MICHIGAN ENGINEERING
UNIVERSITY OF MICHIGAN

POWER ELECTRONICS AND ENERGY RESEARCH STUDIOS

EECS215 Discussion 240912

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Covered area: Lectures in 08/26-09/09

Date: 240912 (05:30 pm – 06:30 pm)

Tips

- Understanding electrical circuits is <u>fundamental</u> to the study of electrical engineering, so it is beneficial to have a solid grasp of the basics.
- To ensure comprehension and achieve good grades, start by solving <u>simple examples</u>. Gradually tackle more <u>challenging problems</u> and contemplate them to develop a physical intuition.
- Ref: https://ocw.mit.edu/courses/6-002-circuits-and-electronics-spring-2007/download/, EECS215 lecture notes, and so on…
- Need some materials to recommend? (Problem sets, …)

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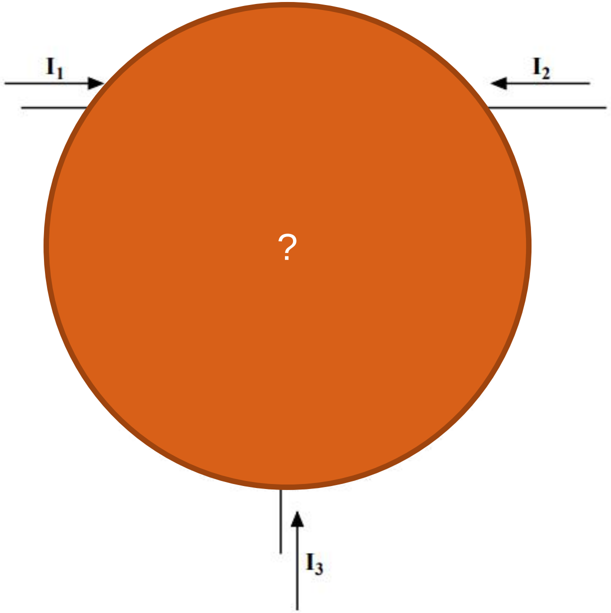
Review

- KCL
- KVL
- Ohm’s Law
- Equivalent circuit
- Source transformation

Review - KCL

$$I_1 + I_2 + I_3 = 0$$

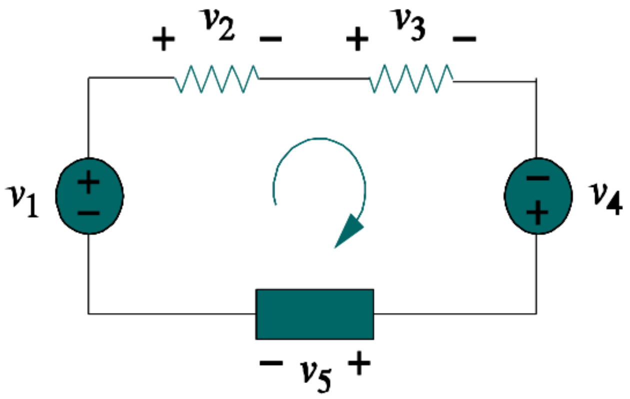


Review - KVL

Sum of voltages around a closed path is zero
Sum of voltage drops = sum of voltage rises
Result of Conservation of Energy Assumption

$$\sum_n V_n = 0$$

Define V_n's +/- in direction of loop



$$-v_1+v_2+v_3-v_4+v_5=0$$

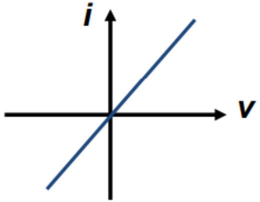
$$v_2+v_3+v_5= v_1+v_4$$

Review – Ohm's law

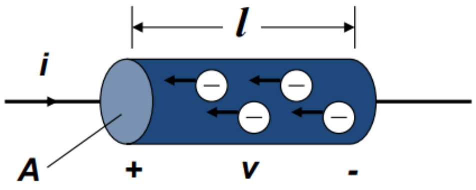
Voltage across resistor is proportional to current

