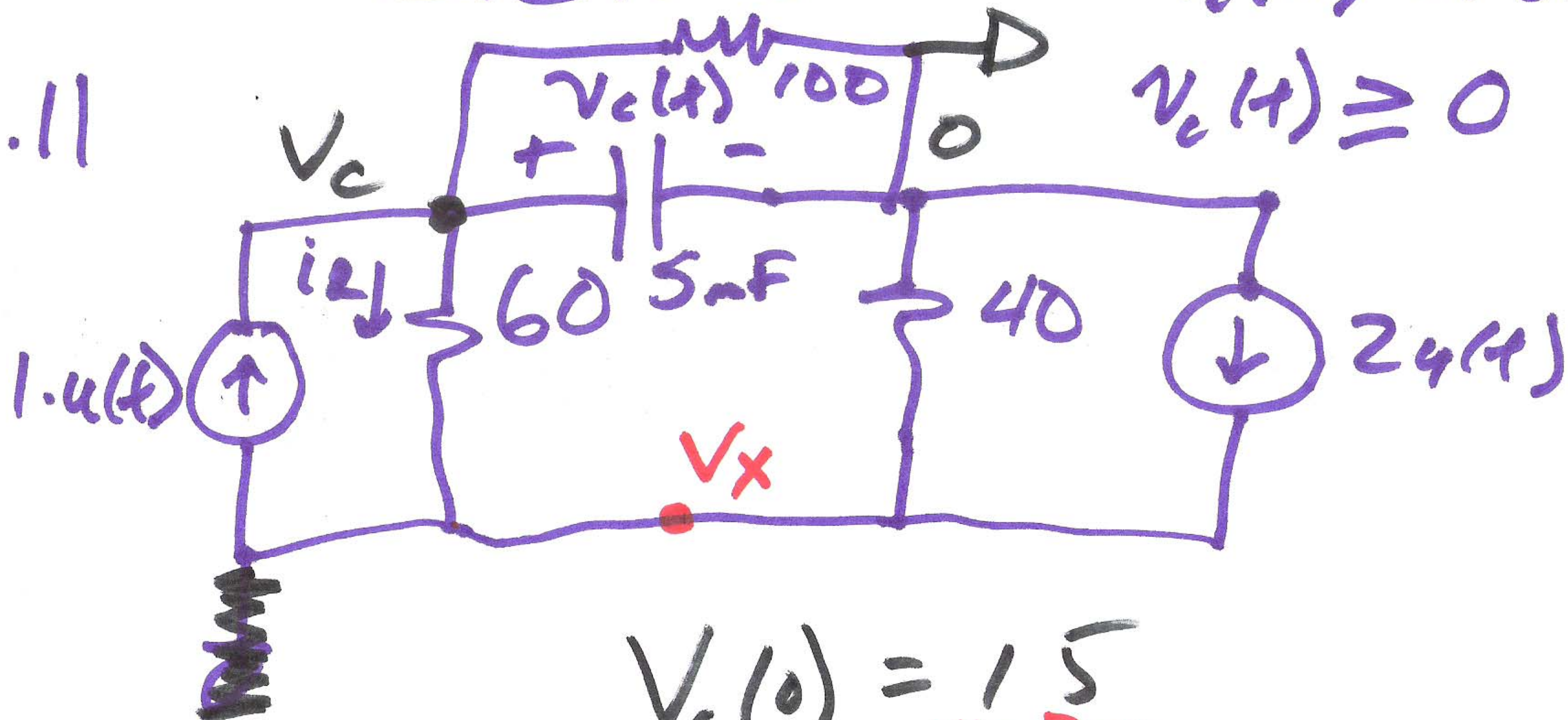
July 7, 2014

Lecture 20

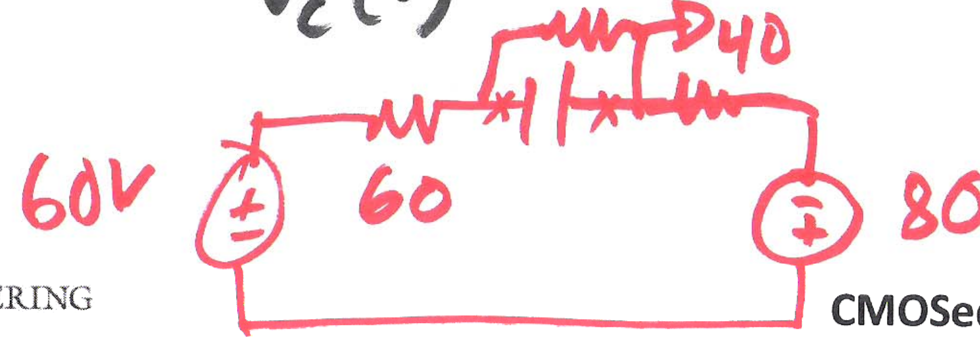
8.11

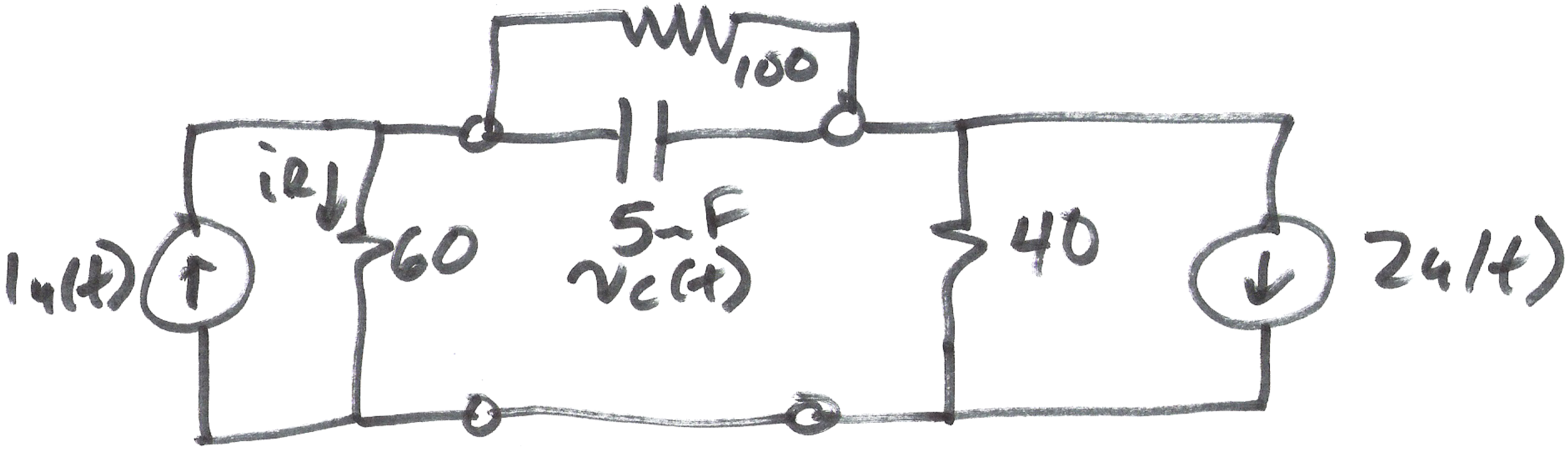
$V_c(0^-) = 15V$

