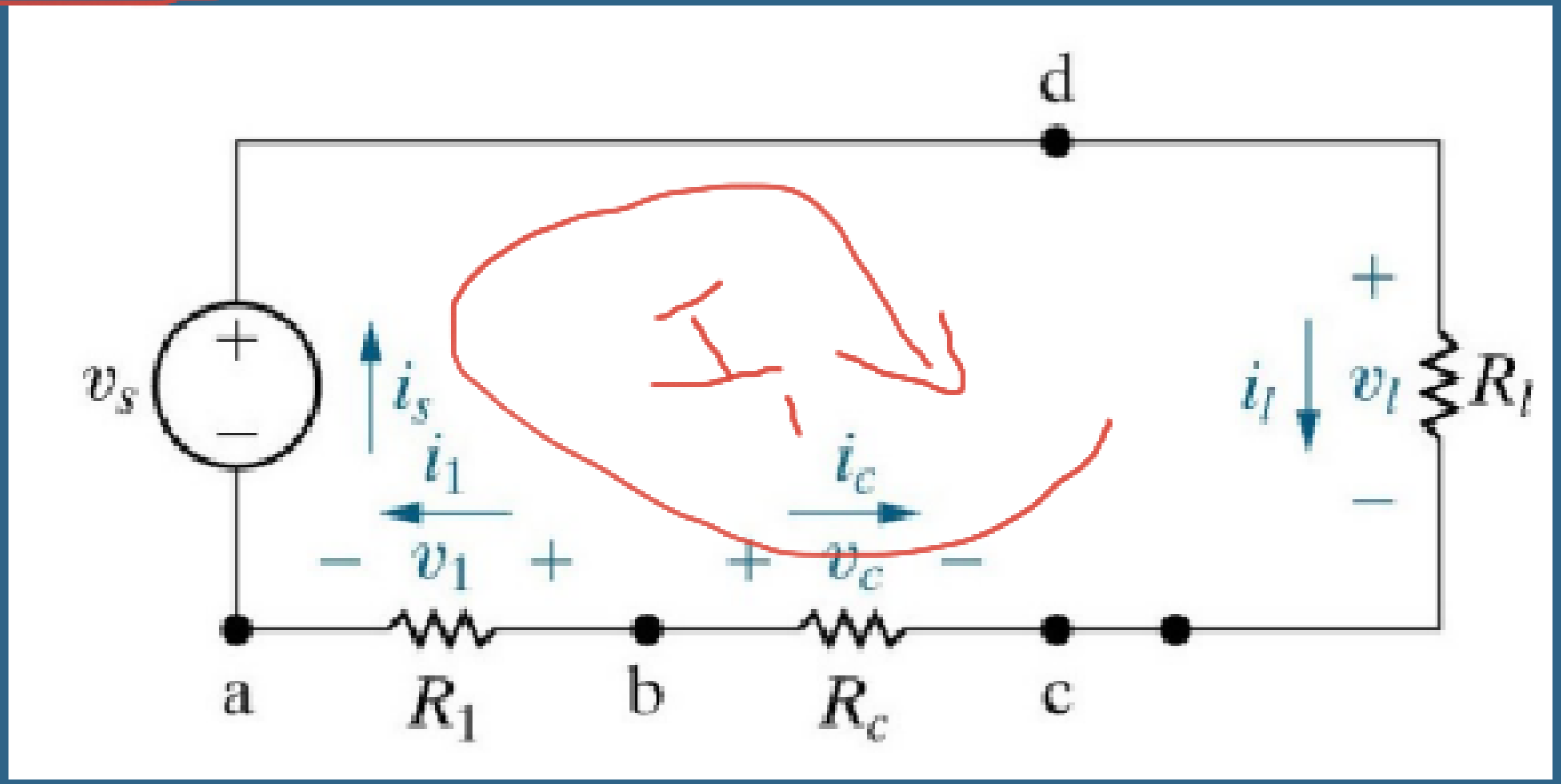
Kirchhoff's Voltage law (KVL)

$$\sum_{i=1}^{n} V_i = 0$$

- The algebraic sum of all the voltages around any closed path in a circuit equals zero.



$$\underbrace{-V_s + \overbrace{I_1 R_1}^{V_L} + \overbrace{I_1 R_c}^{V_c} + \overbrace{I_1 R_l}^{V_l}}_{} = 0$$

$$i_c = -I_1$$

Kirchhoff's current law (KCL)

The algebraic sum of all the currents at any node in a circuit equals zero. $\sum_{j=1}^{n} I_j = 0$

