Review: Quiz 2

Session 2f of “Basic Electricity”
A Fairfield University E-Course
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Basic Electricity

Two Sections

- Electron Flow and Resistance
  - 5 on-line sessions
  - Lab
- Inductance and Capacitance
  - 5 on-line sessions
  - Lab

Mastery Test, Part 1

Basic Electricity (Continued)

- Text: "Electricity One-Seven," Harry Mileaf, Prentice-Hall, 1996, ISBN 0-13-889585-6 (Covers several Modules and more)
- References:
  - "Digital Mini Test: Principles of Electricity Lessons One and Two," SNET Home Study Coordinator, (203) 771-5400
  - Electronics Tutorial (Thanks to Alex Pounds)
  - Electronics Tutorial (Thanks to Mark Sokos)
  - Basic Math Tutorial (Thanks to George Mason University)
  - Vector Math Tutorial (Thanks to California Polytec at atom.physics.calpoly.edu)

Section 2: AC, Inductors and Capacitors

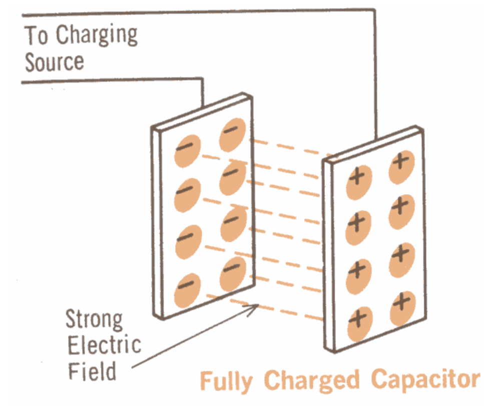
- 0BJECTIVES: This section introduces AC voltage / current and additional circuit components (inductors, transformers and capacitors).

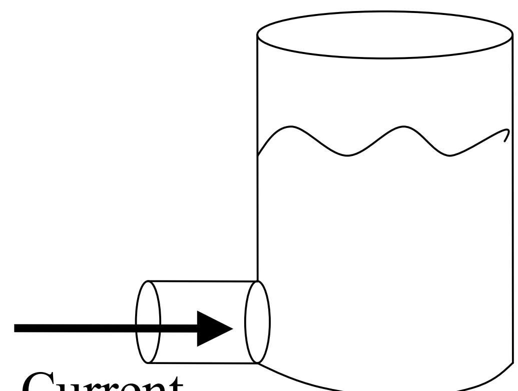
Section 2 Schedule:

Session 2a	– 03/27	AC & Sine Waves	Text 3.1 – 3.41
Vector Math	– 04/01	Sine Waves, Magnitude, Phase and Vectors	Text 4.1 – 4.24
Session 2b (Fri. Q&A session)	– 04/03	Inductors and Circuits	Text 3.42 – 3.73
Session 2c	– 04/08	Transformers	Text 3.74 – 3.100
Session 2d (lab - 04/13, Sat.)	– 04/10	Capacitors	Text 3.101 – 3.135
Session 2e Quiz 2 (due 04/22)	– 04/15	More Capacitors	Text 3.135 – 3.148
Session 2f	**– 04/22**	**Review (Discuss Quiz 2)**	**Text Chapter 2**
Fri. Q&A	– 04/26	Review: Mastery Test Part 1	Text Chap. 2 and 3
Sat.	– 04/27	Mastery Test Part 1	

Capacitor 2 Session Review

- AC & capacitors
  - Capacitive reactance - $X_c = 1 / (2 * \pi * f * C)$
  - $| I | = | V | / X_c$
  - Current “Leads” Voltage (ICE)
- DC and AC: Superposition
- Power Factor [$\cos(\theta)$]
- Physical Capacitors
  - Mica
  - Ceramic
  - Electrolytic (polarized)
  - Adjustable (tuned “resonance”)