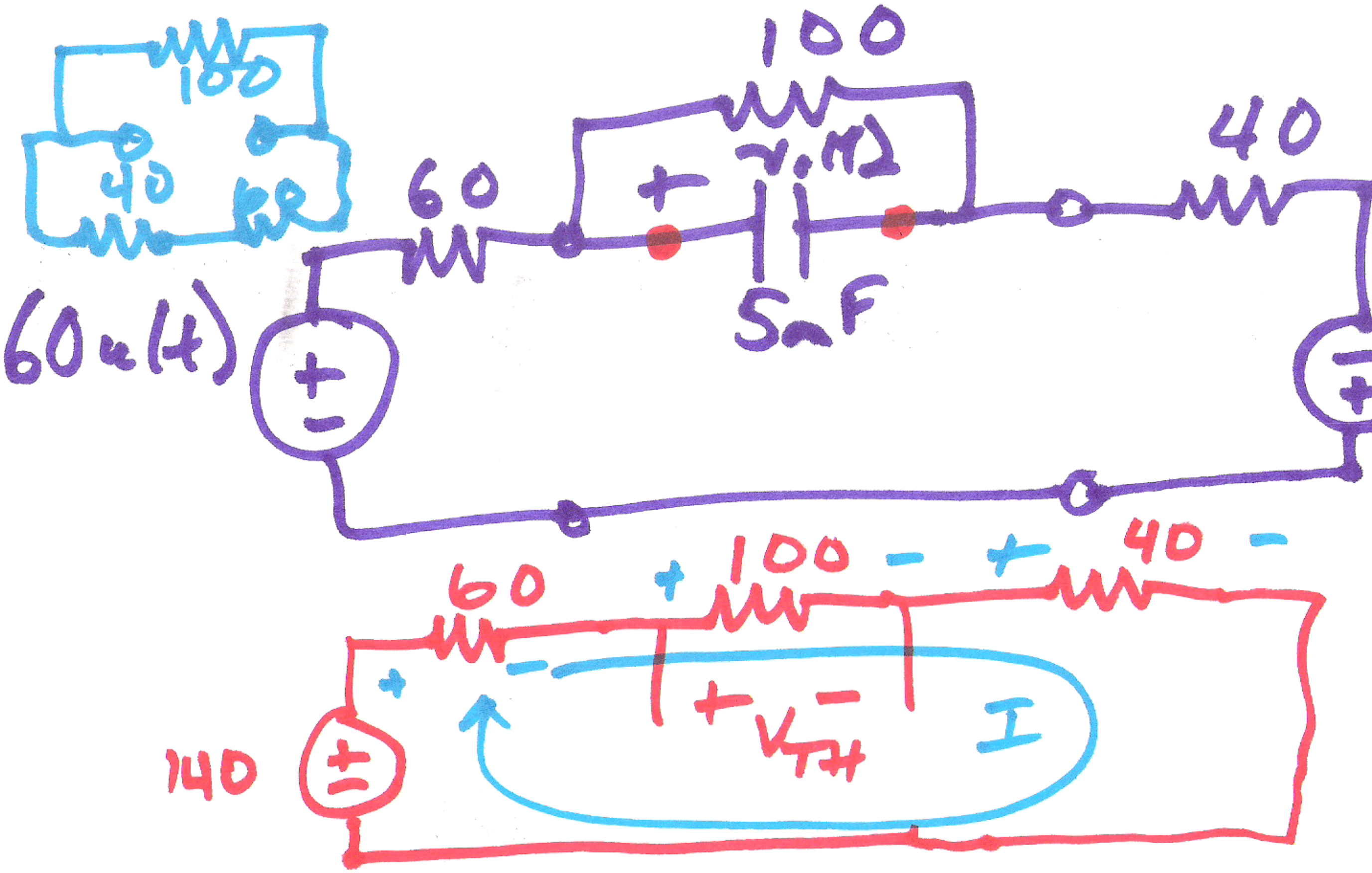
$v_c(t) \geq 0$



$V_c(0) = 15$







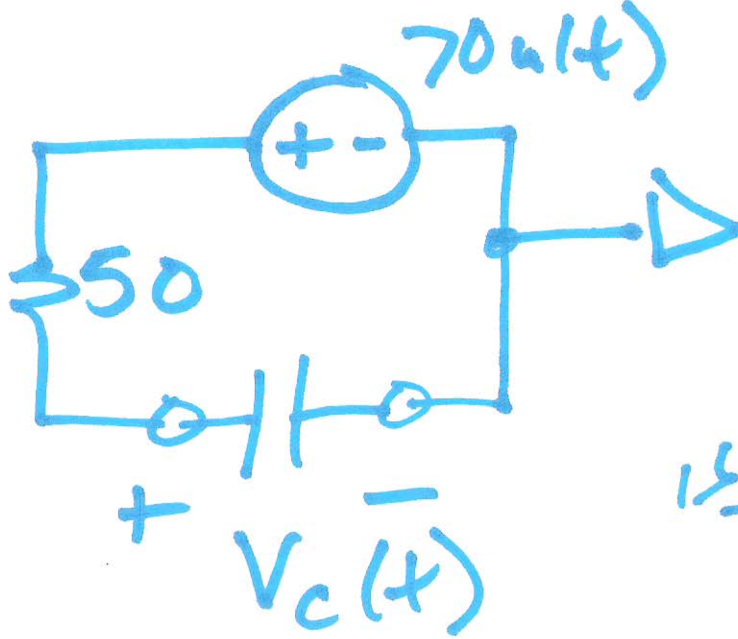
$R_{THN} = 50$

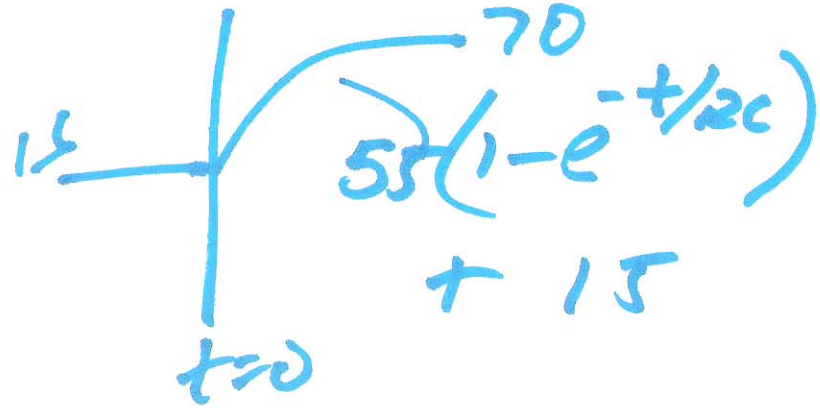