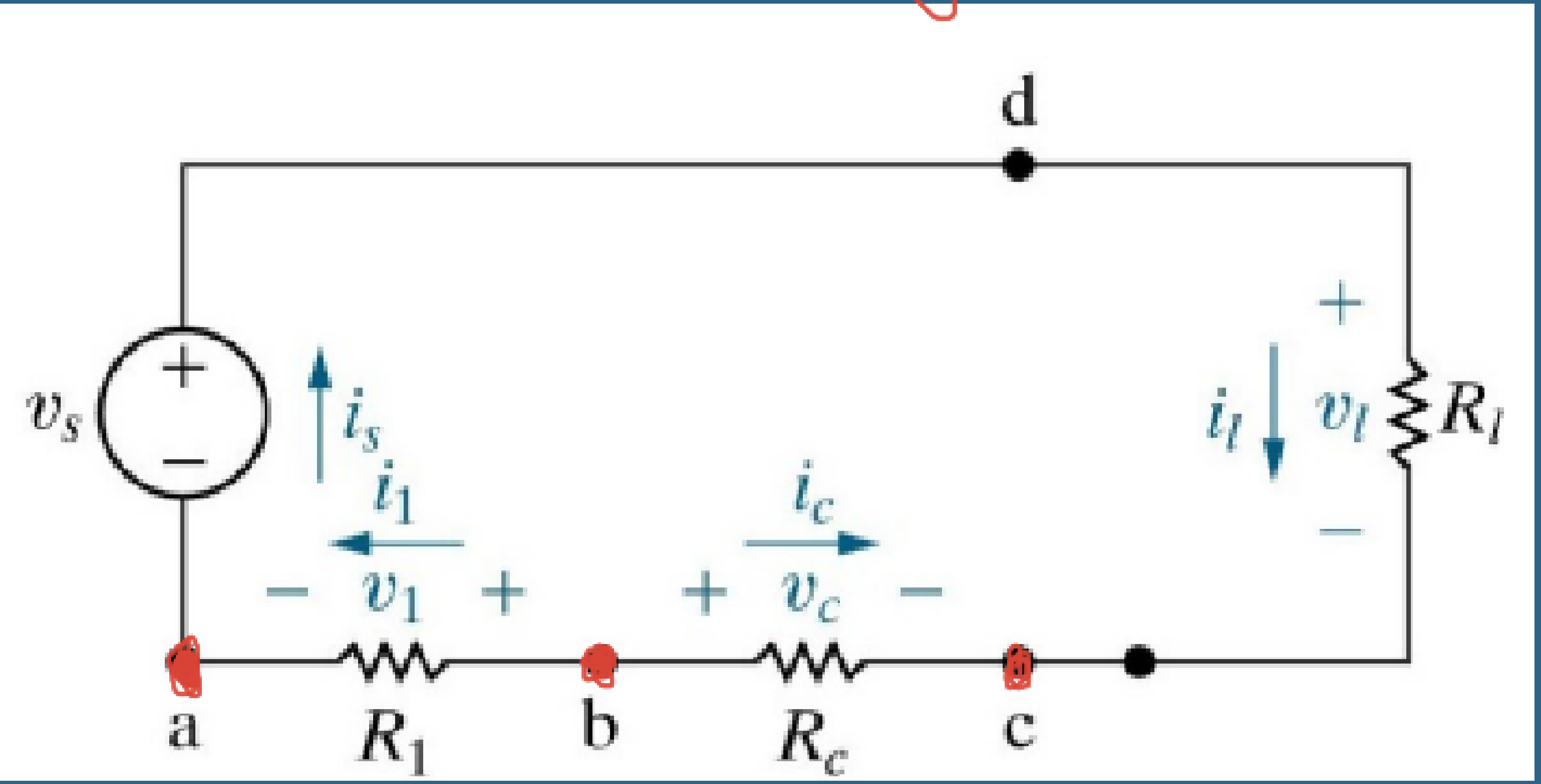
in ==> -ve

out ==> +ve

$+i_s - i_1 = 0$

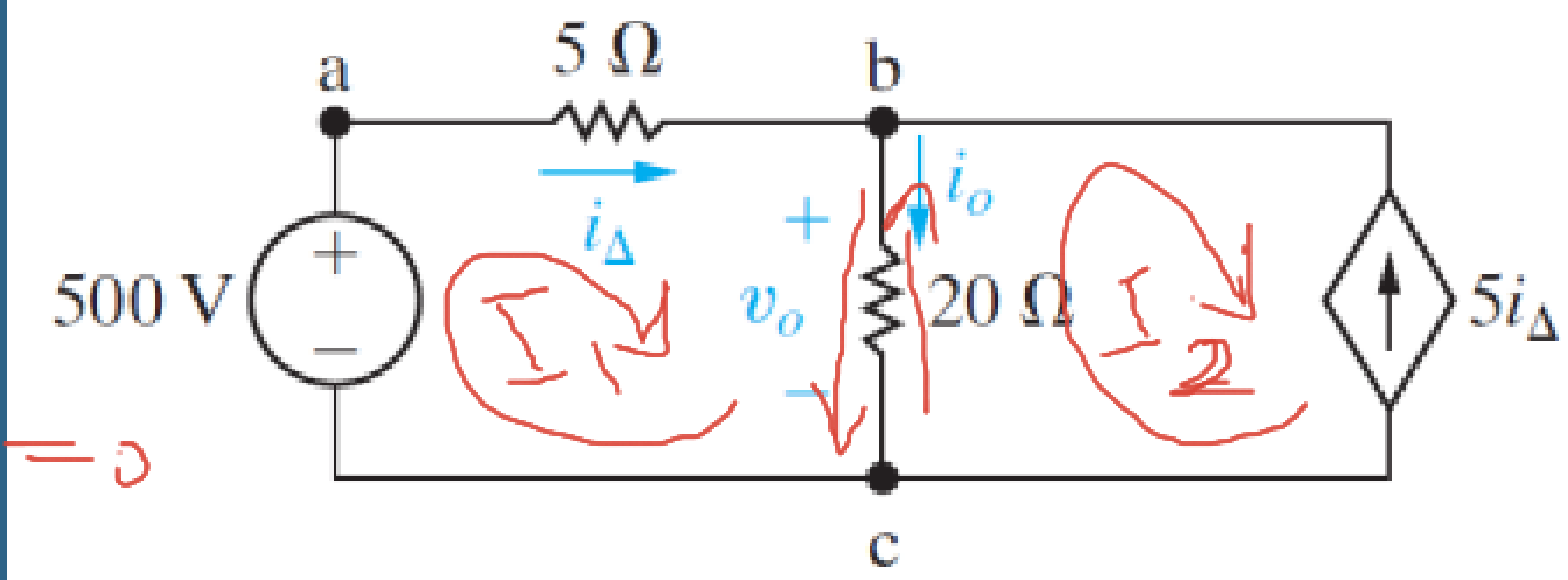
$i_1 + i_c = 0$

$-i_l - i_c = 0$



Analyzing a Circuit Continuing Dependent Source

Solve using KVL



$$-500+5I_1+20(I_1-I_2)=0$$

$$25\cancel{I_1}-20\cancel{I_2}=500 \quad 1$$

$$i_\Delta \qquad (-5i_\Delta)$$

$$I_2=-5i_\Delta$$

