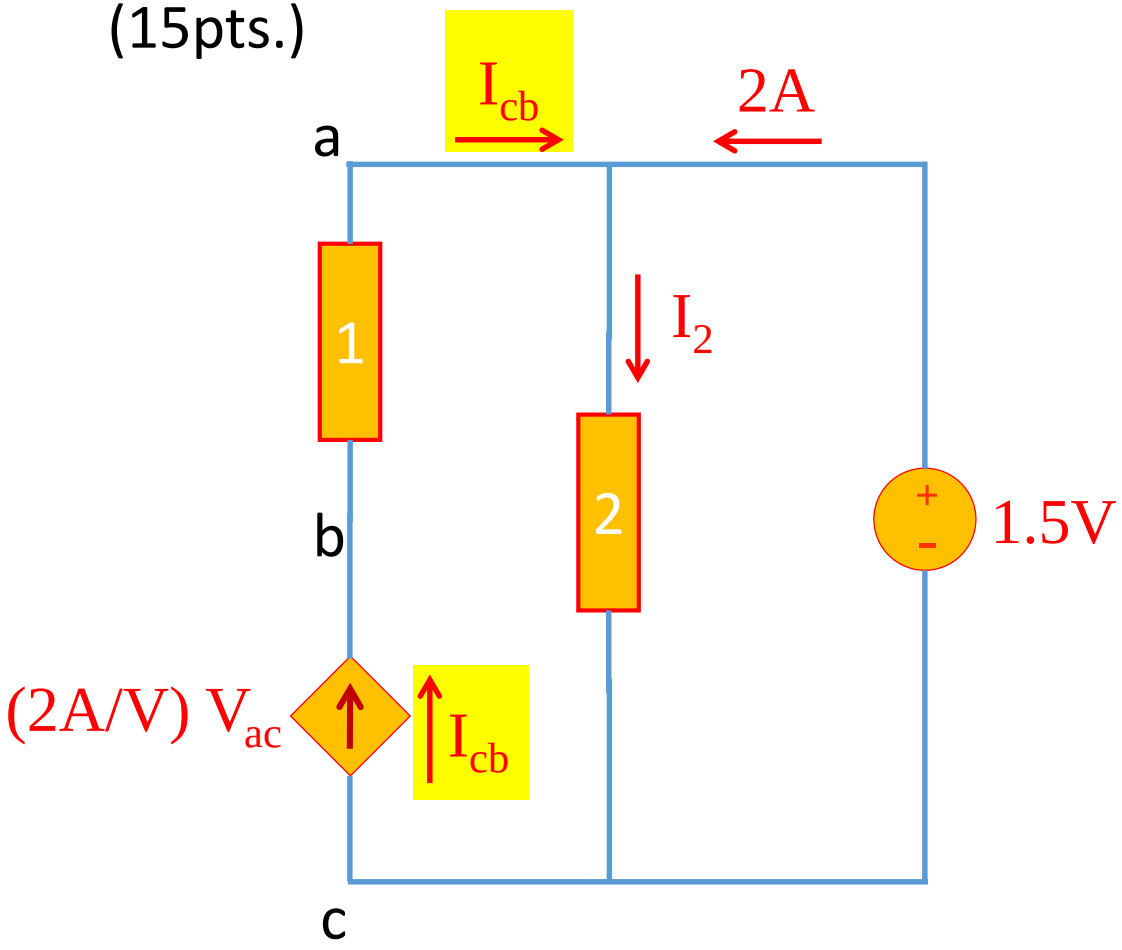
EECS/CSE 70A Network Analysis I

Homework #2
Solution Key

Problem 1: (VCCS) Find I_{cb} and I_2. (15pts.)



Problem 1 Solution

I_{cb} is the current of the voltage-controlled current source flowing from c to b.