$140 - I(200) = 0$

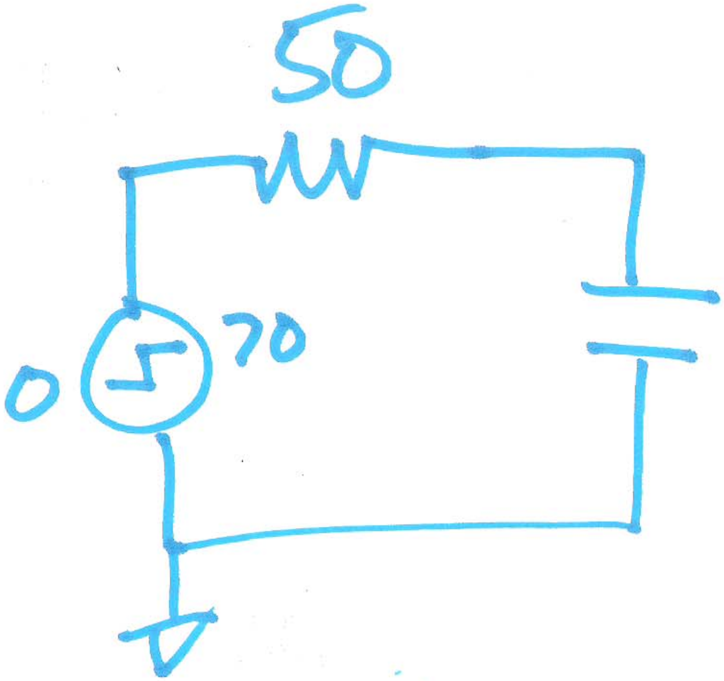
$I = \frac{140}{200} = 0.7$

$V_{THN} = 0.7 \cdot 100$

$= \underline{70V}$

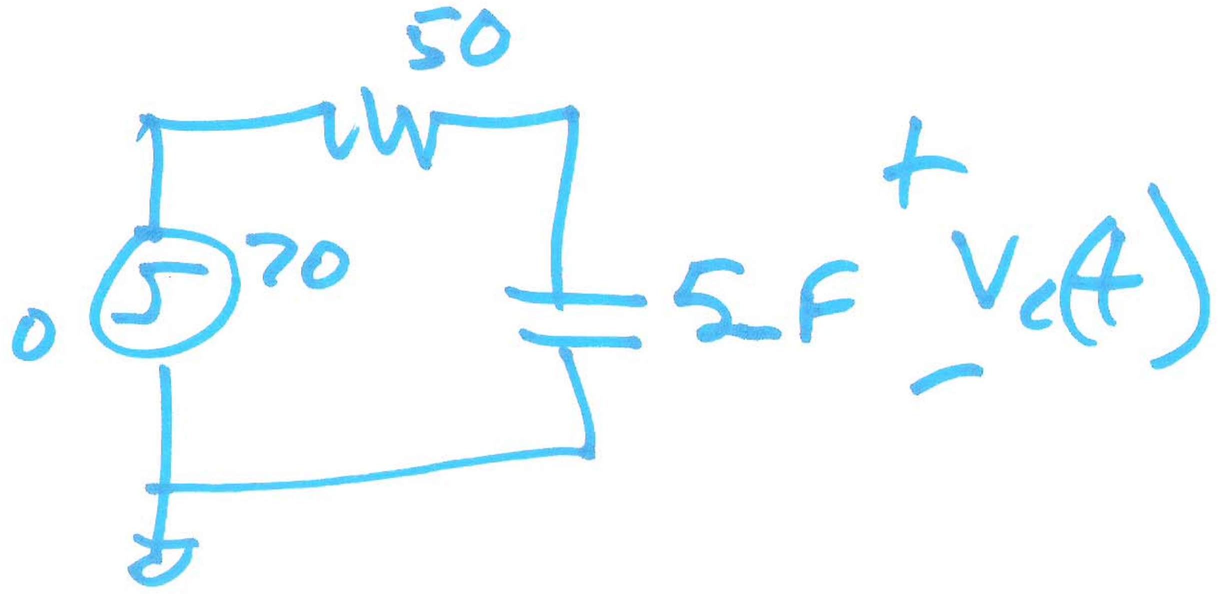