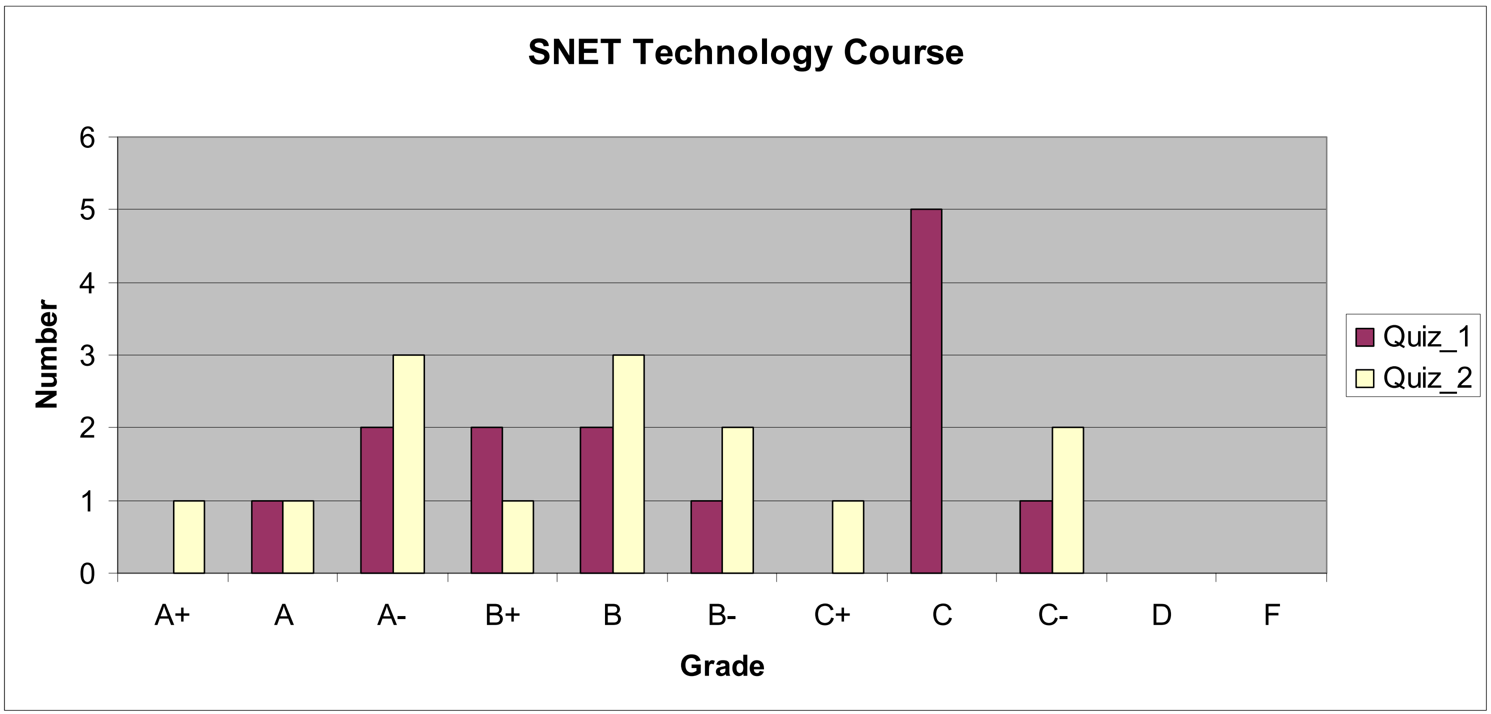


Current

Voltage: pressure at bottom

Quiz_2 Results

- The class had a B average – Nice Job.
- Most of you should find the Mastery Test Part 1 easy.
- 2 or 3 of you need to correct minor deficiencies.