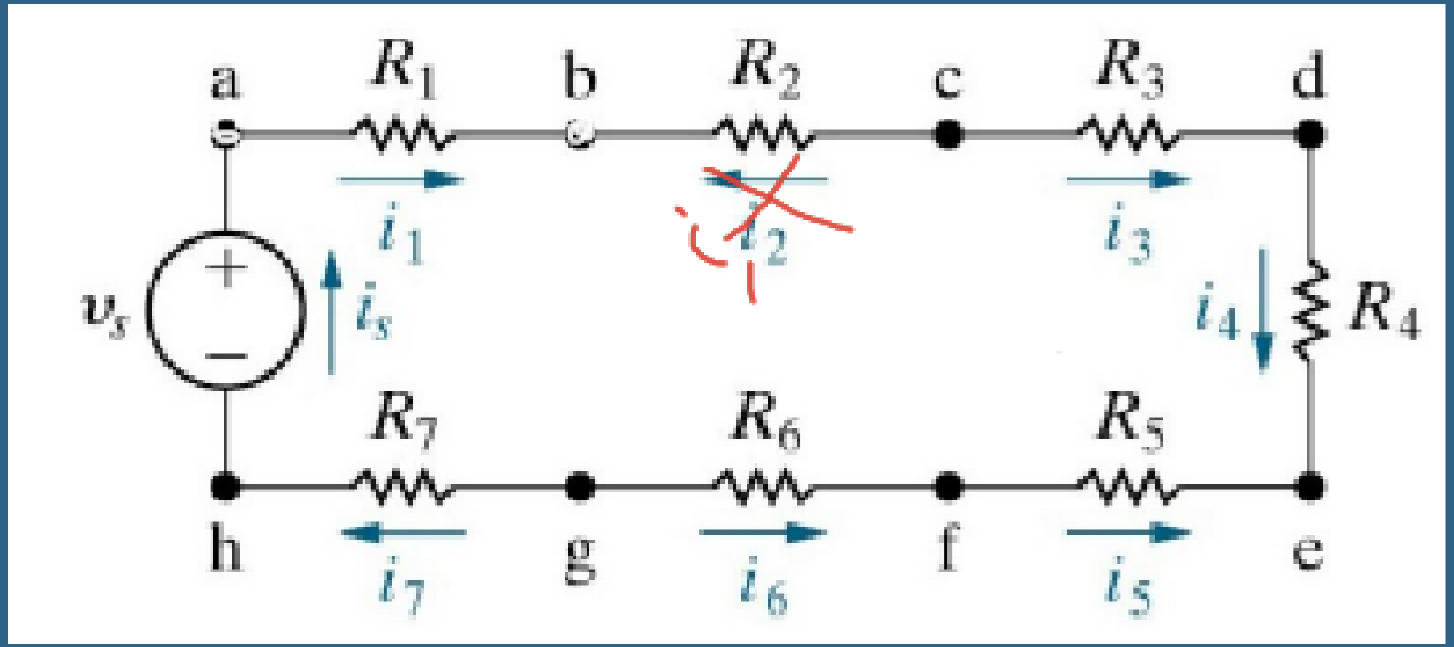
$$i_\Delta =$$

$$25i_\Delta+100i_\Delta=500$$

Resistors in Series

$i_s = i_1 = -i_2 =$

$v_s = i_s(R_1 + R_2 + R_3 \rightarrow$



$R_{eq} = \sum_{i=1}^{k} R_i$

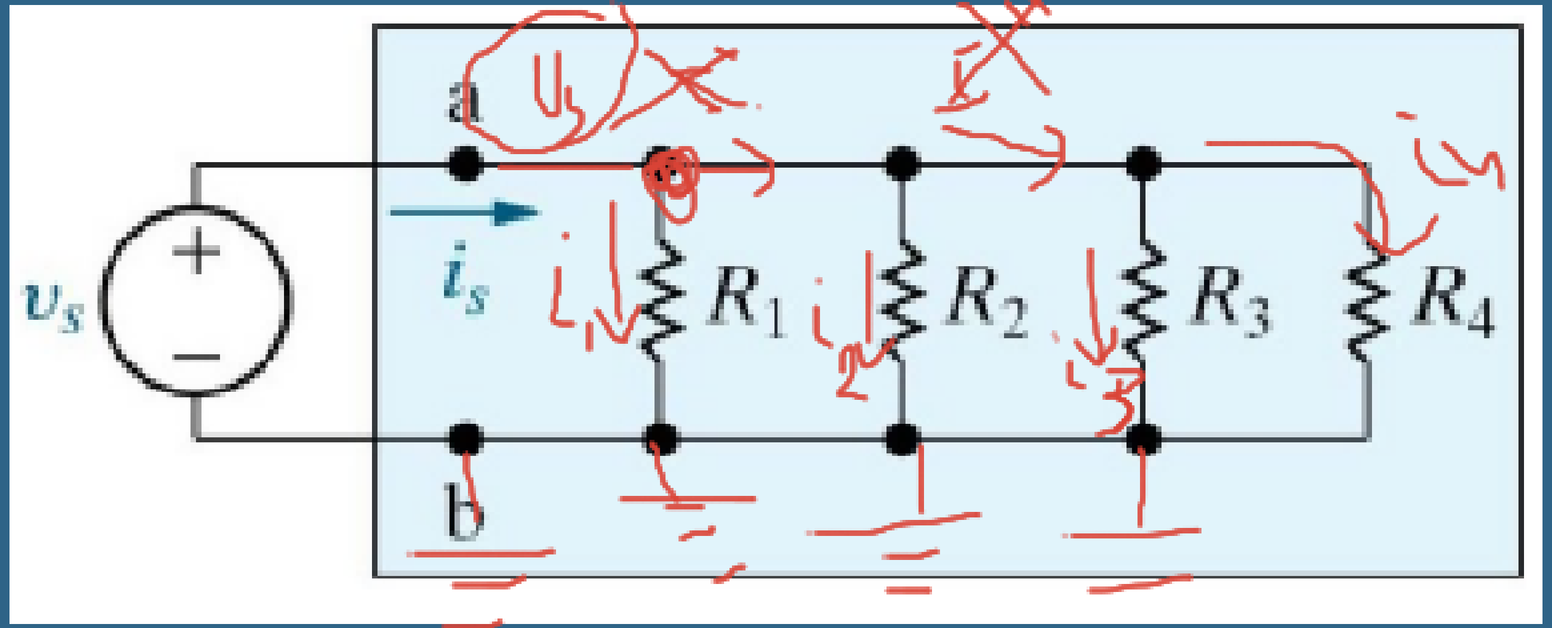
$$v_s = i_s(R_1 + R_2 + R_3 + R_4 + R_5 + R_6 + R_7).$$

$$R_{eq} = R_1 + R_2 + R_3 + R_4 + R_5 + R_6 + R_7$$

$$R_{eq} = \sum_{i=1}^{k} R_i = R_1 + R_2 + \cdots + R_k.$$

Resistors in Parallel

$v = iR$



$i_s = i_1 + i_2 + i_3 + i_4$

$i_s = \frac{v_s}{R_1} + \frac{v_s}{R_2} + \frac{v_s}{R_3} + \frac{v_s}{R_4}$

$i_s = \cancel{v_s}\left(\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \frac{1}{R_4}\right)$

$\frac{i_s}{v_s}$

$\frac{1}{R_{eq}} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \frac{1}{R_4}$

