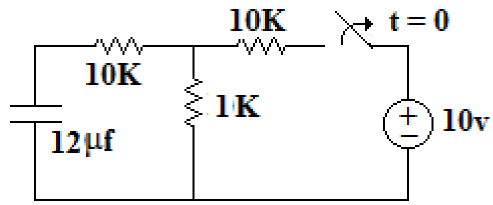
EE 210
MATLAB® Plots

1. Use MATLAB® to plot the voltage vs. time function for the capacitor voltage in the circuit below for t > 0.

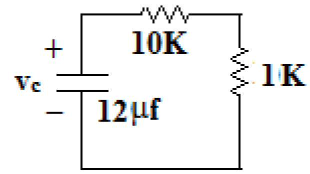
SOLUTION:



For t < 0 the switch is closed and the capacitor can be treated as an open circuit since the voltage has stabilized and there are no transients from -∞ to 0. The capacitor voltage at $t = 0^-$ can be found from the voltage divider.

$$v_c(0^-) = 10\frac{1}{1+10} = 0.9091\text{volts}$$

Because capacitor voltage cannot change instantaneously we have v $v_c(0^+) = v_c(0^-) = 0.9091$ volts. For t > 0 the switch opens and the circuit becomes that shown below.



If we take the loop current to be i_1 we can write:

$$v_c - i_1 10 - i_1 1 = 0$$

But $i_1 = -C\frac{dv_c}{dt}$ which gives

$$v_c - 11000C\frac{dv_c}{dt} = 0$$

Rearranging and letting τ = 11000 x C = 0.132

$$\frac{dv_c}{v_c} = -dt/(11000C) = -t/\tau$$

Integrate both sides to get

$\ln(v_c) = -t/\tau + \ln(k)$ where ln(k) is the constant of integration.

This equation can be written as

$\ln(v_c/k) = -t/\tau$ or

$$v_c = ke^{-t/\tau}$$

When $t = 0^+$ we know that v_c = 0.9091 volts. This gives
0.9091 = *k*.

Putting in the value of C we get

$$v_c = 0.9091e^{-t/0.132}$$

In this equation τ is the time constant and is equal to 132 msec. From our experience with time constants we know that the circuit will reach 99% of its final value in about five time constants or about 650 msec. We can use MATLAB® to plot the equation over this time range.

```
%PlotExmp1.m
tau = .132;
%t goes from 0 to 1 msec in steps of 1 usec
t = 0:.01:1;
%this is the expression for vc
vc = 0.9091*exp(-t/tau);
figure(1);clf;                %Create a figure
plot(t, vc);                  %Do the plot
xlabel('time in seconds');    %label x axis
ylabel('voltage');            %label y axis
title('Example problem');     %Give a title
```