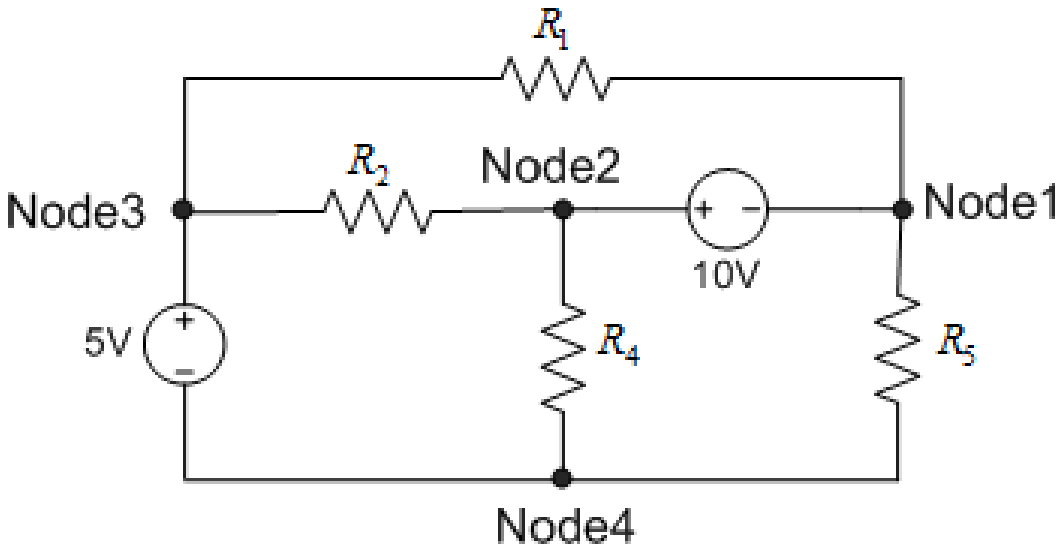
CG1111 Engineering Principles and Practice I

Tutorial for Week 5

Node Voltage Analysis, Capacitors and Inductors

1. Consider the circuit given below. Suppose $\boldsymbol{R_5}$ is the load resistance, derive the Thevenin equivalent circuit as seen by $\boldsymbol{R_5}$.
   (Assume that R_1 = 1 Ω, R_2 = 2 Ω, R_4 = 1 Ω)



Ans:

$V_T = -3$ V

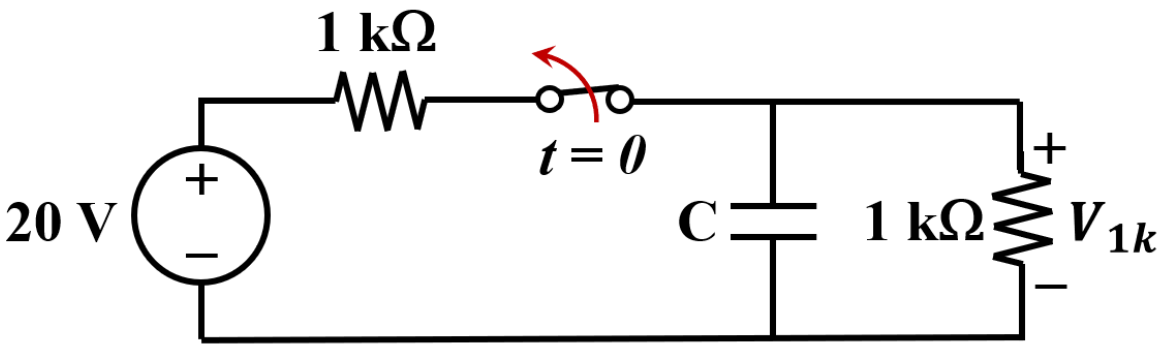
R_T = 0.4 Ω

2. For the circuit given below, the switch was closed for a long time before $t = 0$. At time $t = 0$, the switch is opened.

   a. Determine the value of the capacitance C needed, so that the voltage V_{1k} will remain ≥ 9 V for 2 sec after the switch is opened.

   b. Using the value of minimum capacitance C needed from part (a), determine the energy that was stored in the capacitor at time $t = 0^-$ (i.e., when the switch was still closed).

   c. Sketch and dimension the capacitor's voltage vs. time for $t \geq 0$.



Ans:

a) $C \geq 19$ mF

b) 0.95 J

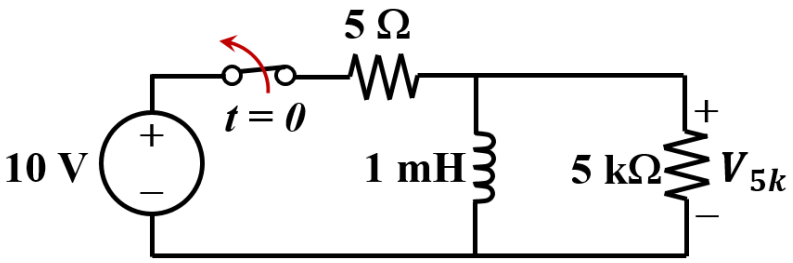
c) Time-constant of 19 sec, and almost completely discharged at about 95 sec.

3. For the circuit given below, the switch was closed for a long time before $t = 0$. At time $t = 0$, the switch is opened.

   a. Determine the energy that was stored in the inductor at time $t = 0^-$ (i.e., when the switch was still closed).

   b. Determine the voltage V_{5k} across the 5 kΩ resistor, at time $t = 0^-$ and at time $t = 0^+$ (i.e., right after the switch is opened).

   c. What is the time constant of the circuit for time $t \geq 0$?



Ans:

a) 2 mJ

b) At $t = 0^-$, $V_{5k} = 0$ V
   At $t = 0^+$, $V_{5k} = -10$ kV

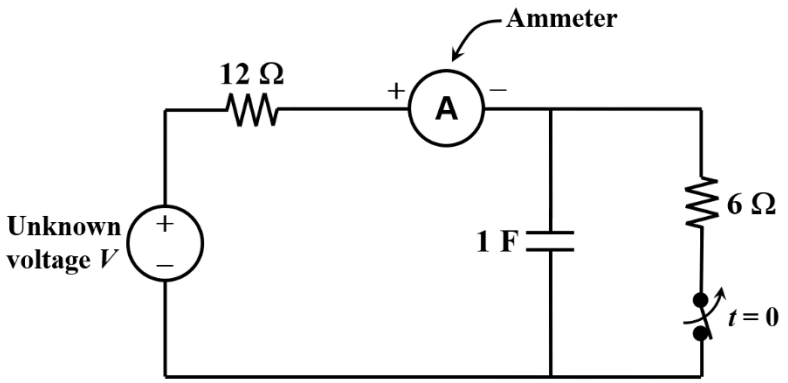
c) 0.2 μs

4. For the circuit shown in the figure below, the switch has been closed for a long time, and the current measured by the ammeter was 1 A before time $t = 0$. At time $t = 0$, the switch is opened.

   a. What is the value of the unknown voltage?

   b. What would be the current reading on the ammeter at time $t = 0^+$ s?

   c. What would be the current reading on the ammeter at time $t = 12$ s?



Ans:

a) 18 V

b) 1 A

c) 0.368 A