$$V_c(t) = 55e^{-t/.25} + 15$$

$$V_c(t) = 15 + 55e^{-t/.25}$$



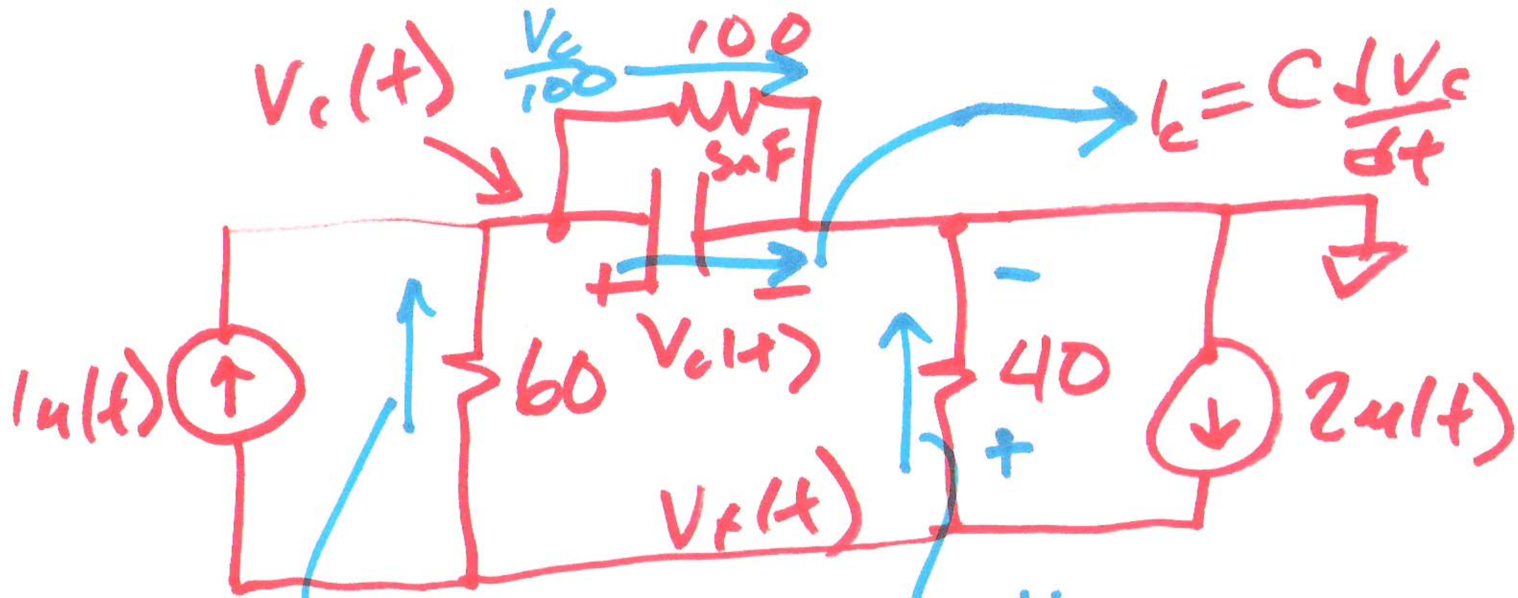
$$v_c(t) = 15 + 55\left(1 - e^{-t/.25}\right)$$