Quiz True/False

1. Inductors block DC. (Capacitors block DC) _F_
2. A larger inductor allows less current (for the same V & f). _T__
3. An inductor allows more current at a higher frequency. _F__
   ($X_L = 2\pi fL$, higher reactance $\Rightarrow$ less current)
4. A capacitor allows more current at a higher frequency. _T__
5. A larger capacitor allows less current (for the same V & f). _F__
6. Capacitors block DC. _T__
7. Current leads voltage in an inductor _F__
8. Current leads voltage in an capacitor _T__
9. A transformer can change the voltage to current ratio at all frequencies. (Doesn't work at DC, f = 0) _T_F_
10. A transformer can be used to "match" impedances. _T__

Quiz Multiple Choice

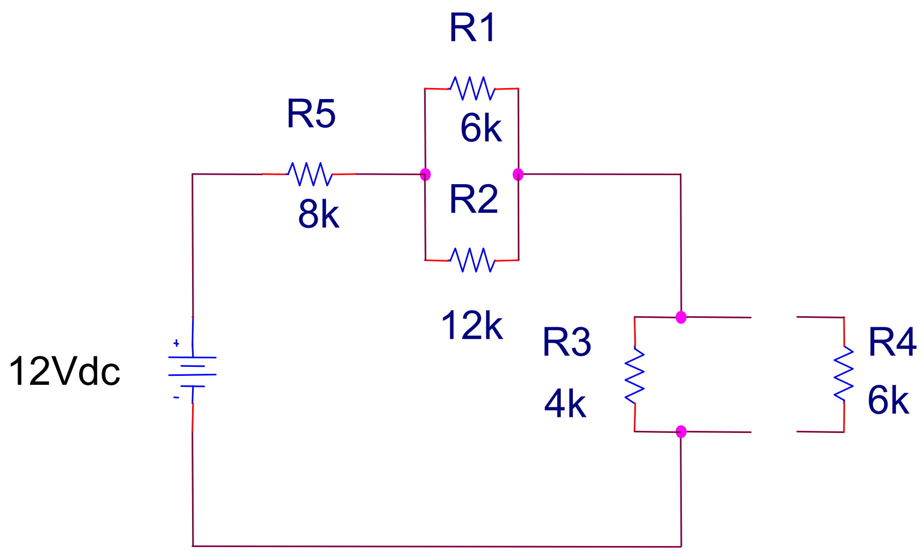
1. A "Short Circuit" :
   a. Is a small one (zero resistance)
   b. Allows high current to flow
   c. Stops current from flowing (only when a fuse blows)
   d. Has a high voltage drop (actually zero voltage drop)
2. Solder is used to:
   a. Make the circuit pretty
   b. Glue the components to the circuit board
   (you should provide some mechanical strength separately)
   c. Provide reliable electrical connection
   (wire nuts used for power)
   d. None of the above
3. What value of inductor would you put in parallel with a 12H inductor to get an inductance of 4H?
   a. 4kΩ
   b. 6kΩ (Inductors in parallel add as inverses)
   c. 8kΩ
   d. 12kΩ

Quiz Multiple Choice (cont.)

4. What value of capacitor would you put in parallel with a 2µF capacitor to get an capacitance of 5 µF?
   a. 1 µF
   b. 2 µF (Capacitors in parallel add)
   c. 3 µF
   d. 4 µF
5. A capacitor can be placed across the contacts of a switch to:
   a. Make the switch work at a higher voltage.
   b. Protect the contacts from arcing due to an inductive load. (inductors attempt to keep the current flowing when the switch is opened)
   c. Protect the contacts from arcing due to an capacitive load.
   d. Make the switch work at higher frequencies.