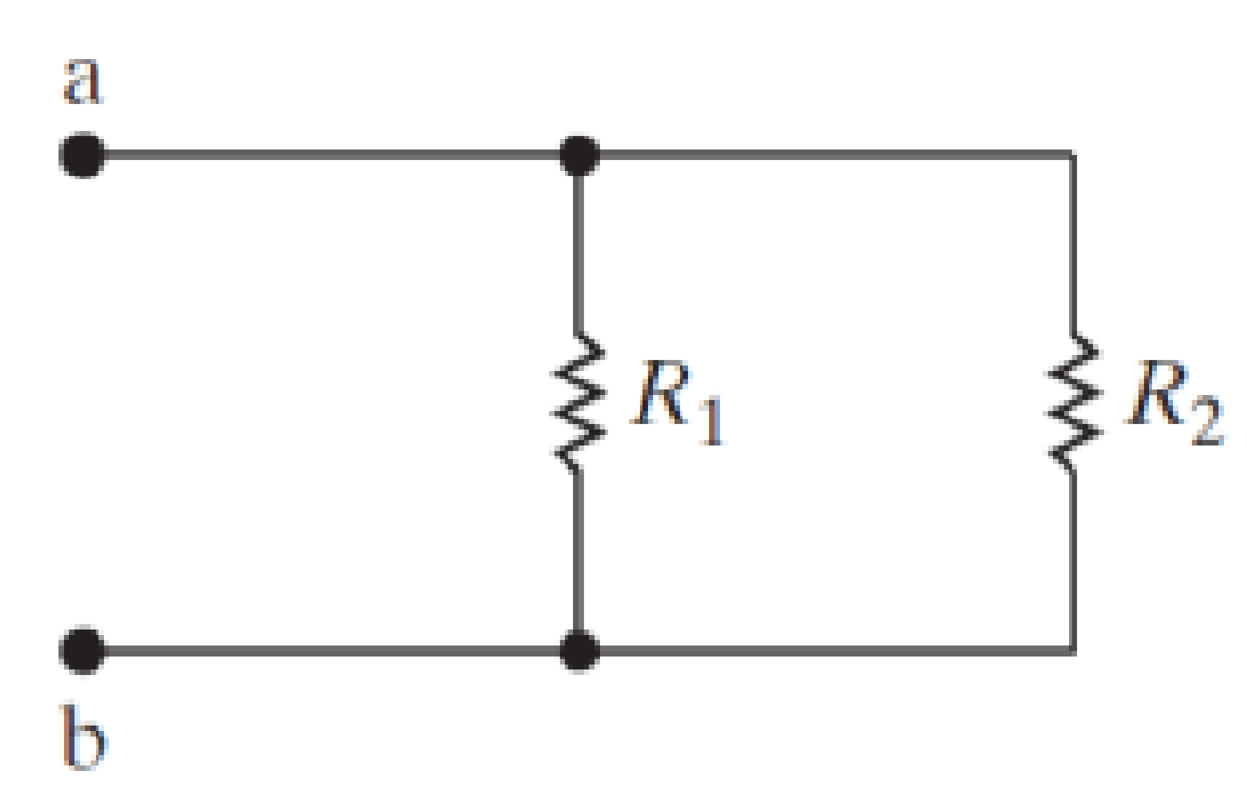
$$\frac{1}{R_{\mathrm{eq}}} = \sum_{i=1}^{k} \frac{1}{R_i} = \frac{1}{R_1} + \frac{1}{R_2} + \cdots + \frac{1}{R_k}$$