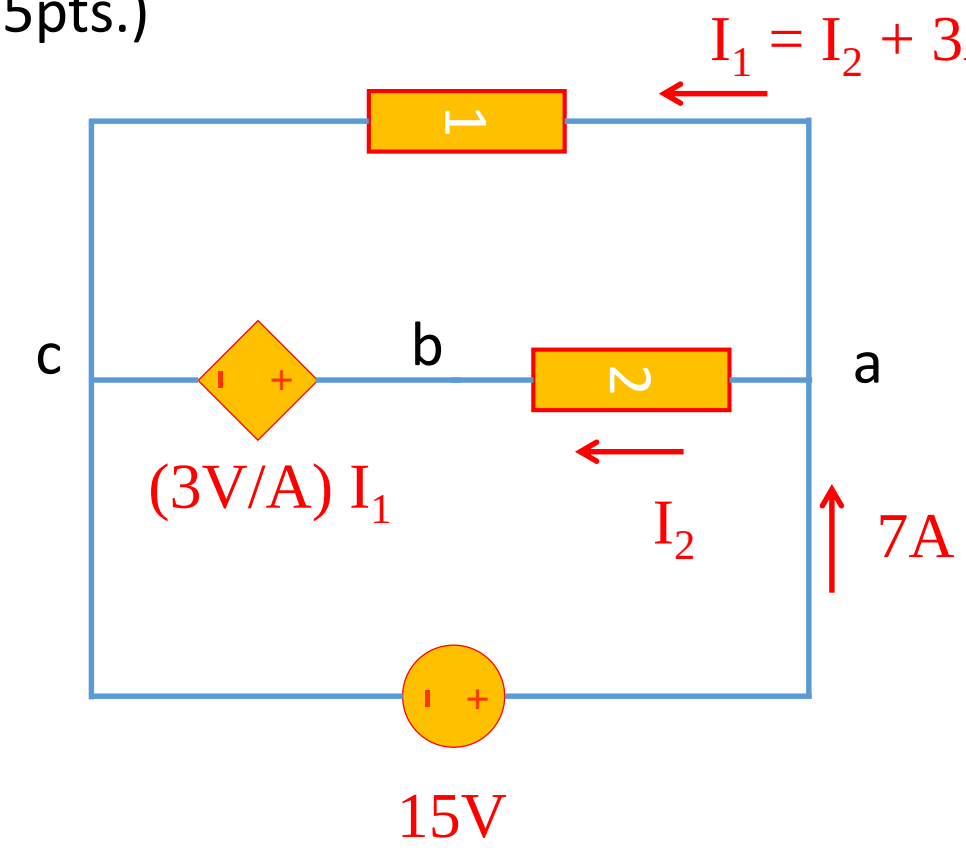
$I_{cb} = (2A/V)\ V_{ac}$ where $V_{ac} = 1.5V$

$I_{cb} = (2A/V)x1.5V = 3A$

KCL at the top node

$I_2 = I_{cb} + 2A = 5A$

Problem 2: (CCVS) Find I_1, I_2 and V_{bc} (15pts.)



where $V_{ac} = 1.5V$

Problem 2 Solution

Apply KCL at node a.