$$70 - 55e^{-t/.25}$$

$$i_R = \frac{v_c(t)}{60} = .25 - \frac{11}{12}e^{-t/.25}$$

$$.92\,e^{-t/.25}$$

.25



$$\frac{V_x - V_c}{60}$$

$$\frac{V_x}{40}$$

$$1 + \frac{V_x - V_c}{60} + \frac{V_x}{40} = 2,$$

$$120 + 2V_x - 2V_c + 3V_x = 240$$

$$5V_x - 2V_c = 120$$

$$V_x = \frac{120 + 2V_c}{5}$$

$$1 + \frac{V_x - V_c}{60} = \frac{V_c}{100} + C\frac{dV_c}{dt}$$

$$60 + V_x - V_c = 0.6V_c + 60C \cdot \frac{dV_c}{dt}$$

$$60 + 24 + 0.4V_c - V_c = 0.6V_c + 60C\frac{dV_c}{dt}$$

$$84 = 1.2V_c + 60C\frac{dV_c}{dt}$$

$$V_c(t) = K_0 + K_1 e^{-t/RC}$$

$$t = 0$$

$$V_c(t) = 15 = K_0 + K_1$$

$$t = \infty$$

$$V_c(t) = 70 = K_0$$

$$K_1 = -55$$

$$\boxed{V_c(t) = 70 - 55e^{-t/RC}}$$

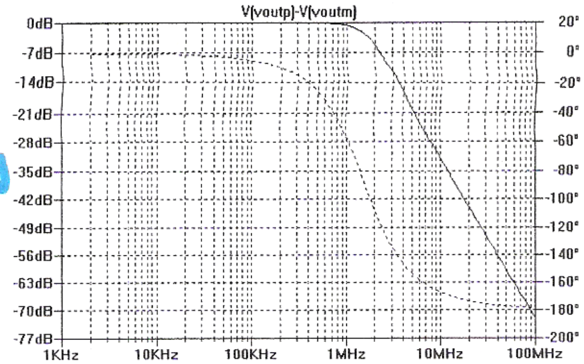


Figure 3.38 Magnitude and phase responses for the active-RC filter of Ex. 3.9.

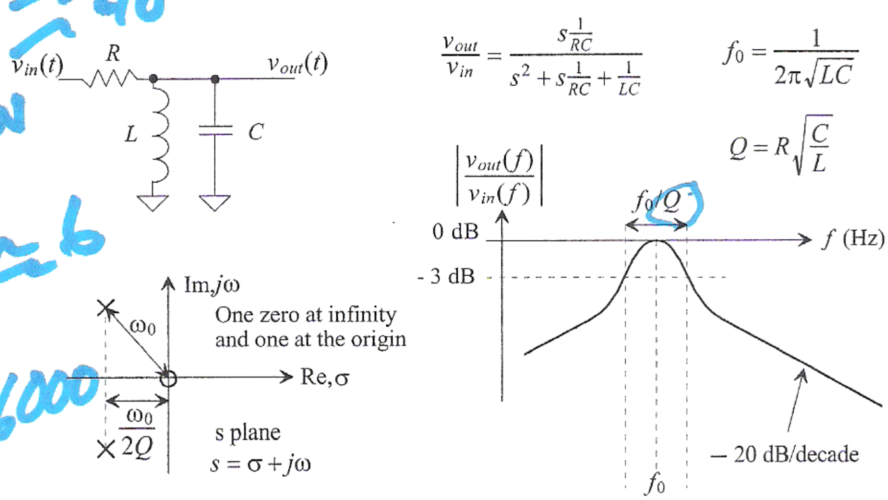


Figure 3.39 Second-order bandpass filter.

Example 3.10
Repeat Ex. 3.8 for the bandpass *LRC* circuit.

Again, we can set C = 100 pF and L = 100 μF. Solving for Q using the equation in Fig. 3.39 results in

$$Q = R\sqrt{\frac{C}{L}} = 0.707 = R\sqrt{\frac{100p}{100\mu}} \rightarrow R = 707$$