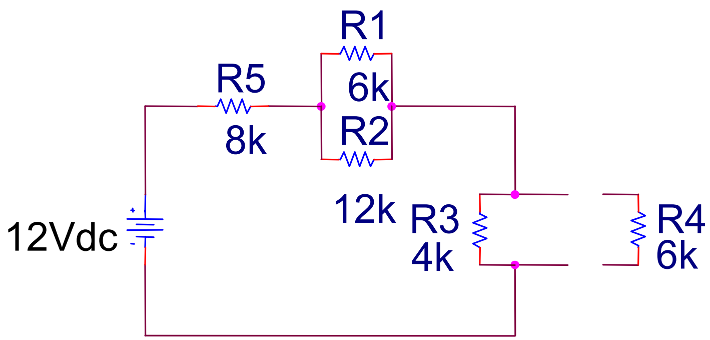
Circuit Analysis

1. For the following circuit treat R4 as a "load resistor" and find the Thevenin equivalent circuit.



Thevenin

1a. Now treat resistor R4 as the "load" resistor. Find the Thevenin equivalent circuit.



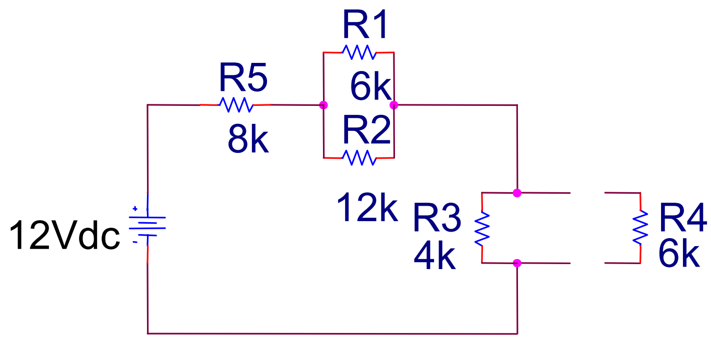
We are trying to find a simple circuit with one battery and one resistor in series that will behave the same as this circuit when we re-attach R4.

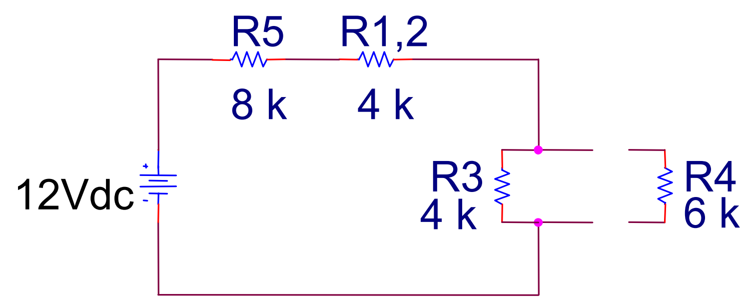
There are two steps

1. Find the voltage when the load is not attached
2. Find the value of the resistance to place in series with that voltage
3. Both of these are easier if we first reduce the circuit (no R4)

Thevenin (Cont.)

1b. Now simplify the parallel resistors R1 and R2 and use a voltage divider to find the "open circuit" voltage (V_{R3})



