Problem (2-9)

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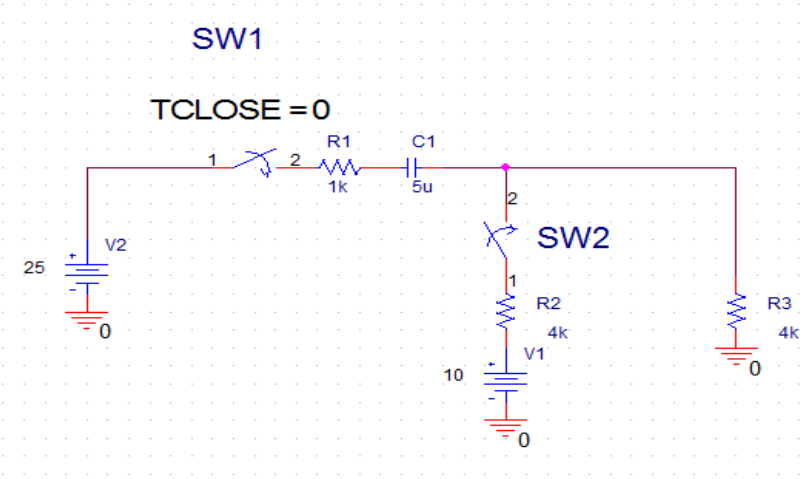
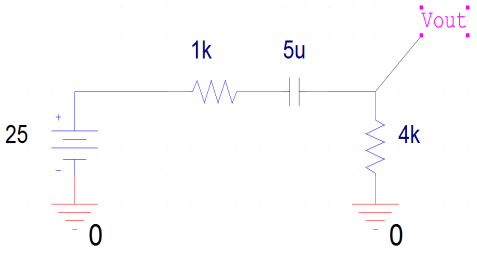
If at t=0, SW1is closed and SW2 is opened, and at V_o =10 V, SW2 is closed. Calculate $V_o(t)$, $V_c(t)$, and i(t) for the circuit shown in the following figure.



Analytical Solution

@ t= 0 the circuit will be



τ= R*C= (1+4)k*5u=25m sec.

V_o= Vcc-V_c-I*R1

@ t= 0 V_c=0,

I_o= 25/(1+4)= 5mA.

V_o= 25*4/5=20V

@ V_o=10V , I= 10/4=2.5 mA →t=?