$$v = iR$$

$$R = \frac{v}{i}$$



Resistance: ability to resist flow of electric current



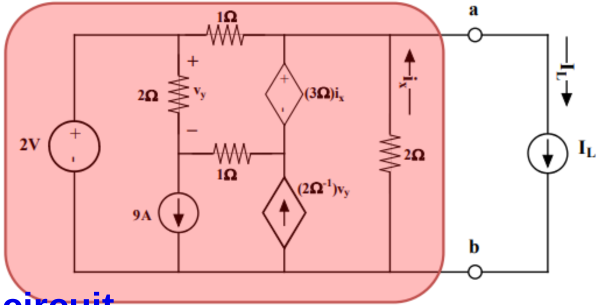
$$R = \frac{\rho l}{A} \quad \text{Standard units } \Omega$$

$$\rho = \text{Resistivity} \quad \text{Standard units } \Omega - m$$

resistivity is a material parameter (this should become clear in 230&320)

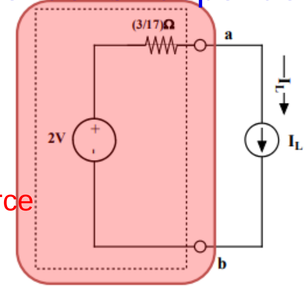
Review – Equivalent circuit

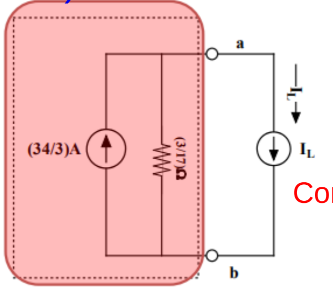
If the circuit is **linear circuit**,
We can express this circuit
with following **two forms** at the two terminals



- The i-v behavior at the output terminals (a,b) is the same even though the 3 circuit are different internally

Only for **linear circuit**
(No matter dependent/independent sources)





Constant Voltage source
+
Series resistor
(Thevinin equivalent)

$V_{ab} = R\, i_L + V_{oc}$

$y = ax + b$

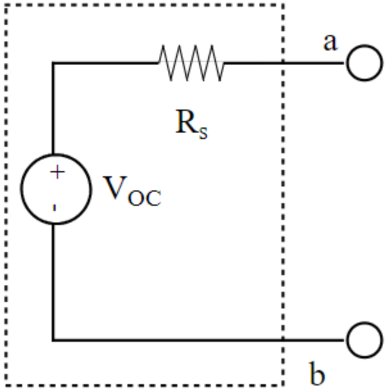
Constant Current source
+
Paralelled resistor
(Norton equivalent)

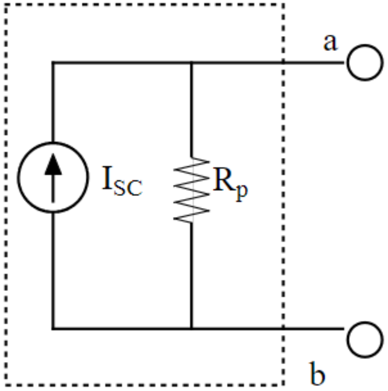
$V_{ab} = R\, i_L + R\, i_{sc}$

$y = ax + b$

Review – Source transformation

- Viewed from the output terminals a&b, the two circuits below are *equivalent*
- Replacement of a circuit by an equivalent can make some problems easier to solve





$$\boxed{\begin{aligned} R_S &= R_P \\ V_{OC} &= R_P I_{SC} \\ I_{SC} &= V_{OC}/R_S \end{aligned}}$$

Problem set 0

(1) $t = \left[0 \text{ ms}, \dfrac{1}{240} \text{ ms} \right]$

$i(t) = 25\sin(60\pi t) \text{ A}$

Transfered charges: $\Delta q(t)$?