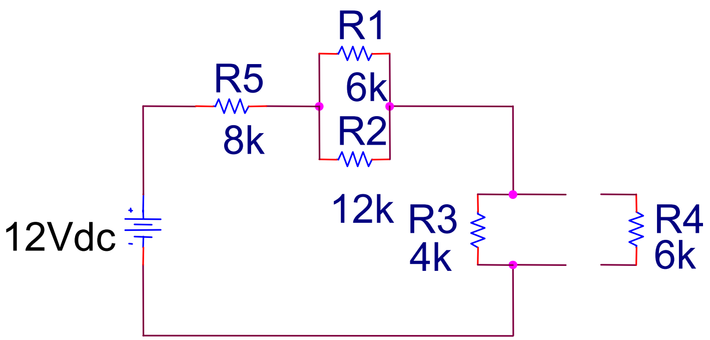


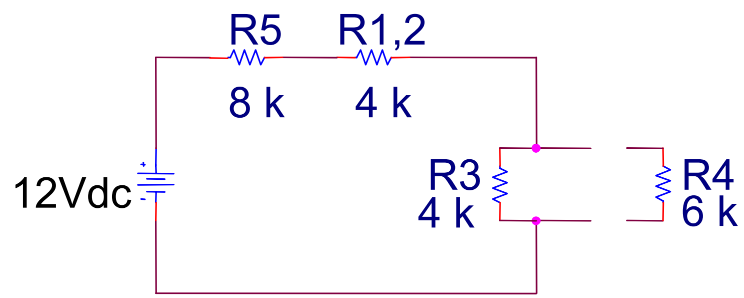
The "open circuit" voltage (no R4) is the Thevenin voltage.
We now have a "Voltage Divider"

$V_{R3} = V_{TH} = 12V*4k/(8k+4k+4k) = 12*4/16 = 12*1/4 = 3V$

Thevenin (Cont.)

1c. Now find the Thevenin resistance.

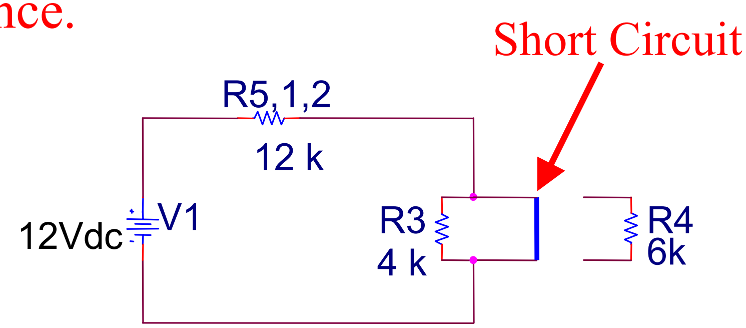




Now we need to find the Thevenin resistance.
There are two ways to do this.
The first is to "short out" output terminals and find the current that flows through the shorting element.

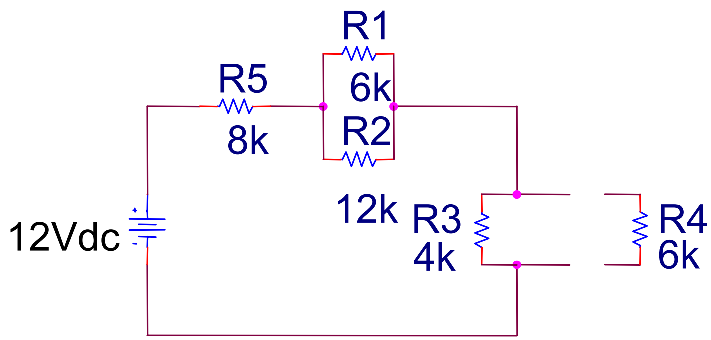
I_{SC} = 12V/12kΩ = 1 mA, and

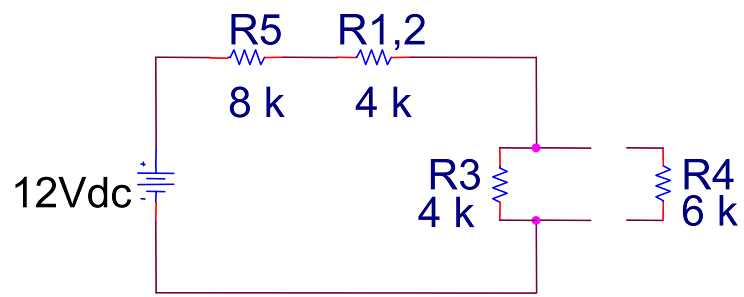
R_{TH} = V_{TH} / I_{SC} = 3V / 1 mA = 3 kΩ



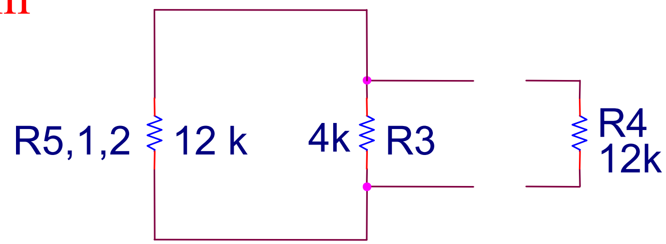
Thevenin (Cont.)