2 Resistors in Parallel

$$\frac{1}{R_{eq}} = \frac{1}{R_1} + \frac{1}{R_2}$$

$$\frac{1}{R_{eq}} = \frac{R_2 + R_1}{R_1 R_2}$$

$$R_{eq} = \frac{R_1 * R_2}{R_1 + R_2}$$



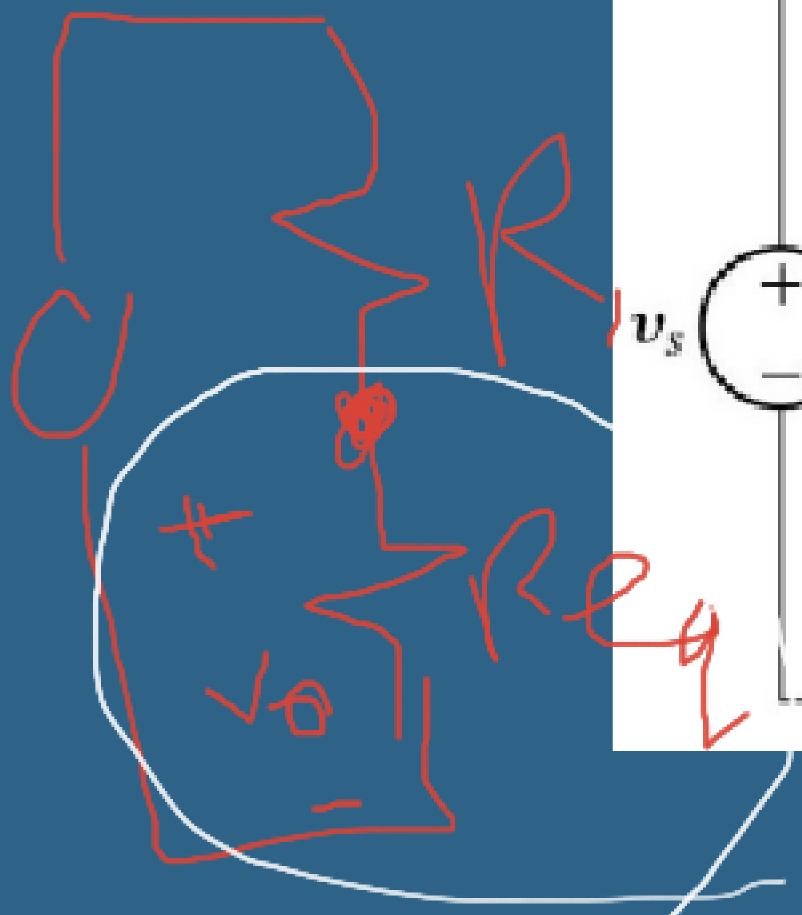
Voltage divider

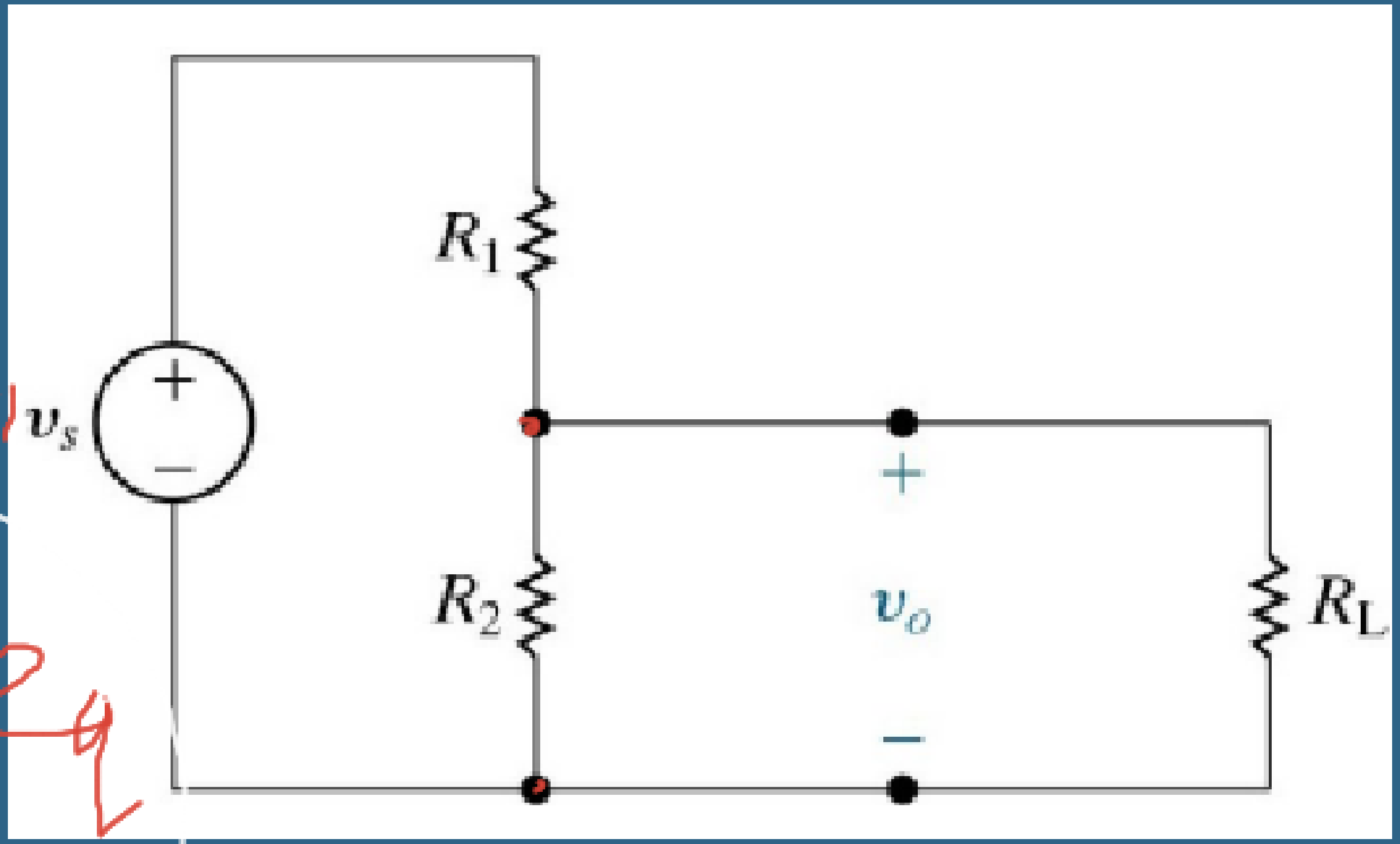
$$R_{eq} = \frac{R_2 R_L}{R_2 + R_L}$$

$$R_{eq,cir} = R_1 + R_{eq}$$

$$i_s = \frac{v_s}{R_{cir}} = \frac{v_s}{R_1 + R_{eq}}$$