$7A = I_1 + I_2$ where $I_1 = I_2 + 3A$ is given

Substitute $I_2 = I_1 - 3A$

$7A = I_1 + I_1 - 3A$

$10A = 2I_1$

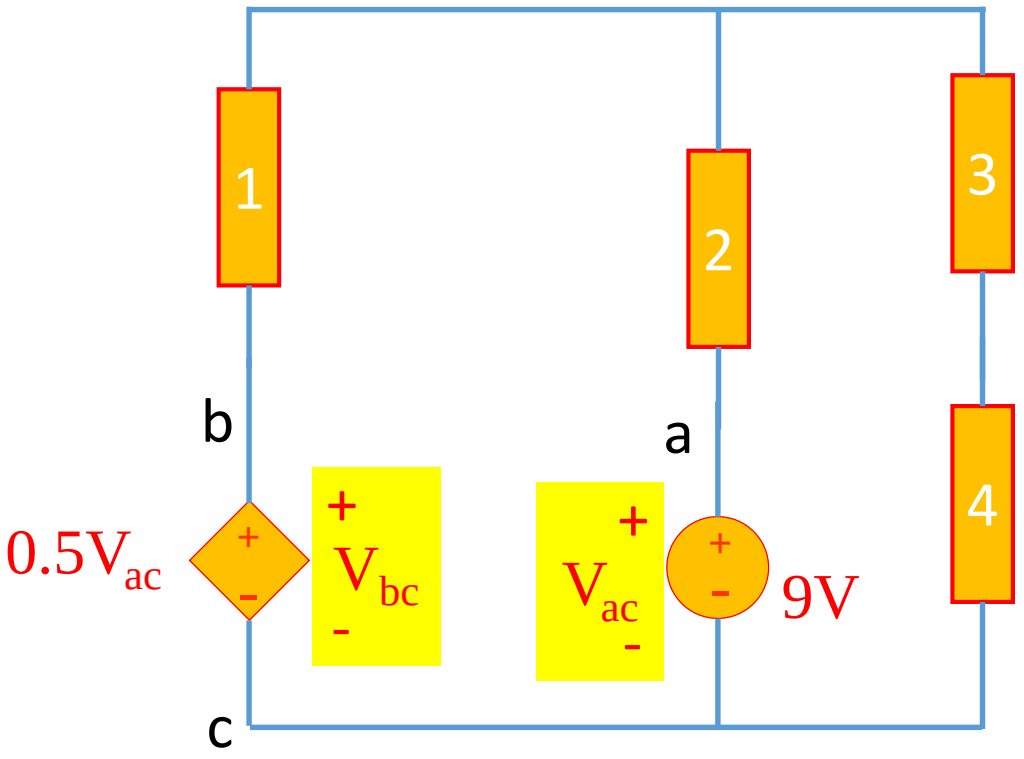
$I_1 = 5A$,

$I_2 = I_1 - 3A = 2A$

V_{bc} is the voltage across the current-controlled voltage source

$V_{bc} = (3V/A) \times 5A = 15V$

Problem 3: (VCVS) Find V_{bc} and V_{ab} . (15pts.)



Problem 3 Solution

V_{bc} is the voltage across the voltage-controlled voltage source

$V_{bc} = 0.5V_{ac}$

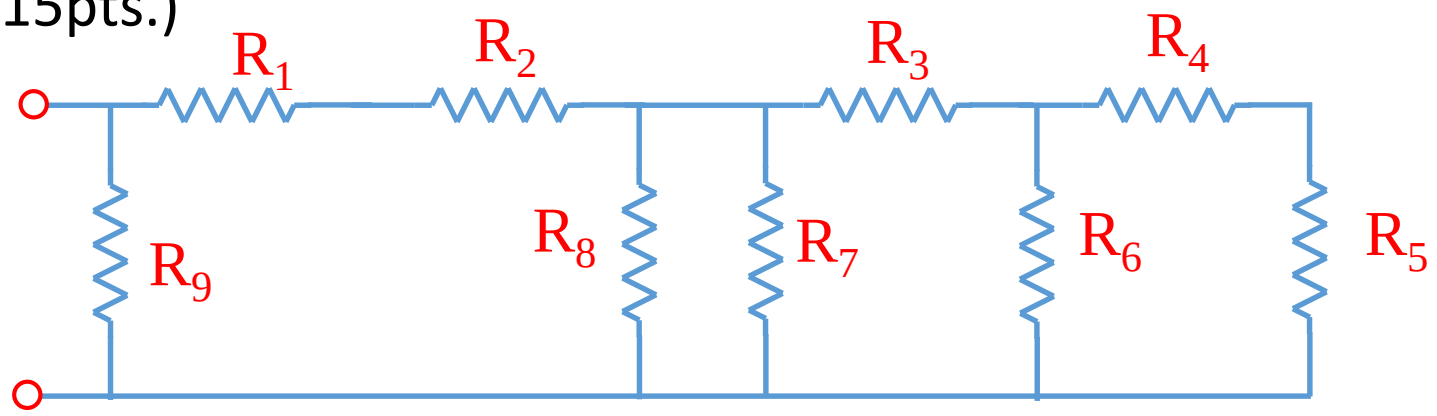
V_{ac} is the voltage across 9V voltage source, $V_{ac} = 9V$