The simulation results are seen in Fig. 3.40. ■

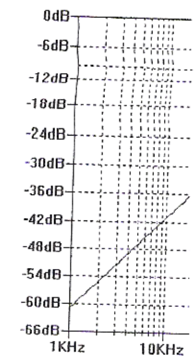


Figure 3.40 Bandpass re

Example 3.11
Repeat Ex. 3.10 if the Q is inc

Figure 3.41 shows the simulat
20k with the inductor and capa

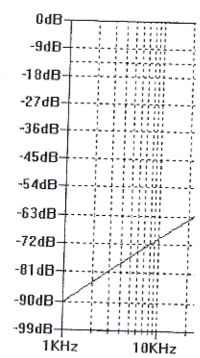


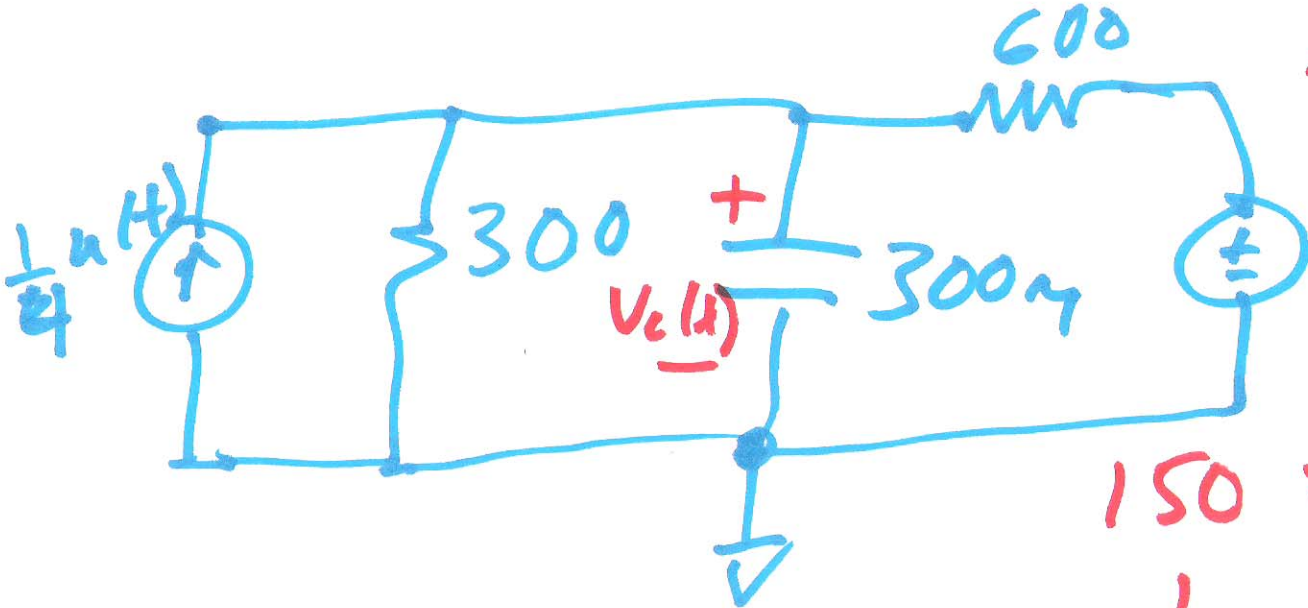
Figure 3.41 Bandpass re

Example 3.12
Use an active-RC filter to imple

Let's begin by writing the filter's

$$\frac{v_{out}}{v_{in}} = \frac{a_1 s}{s^2 + \left(\frac{2\pi f_0}{Q}\right)s + \ldots}$$