$i(t) = 400 \text{ mA}$

(2) $v(t) = 400 \text{ V}$

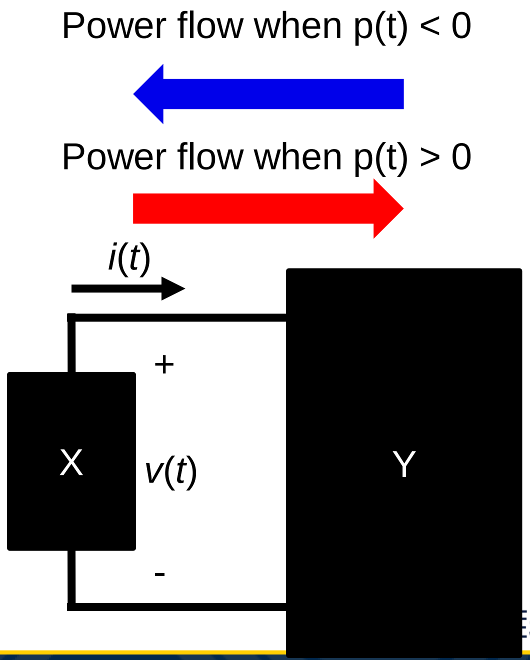
$p(t) = i(t)v(t)$?

Supplied Power by X, $p_1(t)$?

Supplied Power to X, $p_2(t)$?

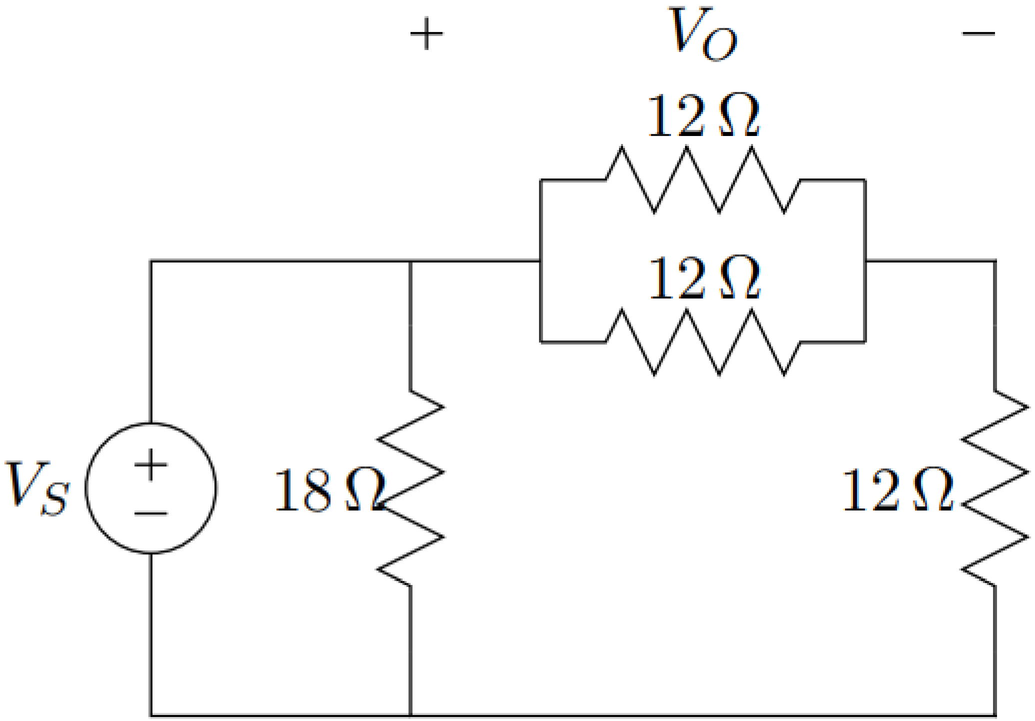
Supplied Power by Y, $p_3(t)$?

Supplied Power to Y, $p_4(t)$?



Problem set 1

V_o/V_s?