$V_{bc} = 0.5 \times 9V = 4.5V$

$V_{ab} = V_{ac} + V_{cb}$ where $V_{cb} = -V_{bc}$

$V_{ab} = V_{ac} - V_{bc} = 9V - 4.5V = 4.5V$

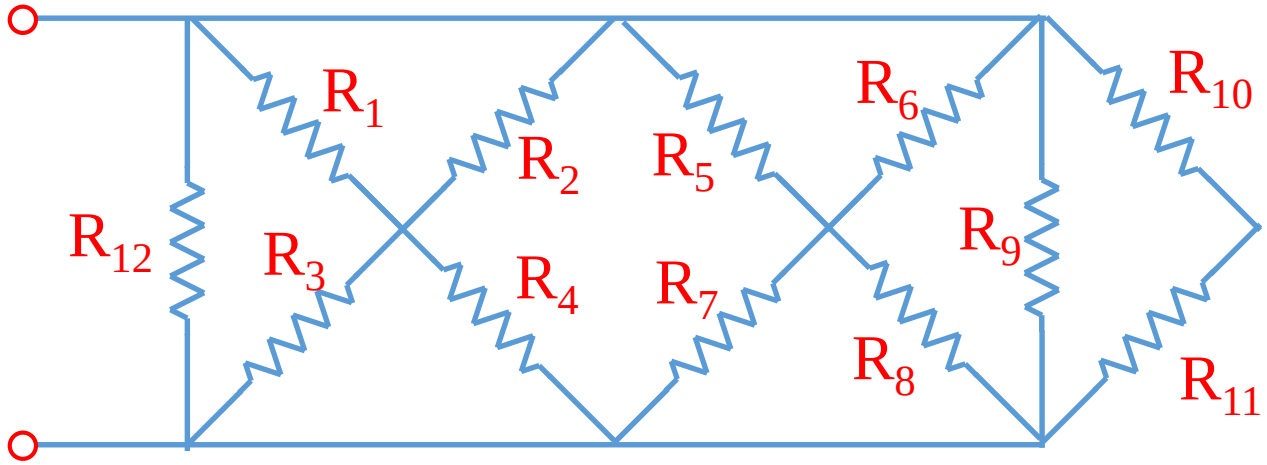
Problem 4: Find R_{eq} . Please use the parallel sign "//" as discussed in class. (15pts.)



Problem 4 Solution

$$R_{eq} = \left[\left(\left\{ \left[\left(R_4 + R_5 \right) \| R_6 \right] + R_3 \right\} \| R_7 \| R_8 \right) + R_1 + R_2 \right] \| R_9$$

Problem 5: Find R_{eq} .
(15pts.)