Looking at this equation, Eq. (3
$C_{I2} = 0$ and $R_{I1} = \infty$. Further the



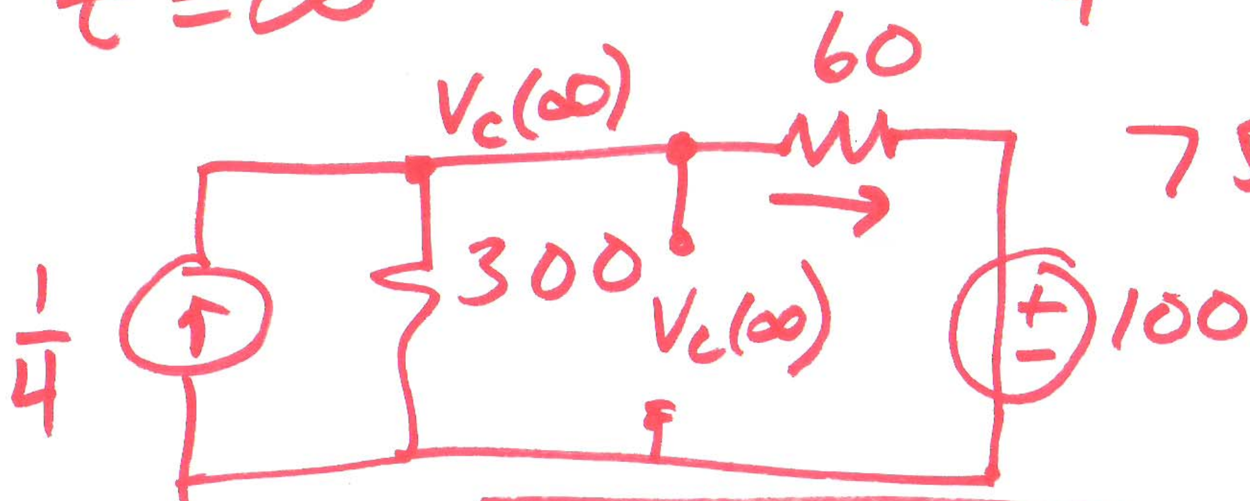
$t=0^-,\ V_c(0^-)=0$

$3V_c = 250$

$150 = 2V_c + V_c - 100$

$$\frac{1}{4} = \frac{V_c(\infty)}{300} + \frac{V_c(\infty)-100}{600}$$

$t=\infty$



~~$75 = V_c + 5V_c - 500$~~

~~$575 = 6V_c$~~

~~$V_c(\infty) = \frac{575}{6}$~~

~~95.8~~

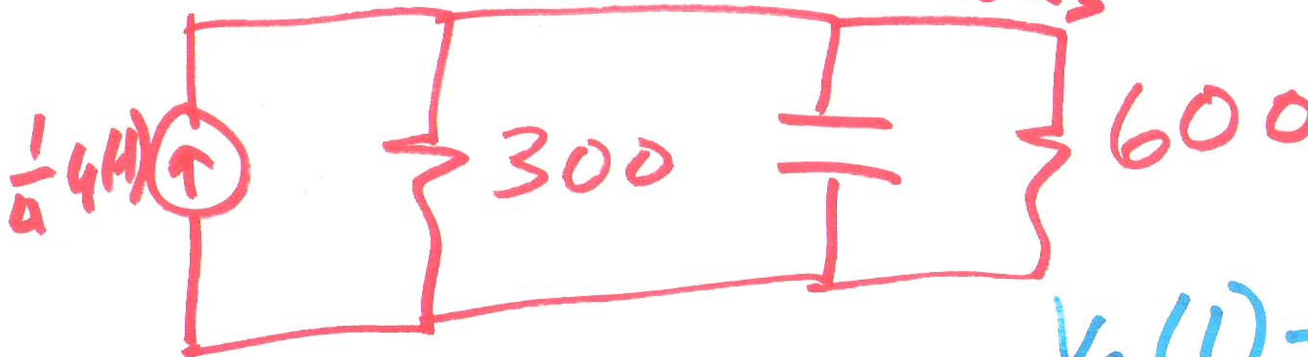
$V_c(\infty) =$ ~~95.8 V~~ 83.33

$V_c(t) = 0 \quad t < 0$

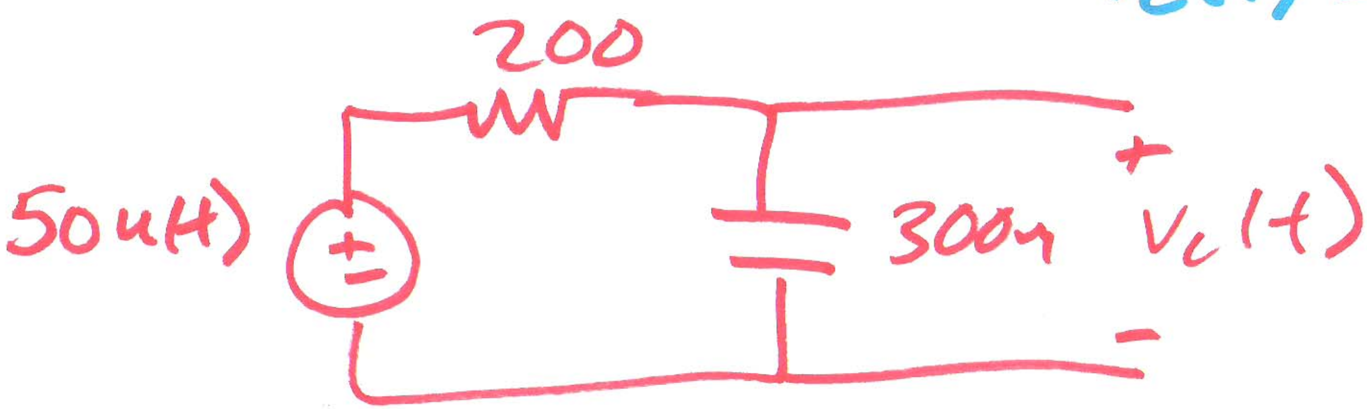
$$V_c(t) = 50\left(1 - e^{-t/RC}\right) \quad \left.\begin{matrix} t > 0 \\ t < 1 \end{matrix}\right\} \; 0 \le t \le 1$$