$$v_o = i_s R_{eq} = \boxed{\frac{R_{eq}}{R_1 + R_{eq}} v_s}$$





$$v_o = \frac{R_{eq}}{R_1 + R_{eq}} v_s,$$

$$R_{eq} = \frac{R_2 R_L}{R_2 + R_L}.$$

$$v_j = iR_j = \frac{R_j}{R_{eq}} v.$$

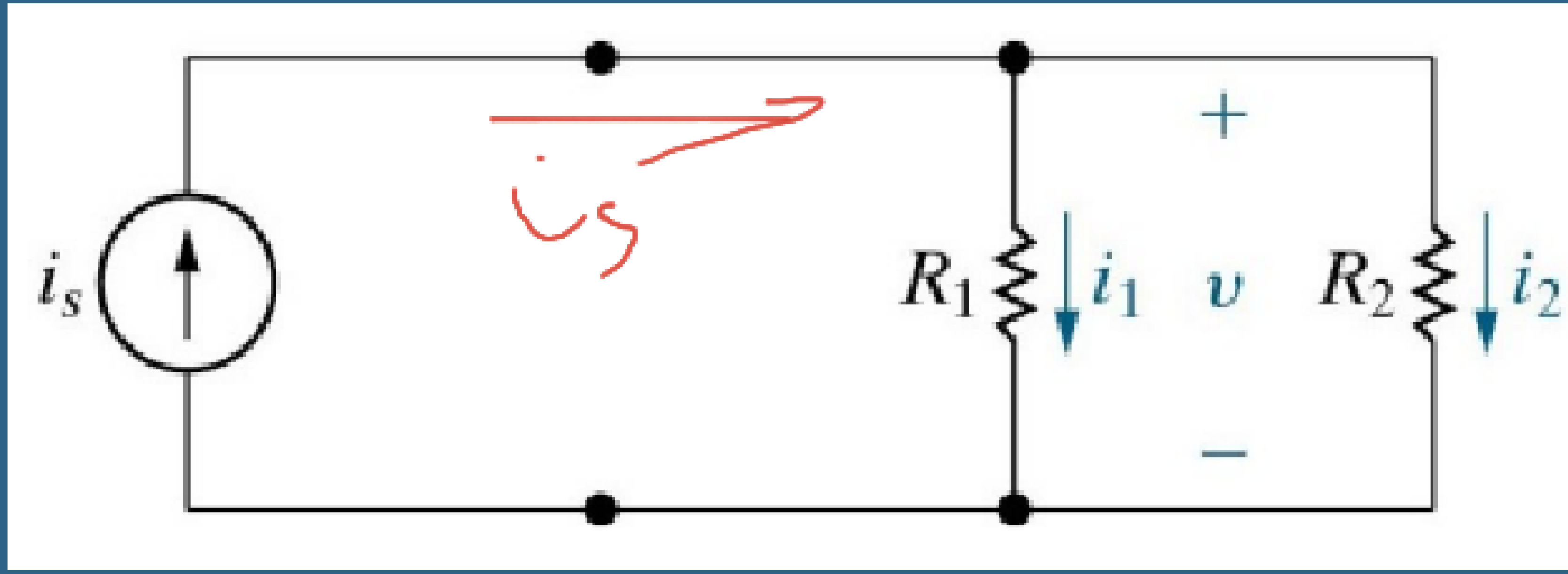
The Current-Divider Circuit

$i_s = i_1 + i_2$

$v = i_1 R_1 = i_2 R_2$

$R_{eq} = \frac{R_1 R_2}{R_1 + R_2}$ $\quad i_1 \cancel{R_1} = i_s \frac{\cancel{R_1} R_2}{R_1 + R_2}$