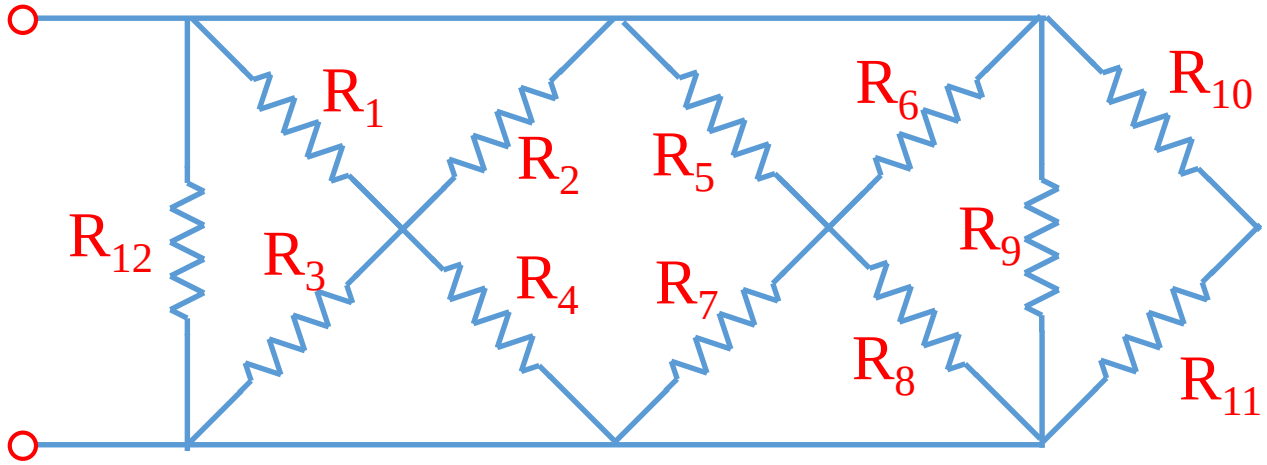


Problem 5 Solution

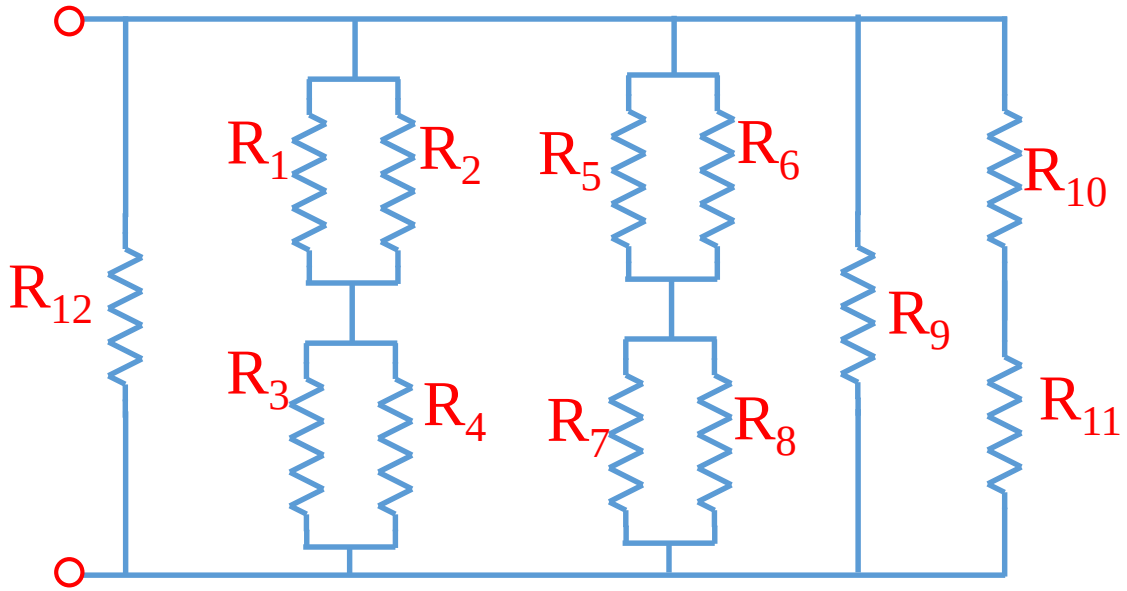
$$R_{eq} = \left(R_{10} + R_{11}\right) \| R_9 \| \left[\left(R_5 \| R_6\right) + \left(R_7 \| R_8\right)\right] \| \left[\left(R_1 \| R_2\right) + \left(R_3 \| R_4\right)\right] \| R_{12}$$

See the same circuit drawn again on the next page where you can recognize the parallel and series components easily.

