Waveform Generation

Use RL or RC circuit to obtain a specific waveform. Response is controlled by a switch.

Recall general solution for RL or RC circuits (with sources).

$$x(t) = x(\infty) + [x(t_o^+) - x(\infty)]e^{-(t-t_o)/\tau}$$

Suppose two excitation levels are required to activate (turn off or turn on) a switch:

$x(t_1) = X_1$ (e.g. turn on @ $i_L(t_1) = 3$ A)

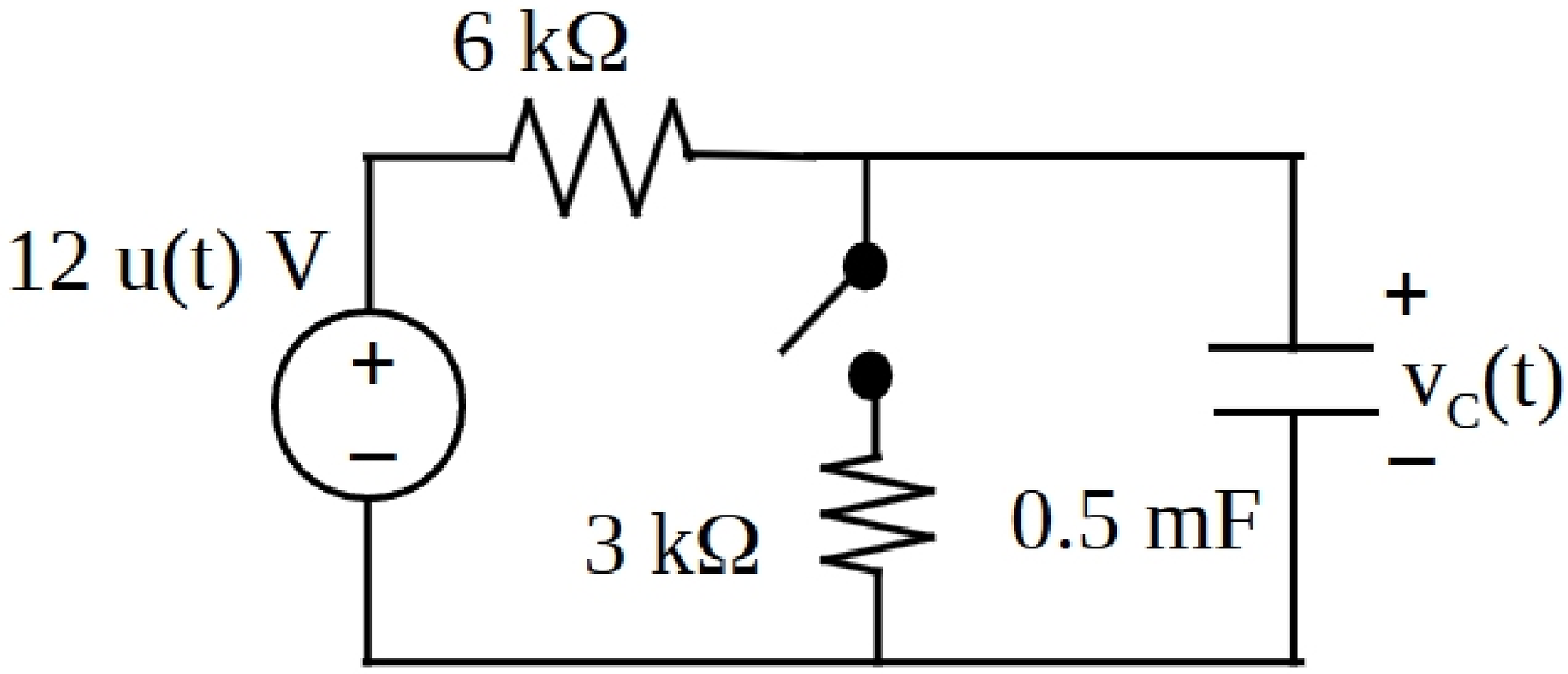
$x(t_2) = X_2$ (e.g. turn off @ $i_L(t_2) = 1$ A)

The time required for circuit to go from one excitation level to the other is,

$$t_2 - t_1 = \tau \ln\left[\frac{X_1 - x(\infty)}{X_2 - x(\infty)}\right] \qquad (21.1)$$

This is the elapsed time formula.

Example: Plot $v_c(t)$ for the circuit below when the switch is activated three times (closed, opened, closed).



Initially, switch is open as shown, and it closes when $v_c(t)$ equals 9 V. Switch opens again when $v_c(t)$ equals 5 V. $v_c(0^+) = 0$ V.

General solution for RC circuit:

$$v_C(t) = v_C(\infty) + [v_C(t_o^+) - v_C(\infty)]e^{-(t-t_o)/\tau}$$

$t = t_a$: switch closes

$t = t_b$: switch opens

$t = t_c$: switch closes

Step 1: Find waveform for $0 \le t \le t_a$ when open.

$$v_C(0^+) = 0 \text{ V}; \qquad v_C(\infty) = 12 \text{ V}$$

$$R_{TH} = 6 \text{ k}\Omega; \qquad R_{TH}C = 3 \text{ s}$$

$$v_C(t) = 12(1 - e^{-t/3}) \text{ V}$$