1d. Another way to find the Thevenin resistance.





The second method for finding the Thevenin resistance is to set the voltage to zero and find the equivalent resistance "looking in" from the output terminals.

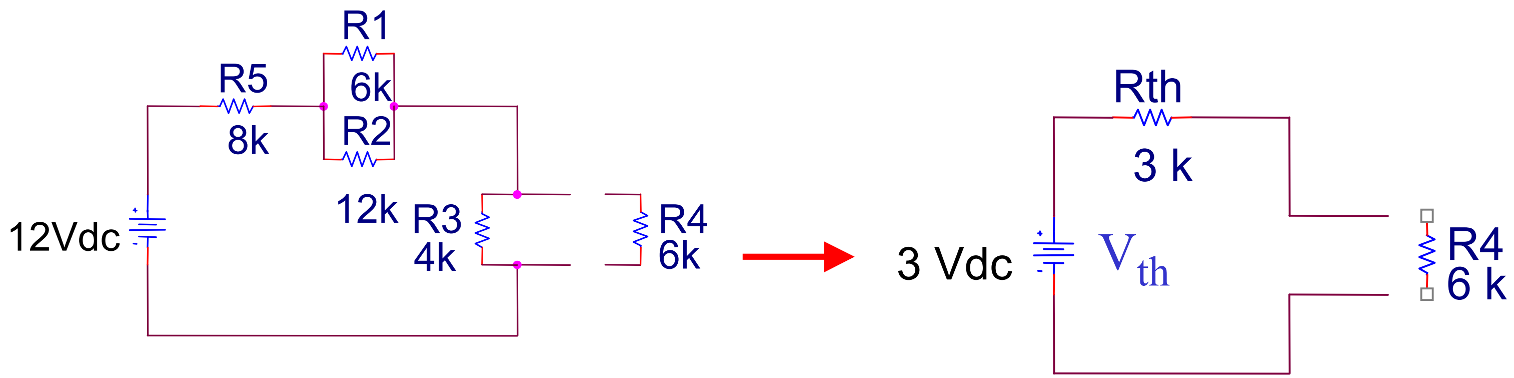


$R_{TH} = 12k\Omega \mid\mid 4k\Omega$ so $R_{TH} = 3k\ \Omega$

(1/12 + 1/4 = 4/12 = 1/3)

Thevenin (Cont.)

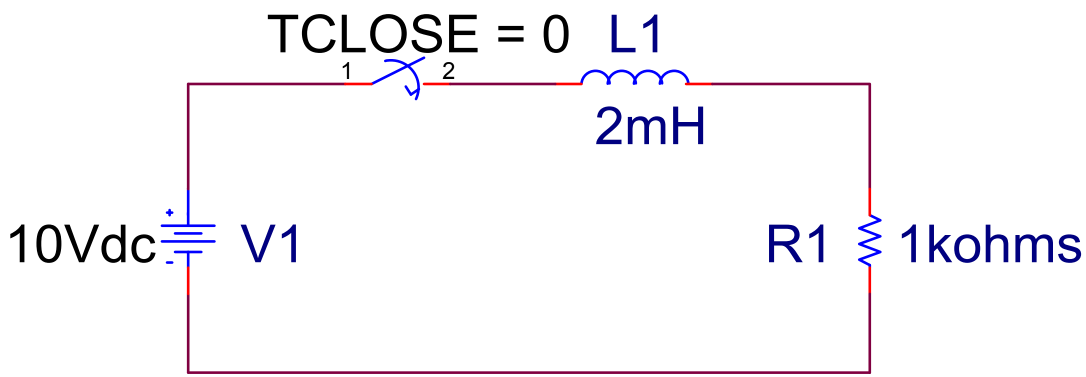
1e. Here is the Thevenin equivalent circuit.