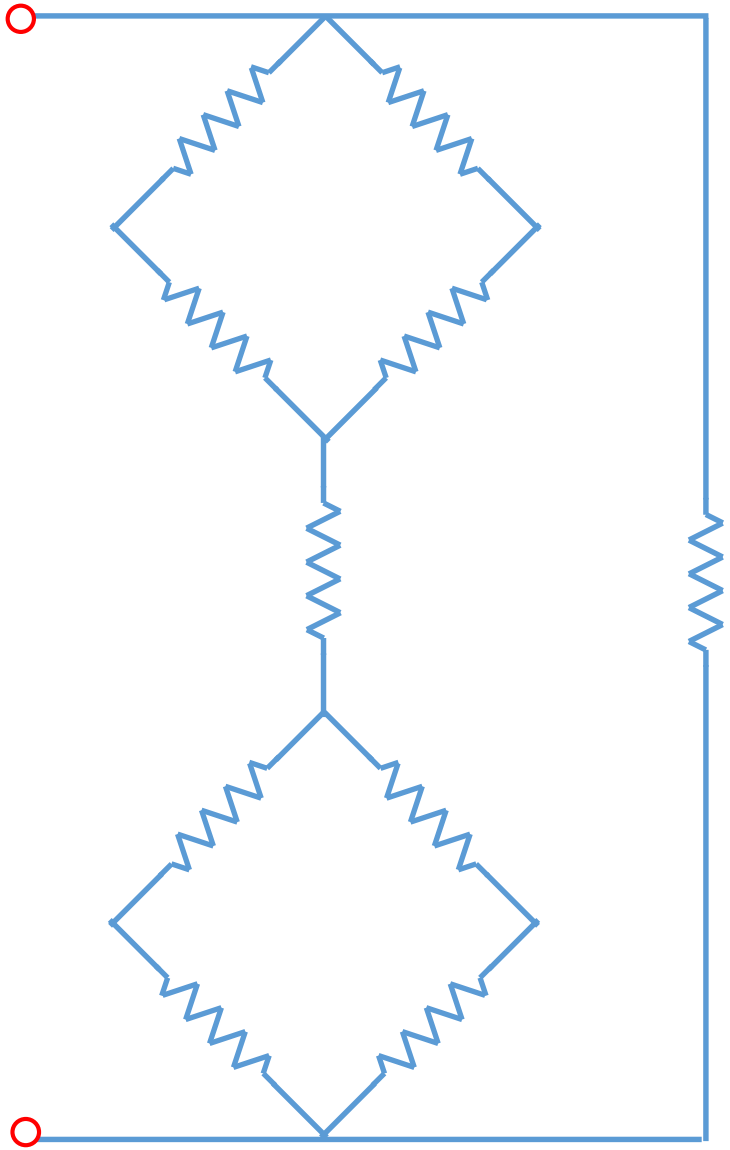
Problem 5: Find R_{eq} .
(15pts.)



Problem 5 Solution cont'd



Problem 6: All of the resistors below are R_0 Ω. Find R_{eq} .
(10pts.)



Problem 6 Solution

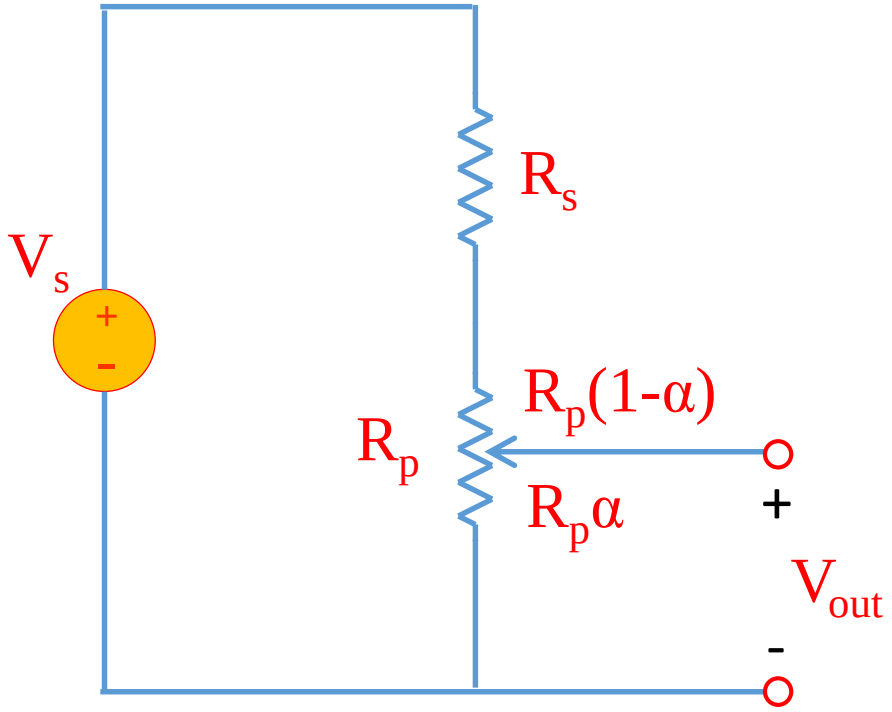
$$R_{eq} = \left\{\left[\left(R_0 + R_0\right) \| \left(R_0 + R_0\right)\right] + R_0 + \left[\left(R_0 + R_0\right) \| \left(R_0 + R_0\right)\right]\right\} \| R_0$$