$v = i_s R_{eq}$ $\quad i_1 = i_s \frac{R_2}{R_1 + R_2}$



$$v = i_1 R_1 = i_2 R_2 = \frac{R_1 R_2}{R_1 + R_2} i_s$$

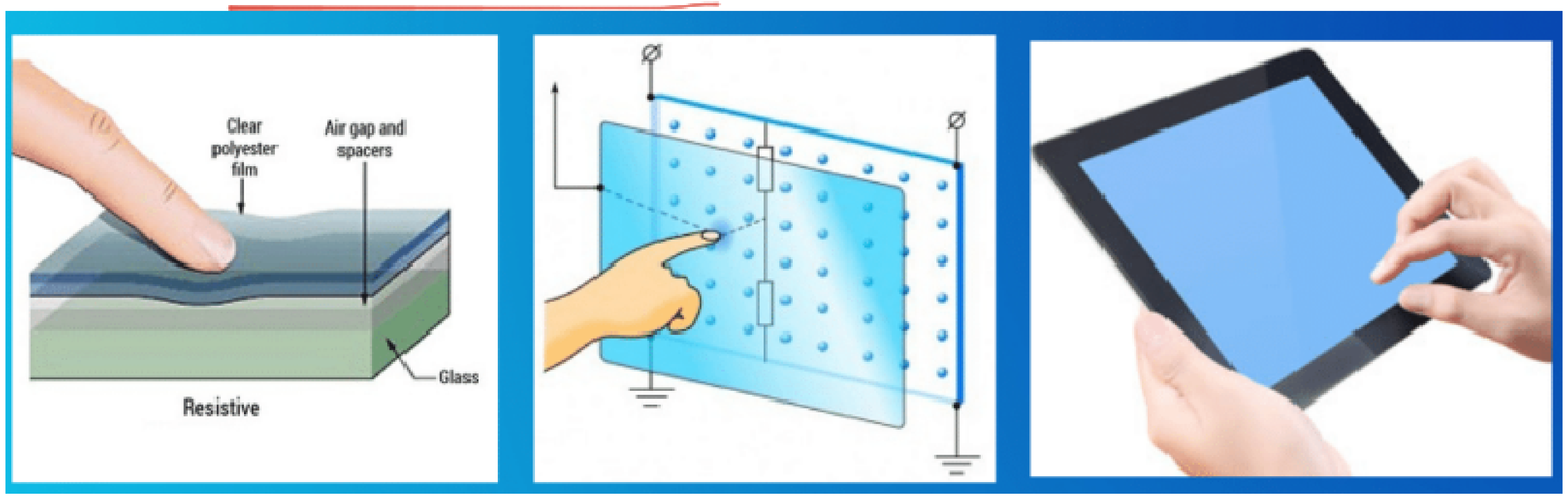
$$i_1 = \frac{R_2}{R_1 + R_2} i_s,$$

$$i_2 = \frac{R_1}{R_1 + R_2} i_s.$$

$$i_j = \frac{v}{R_j} = \frac{R_{eq}}{R_j} i_s.$$

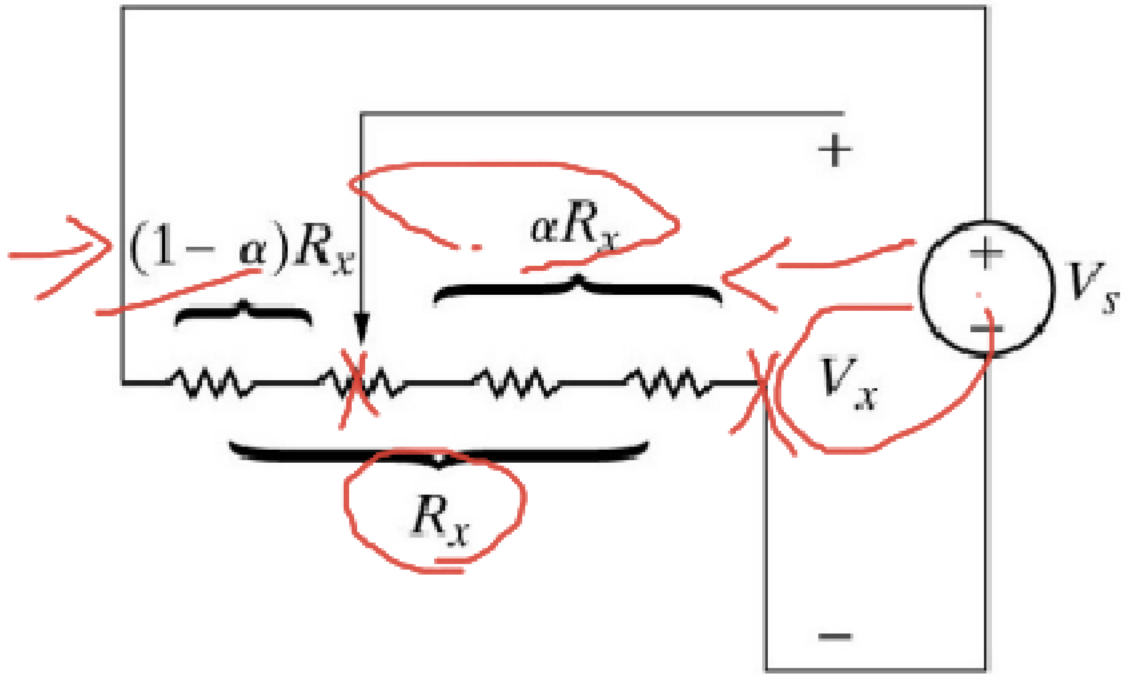
Real-World Applications

Resistive touch screen



$$V_x = \frac{\alpha R_x}{\alpha R_x + (1-\alpha)R_x} V_s = \frac{\alpha \cancel{R_x}}{\cancel{R_x}} V_s = \alpha V_s.$$

$$\boxed{\alpha = \frac{V_x}{V_s}}$$



$$x = (1 - \alpha)p_x$$

p_x pixels in the x-direction
p_y pixels in the y-direction.

α represents the location of the touch point with respect to the right side of the screen,
(1 - α) represents the location of the touch point with respect to the left side of the screen