We now have the Thevenin equivalent circuit.

Transient Circuit

2. In the circuit below, sketch the voltage across the 1 kΩ resistor if the switch is closed at t = 0.

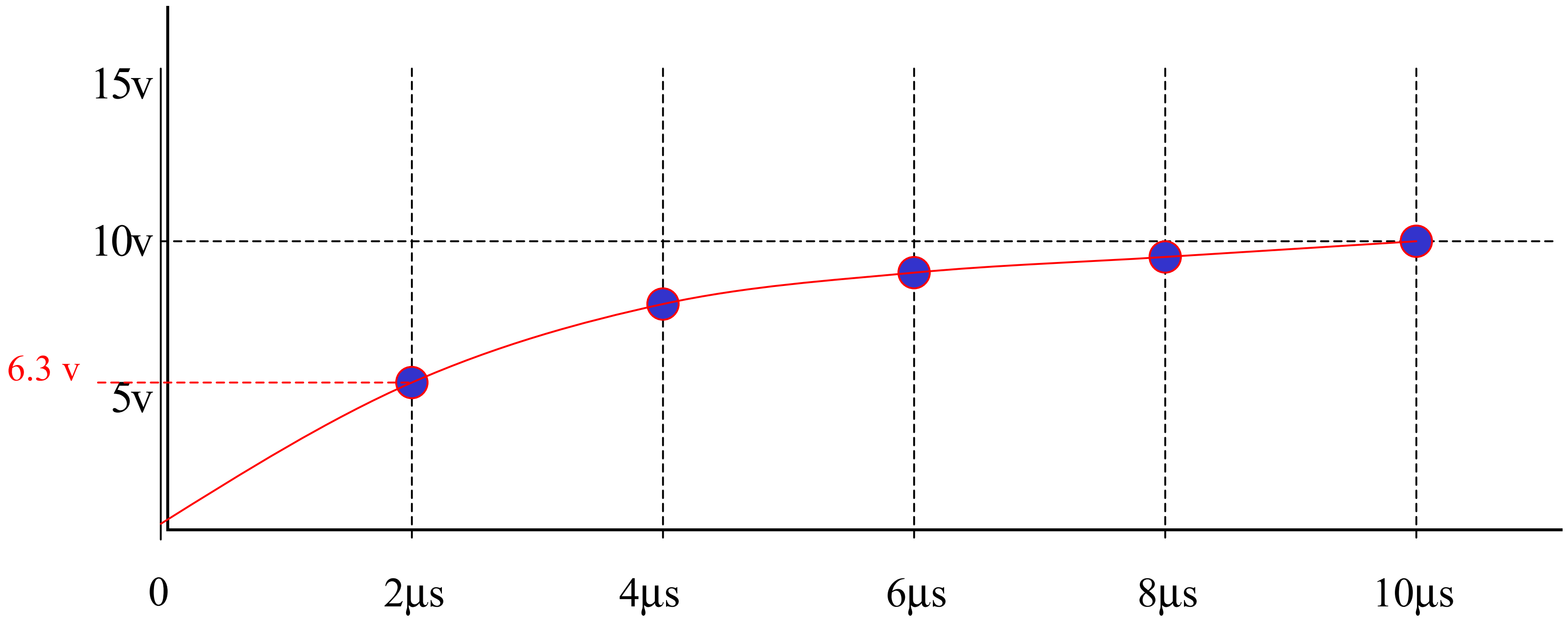


2a. Find the Time Constant:

$\tau = L/R = 2\ \text{mH} / 1\ \text{k}\Omega = 2*10^{-3} / 10^{3} = 2*10^{-6} = 2\ \mu\text{sec}$

Transient Circuit
continued

2.b Now sketch the voltage. It goes from 0 at t=0 to 10 ma as t gets large.



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