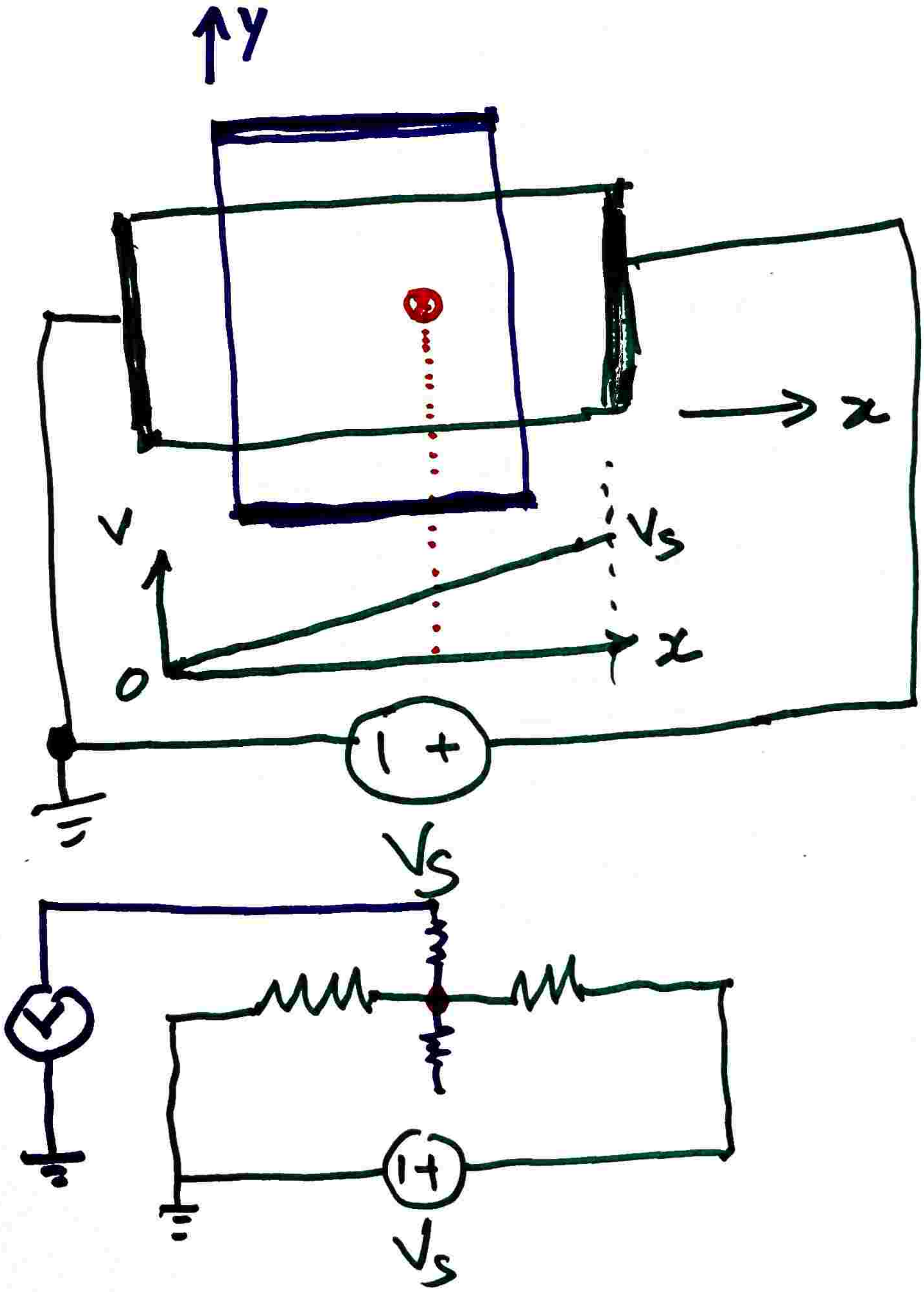
EECS 16A, Module 2, Lecture 4

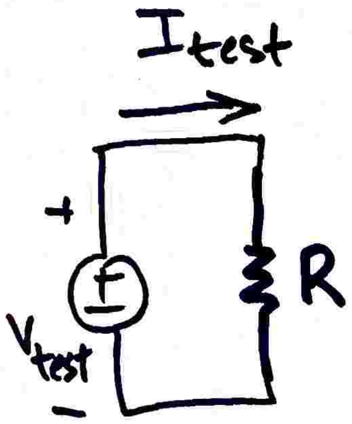
Topics

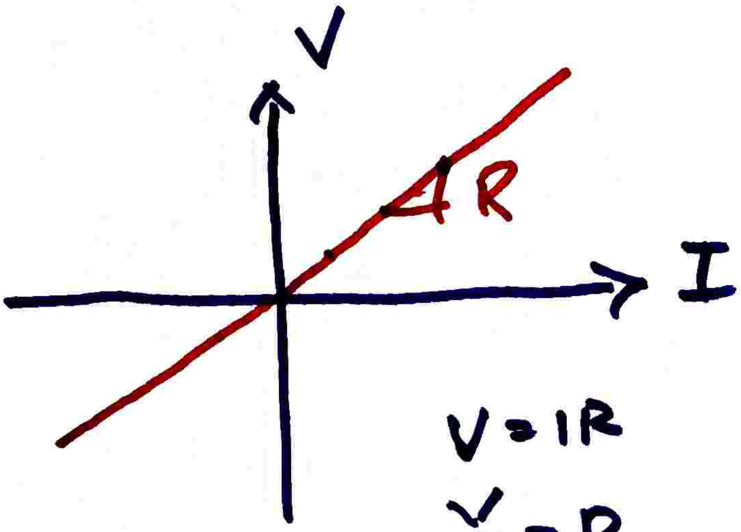
- Finish up 2D resistive touchscreen
- Equivalence
- Controlled Sources
- Superposition