$$R_{eq} = \left\{\left[\underbrace{\left(R_0 + R_0\right)}_{2R_0} \| \underbrace{\left(R_0 + R_0\right)}_{2R_0}\right] + R_0 + \left[\underbrace{\left(R_0 + R_0\right)}_{2R_0} \| \underbrace{\left(R_0 + R_0\right)}_{2R_0}\right]\right\} \| R_0$$

$$= \left\{\underbrace{\left[2R_0 \| 2R_0\right]}_{R_0} + R_0 + \underbrace{\left[2R_0 \| 2R_0\right]}_{R_0}\right\} \| R_0$$

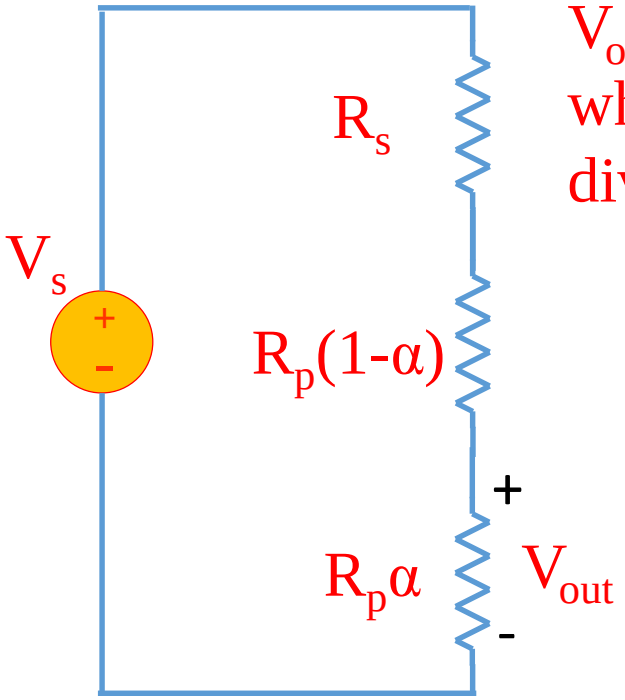
$$= \left\{R_0 + R_0 + R_0\right\} \| R_0 = 3R_0 \| R_0 = \left(\frac{1}{3R_0} + \frac{1}{R_0}\right)^{-1} = \frac{3R_0}{4}$$

Problem 7: (Potentiometer) In the circuit below, the wiper divides the potentiometer resistance R_p between two resistances $R_p(1-\alpha)$ and $R_p\alpha$ where $0<\alpha<1$. α is a parameter modeling the wiper's position. Find the output voltage V_{out} as a function of V_s, R_s, R_p and α. (15pts.)



Problem 7 Solution

The circuit is equivalent to



V_{out} is the voltage across $R_p\alpha$ which can be found by voltage division as

$$V_{out} = \frac{R_p\alpha}{R_s + R_p(1-\alpha) + R_p\alpha} V_s$$

$$= \frac{R_p\alpha}{R_s + R_p} V_s$$