Thursday, February 4, 2016

$$(\times 6000) \quad 5V_a - 75 + 20V_a + 24V_a - 24V_b = 0$$

$$49\,V_a - 24V_b = 75 \qquad (1)$$

Node b: $\frac{V_b - 15}{1000} + \frac{V_b}{200} + \frac{V_b - V_a}{250} = 0$

$$(\times 1000) \quad V_b - 15 + 5V_b + 4V_b - 4V_a = 0$$

$$-4V_a + 10V_b = 15 \qquad (2)$$

$$\text{so} \quad V_b = \frac{15 + 4V_a}{10}$$

Substitute into (1) $\quad 49V_a - \frac{24}{10}(15 + 4V_a) = 75$

$$39.4\,V_a = 111$$

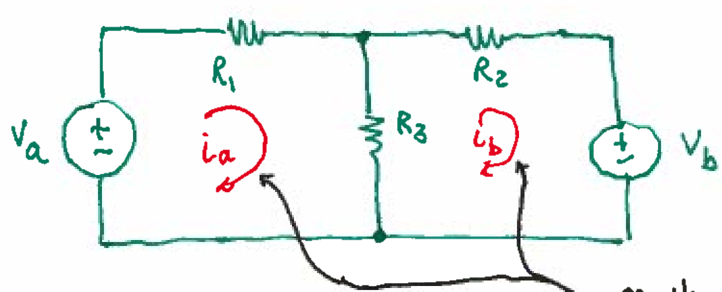
$$\text{so} \quad V_a = 2.817\,\text{v}$$

From (2), $\quad V_b = 2.627\,\text{v}$

Power in 250Ω resistor: $\quad P_{250} = \frac{(V_a - V_b)^2}{250\Omega} = 0.144\ \text{mW}.$

The mesh-current method

Another useful systematic method of circuit analysis.



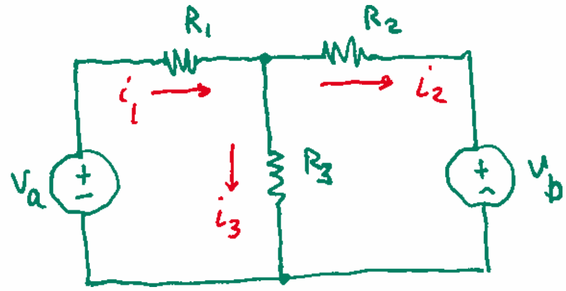
circuit must be planar (i.e., no crossing conductors)

mesh currents

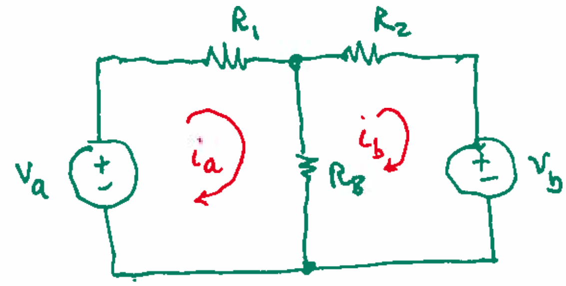
- imagined currents circulating in a closed, or mesh.

Mesh currents are different from branch currents

- we use branch currents to write KCL equations.
- branch currents can be measured with an ammeter.



branch currents,
where $i_1 = i_2 + i_3$

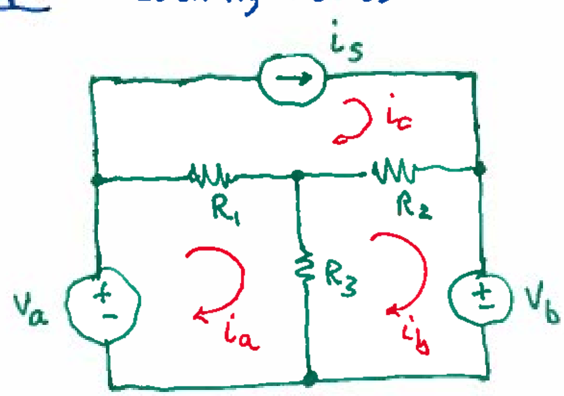


mesh currents, where
$i_1 = i_a$
$i_2 = i_b$
$i_3 = i_a - i_b$

Three main steps in mesh-current analysis.

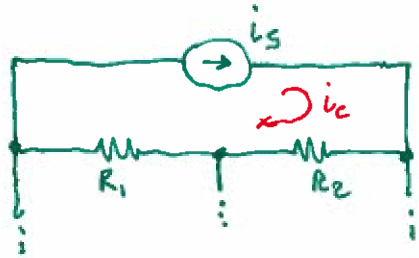
1. Identify meshes
2. Write mesh-current equation for each mesh; develop a system of equations.
3. Solve for mesh equations

Step 1: Identify meshes



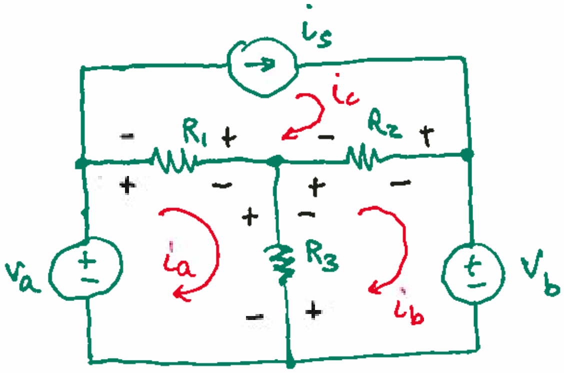
- Imagine circuit as a window with panes; assign a mesh current to each pane.

Note the upper current source in mesh c.



i_s forces the mesh current to be $i_c = i_s$
(i_c known immediately).

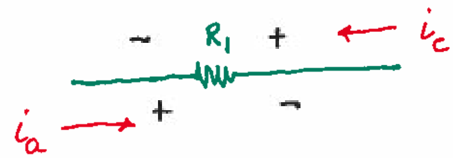
Step 2: Form mesh equations in each mesh



Labeling the circuit:

Indicate a polarity on each resistor <u>inside each mesh</u> in response to the mesh current in that mesh.

Consider R_1:



Now consider mesh a. Voltages around the mesh must sum to zero by KVL.

To find voltages across resistors, we need to determine the <u>branch</u> current in terms of mesh currents.