2D Resistive Touchscreen



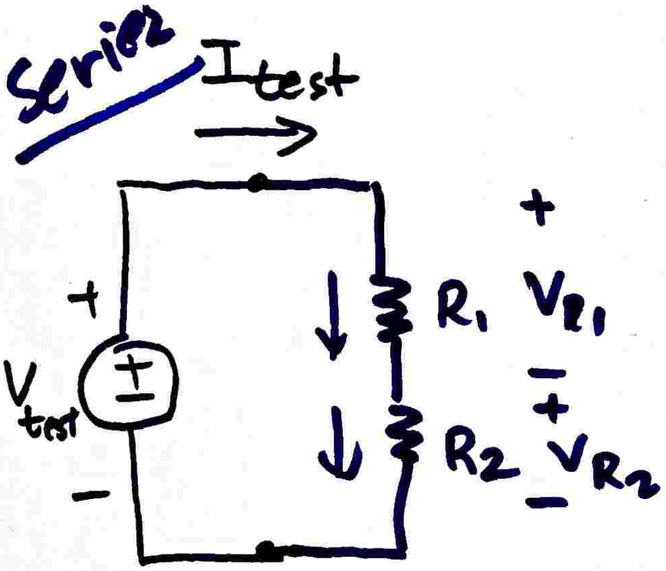
Equivalence



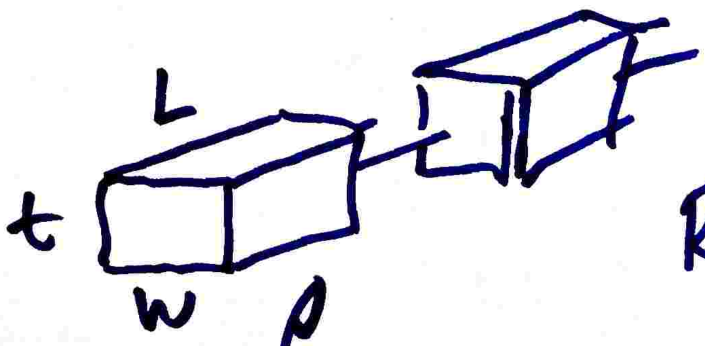


$$V = IR$$

$$\frac{V}{I} = R$$



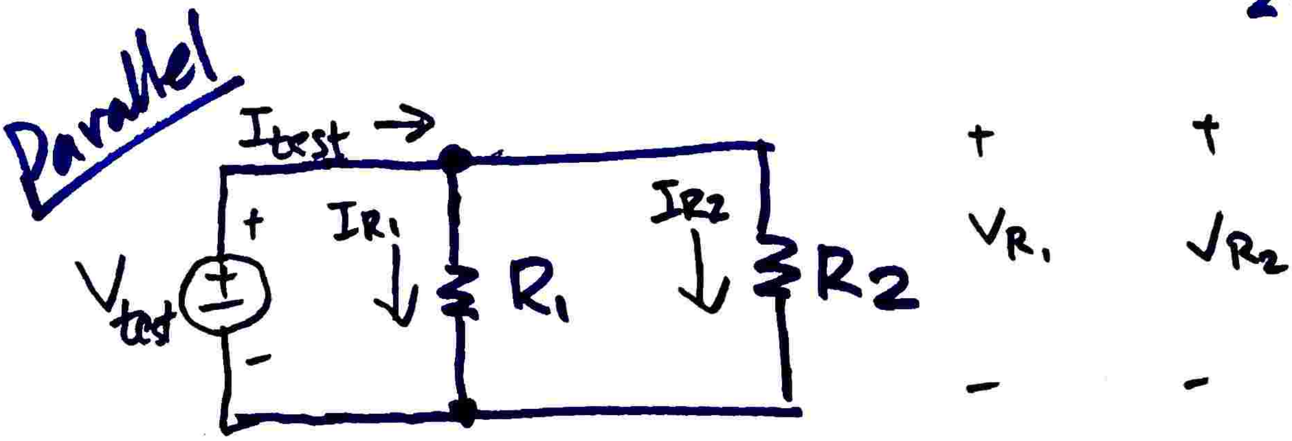
$$V_{test} = \underbrace{(R_1 + R_2)}_{R_{eq}} I_{test}$$



$$R = \rho \frac{L}{w \cdot t}$$

