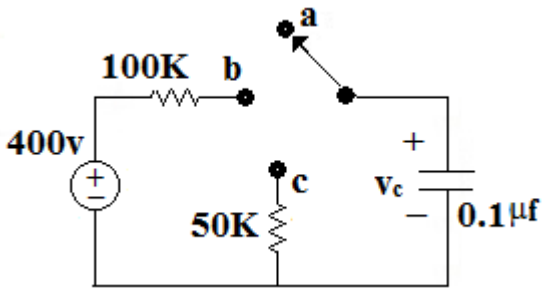
EE 210
RC Transient Response

In the circuit below the capacitor is uncharged and the switch is in position *a*. At t = 0, the switch is moved to position *b*. After 15 msec the switch is moved again to position *c*.

A) Find the expression for the voltage across the capacitor for t > 0.

B) Use MATLAB® to plot the capacitor voltage vs. time.



Part A)

The capacitor is initially uncharged. At t = 0 the switch moves to position *b*. The initial capacitor voltage is 0 and the final capacitor voltage at t = ∞ will be 400 volts. The solution is of the form

$$v(t) = v_{final} - (v_{init} - v_{final})e^{-t/\tau}$$

In our case v_{final} = 400 volts and v_{init} = 0. The value of τ is 100 x 10^3 x 0.1 x 10^{-6} = 0.01. This gives

$$v_c(t) = 400(1 - e^{-100t}) \text{ for } t > 0.$$

At t = 15 msec the switch moves to position c. The value of the capacitor voltage at 15 msec will be

$$v_c(0.015) = 400(1 - e^{-100x0.015}) = 310.75 volts$$

When the switch is moved to position c, the initial capacitor voltage will be 310.75 volts. The final capacitor voltage with the switch in position c will be 0 volts and the time constant will be 50 x 10^3 x 0.1 x 10^{-6} = 0.005 sec

The capacitor voltage is given by

$$v_c(t) = 0 + (310.75 - 0)e^{-200(t-0.015)} \text{ Or } v_c(t) = 310.75e^{-200(t-0.015)}$$

Part B)

```
%RCTransient.m
incr = 0.0001;    %tenth of a msec
t1 = 0:incr:0.015;  %0 to 15 msec
t2 = 0.015:incr:0.030; %15 to 30 msec
vc1 = 400*(1 - exp(-100*t1));
vc2 = 310.75*exp(-200*(t2 - 0.015));
t = [t1 t2]; %Form a single vector
vc = [vc1 vc2]; %for plotting
figure(1);clf;
plot(t, vc);
xlabel('time in seconds');
ylabel('voltage');
title('RC Circuit response');
```