Problem set 2

The following two resistor circuit is assembled in a series connection, as one resistor follows the other in a series. For this circuit, answer the following questions.

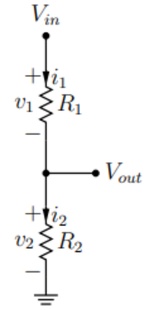


Figure 7: Circuit for problem 1. i_1 is the current flowing into R_1 and i_2 is the current flowing into R_2. V_{out} is unconnected.

a. What is the relationship between i_1 and i_2?

b. What is the voltage drop across R_1 in terms of i_1 and R_1?

c. What is the voltage drop across R_2 in terms of i_2 and R_2?

d. What is the voltage at V_{out} in terms of v_2?

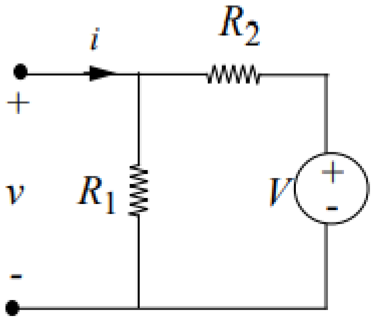
e. What is the voltage at V_{in} in terms of v_2 and v_1?

f. What is the relationship between V_{in} and V_{out} in terms of R_1 and R_2? (Note that this is the voltage divider equation)

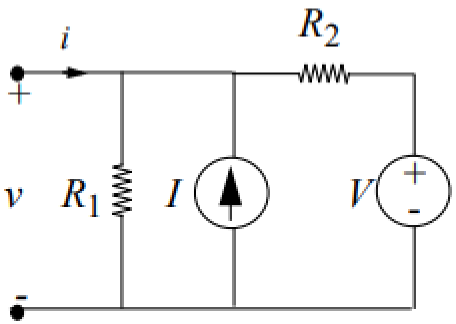
g. What is V_{in}/i_1 in terms of R_1, and R_2? (Note that this is the formula for summing resistors in series)

Problem set 3

Problem 2.1: Find the Thevenin and Norton equivalents of the following networks, and graph their i–v relations as viewed from their ports. (*Hint: use superposition for Network B.*)



Network (A)



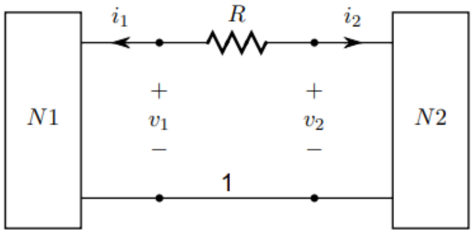
Network (B)

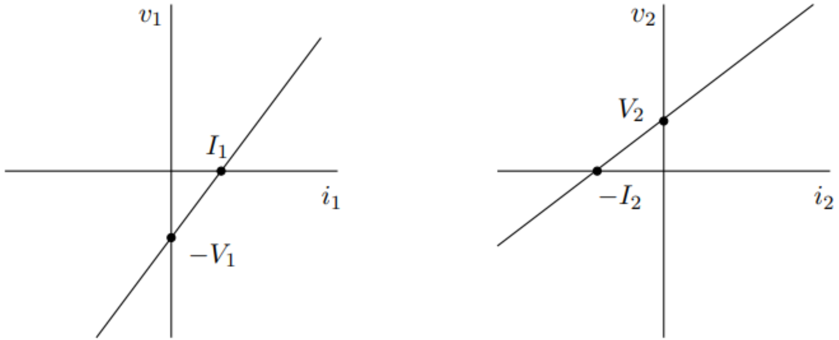
Problem set 4

Problem 2.3: Two networks, N1 and N2, are described graphically in terms of their i–v relations, and connected together through a single resistor, as shown below.

(A) Find the Thevenin and Norton equivalents of N1 and N2.

(B) Find the voltages v_1 and v_2 that result from the interconnection of N1 and N2.





(a) Network 1 (N1) (b) Network 2 (N2)