Equivalence: Displays same I·V characteristics

Parallel



$$I_{test} = I_{R_1} + I_{R_2}$$

$$I_{test} = \frac{V_{test}}{R_1} + \frac{V_{test}}{R_2}$$

$$I_{test} = V_{test}\left(\frac{1}{R_1} + \frac{1}{R_2}\right)$$

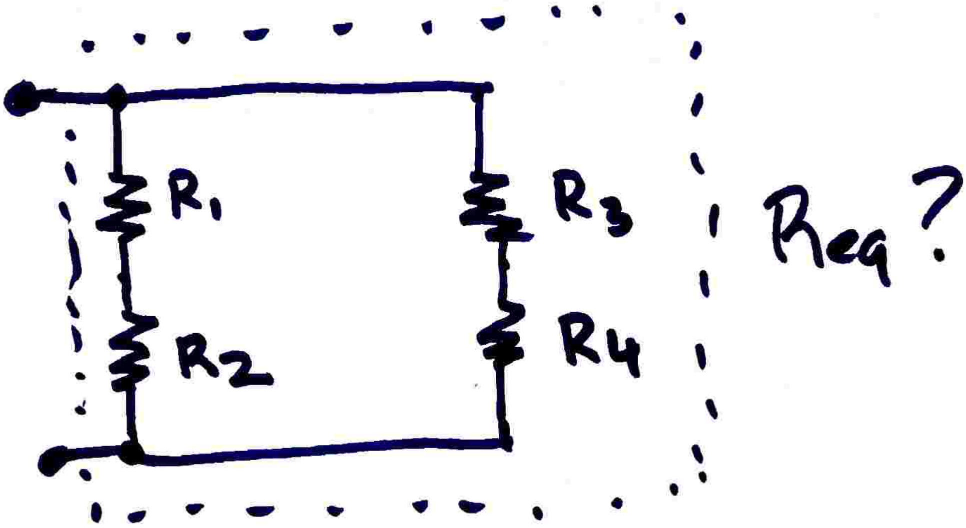
$$\frac{I_{test}}{V_{test}} = \frac{1}{R_1} + \frac{1}{R_2} = \frac{1}{R_{eq}}$$