$RC = 200 \cdot 300n = 60\,\mu s$

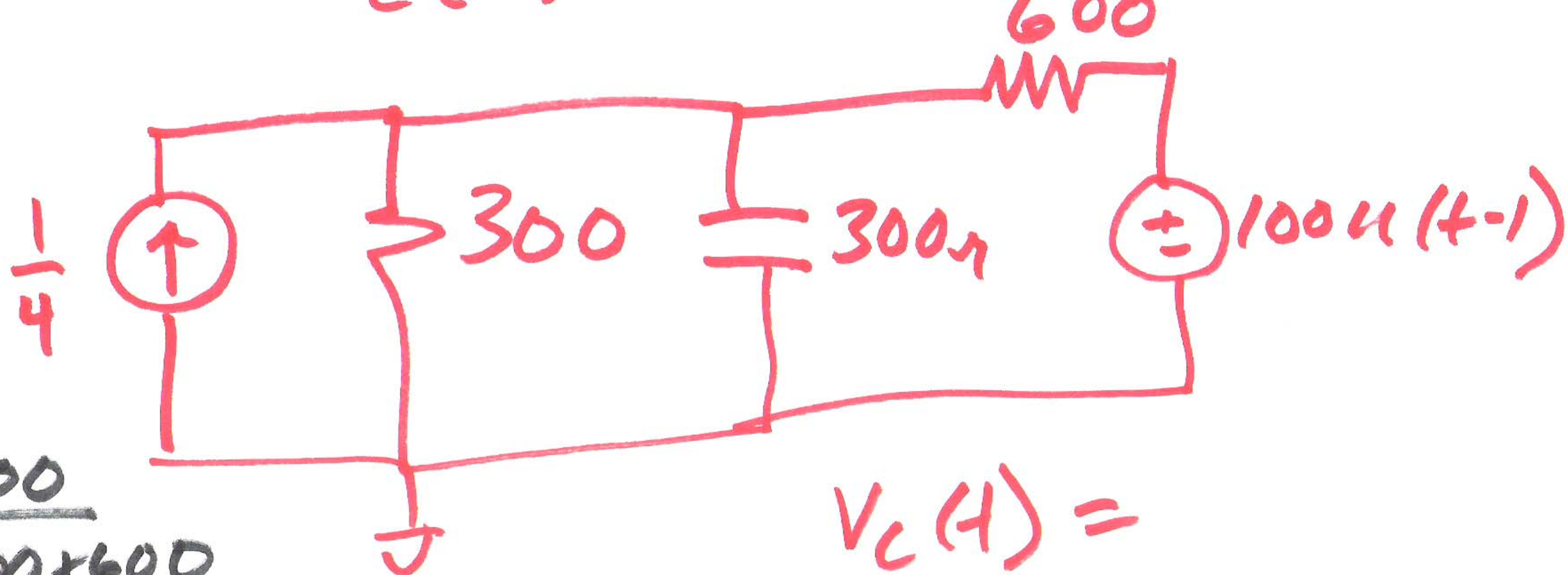
$300 \parallel 600 = 200$



$V_c(1) = 50V$



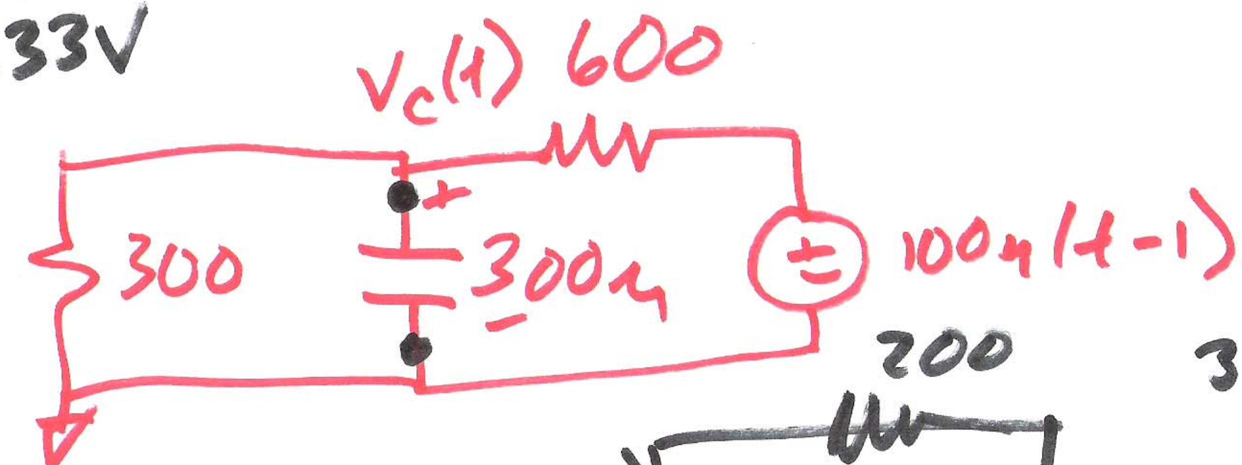
$V_c(1^-) = 50V$



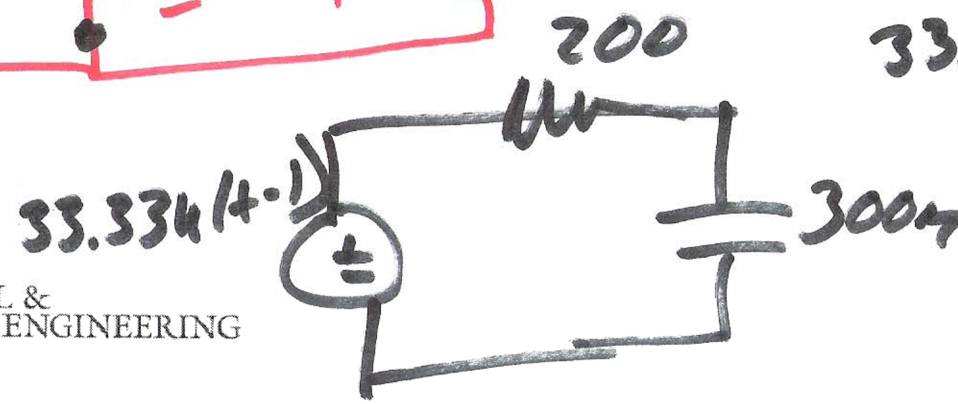
$100 \cdot \frac{300}{300+600} = 33.33V$

$V_c(t) =$

$t > 1$



$33.33\left(1 - e^{-\frac{(t-1)}{60ms}}\right)$



$$V_c(t) = 50 + 33.33\left(1 - e^{-\frac{(t-1)}{60\,ms}}\right) \Big|_{t>1}$$

$$V_c(t) = 50\left(1 - e^{-t/60\,ms}\right) \quad 0 \le t \le 1$$

$$V_c(t) = 0 \quad t < 0$$