$V_c(t=?)$ = Vcc-10-(2.5 mA)*(1 kΩ) = 25-10-2.5= 12.5 V

$V_c(t=?) = 12.5 = 25-[25-0]e^{-t/25m}$

$12.5=25\ e^{-t/25m}$

$0.5=\ e^{-t/25m}$

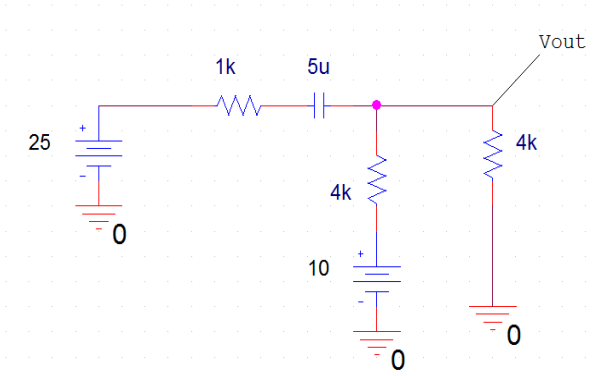
$\ln(0.5) = -t/25m$

$0.693*25=t$

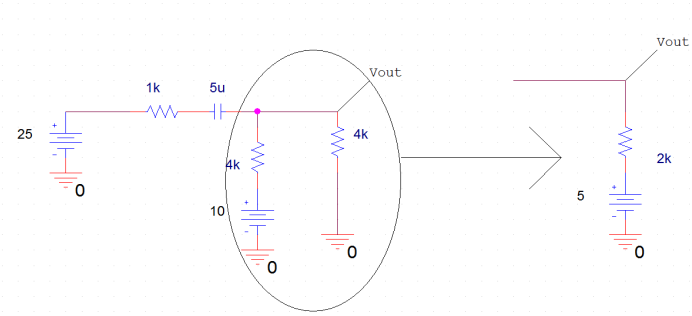
$t=$ 17.33 m sec

this indicate that after t= 17.33m sec SW2 will open

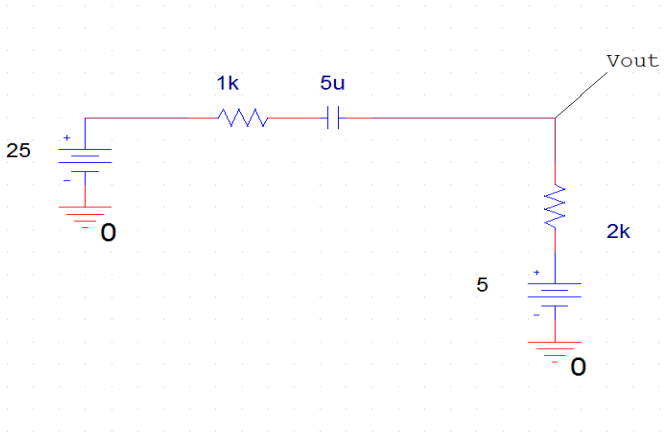
@ t = 17.33 msec



By taking thevinen to the last two branches as shown



so the circuit will be



for this conditions

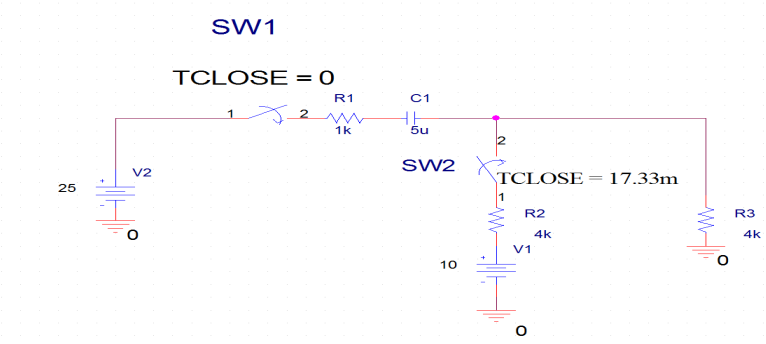
$V_c(\infty)$=20V

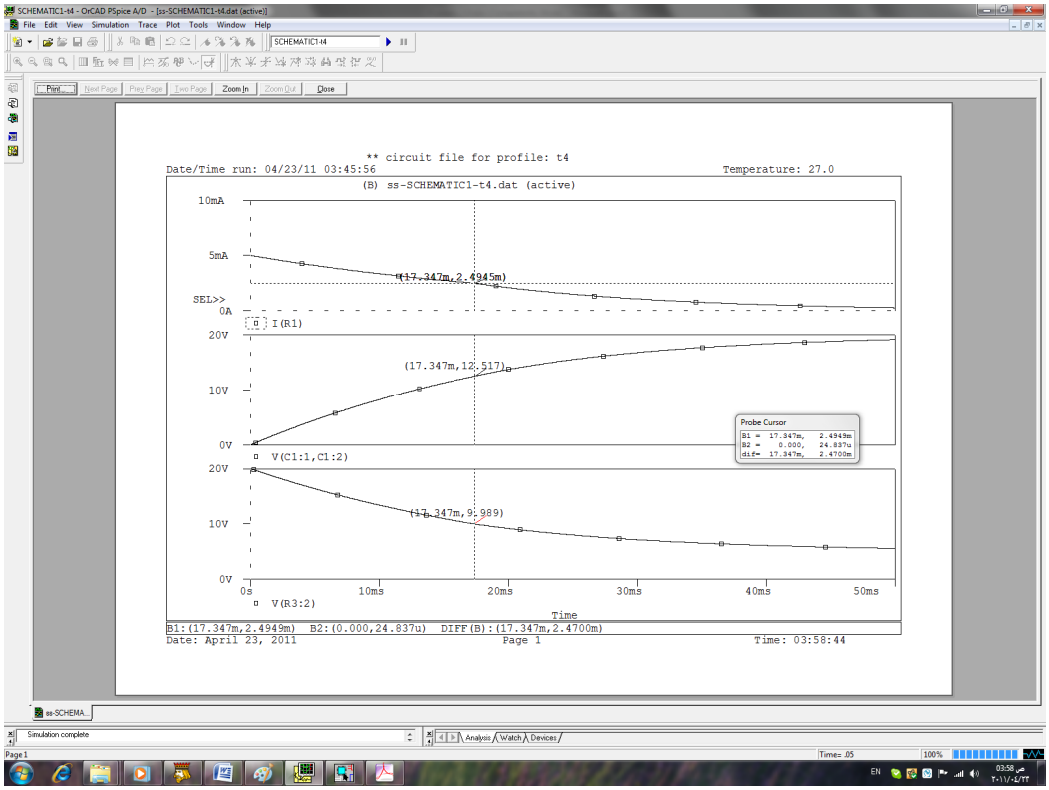
V_c(initial value for this case) = 12.5V

$V_o(\infty)$= 5V because the current in the circuit at ∞ equal to zero

So we can draw the waveforms as mentioned in the question

ORCAD SOLUTION





The waveforms as follows: I(t), $V_c(t)$, $V_o(t)$

Note: the breakpoint at t=17.33m is not so clear because the two slopes of the two curves are so close to each other but you can check it by zooming at the break point.