$$\frac{V_{test}}{I_{test}} = \frac{R_1 \cdot R_2}{R_1 + R_2}$$

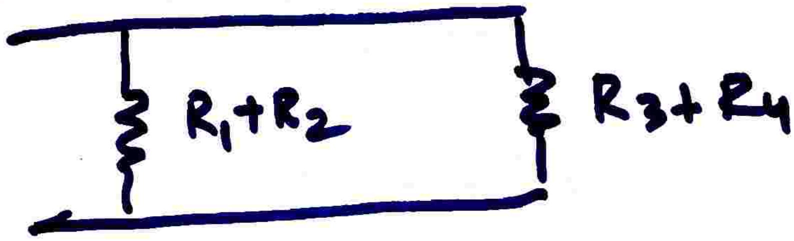
$$\boxed{R_{eq} = \frac{R_1 \cdot R_2}{R_1 + R_2}}$$

$$R_1 \| R_2 \equiv \frac{R_1 \cdot R_2}{R_1 + R_2}$$

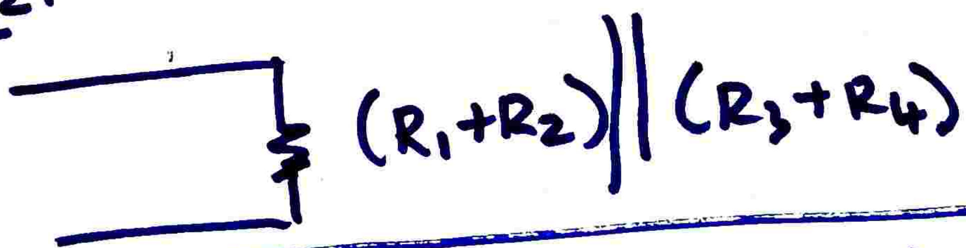
2.4.5



Step 1:

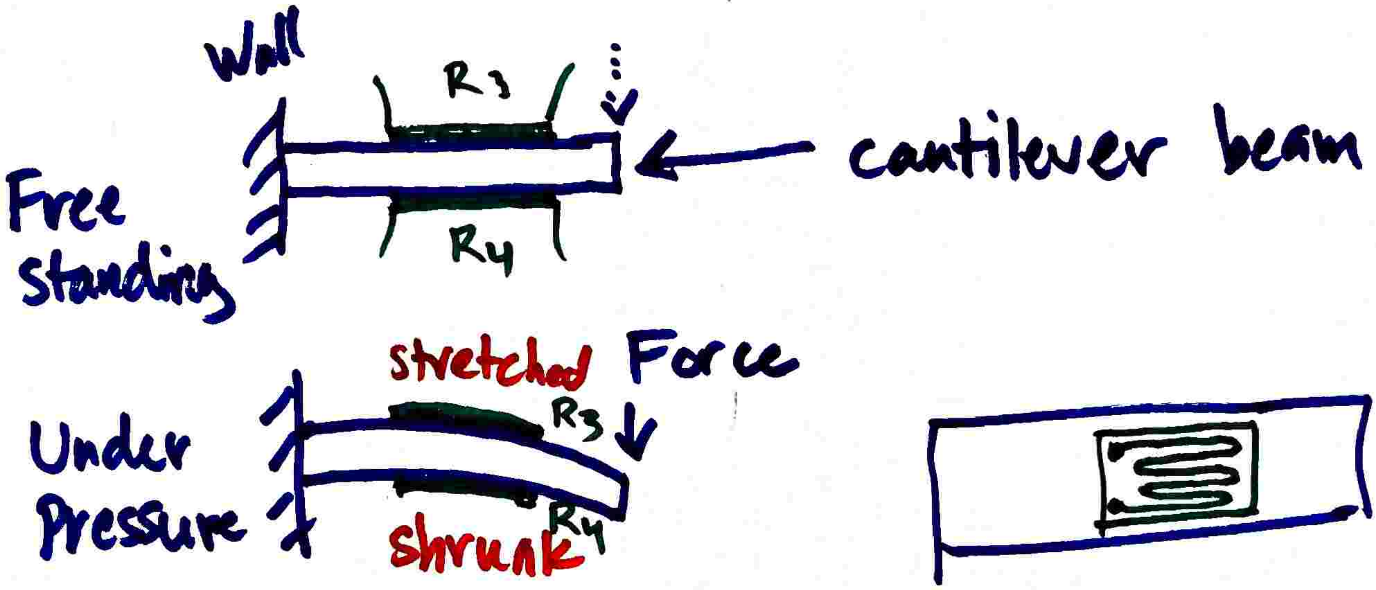


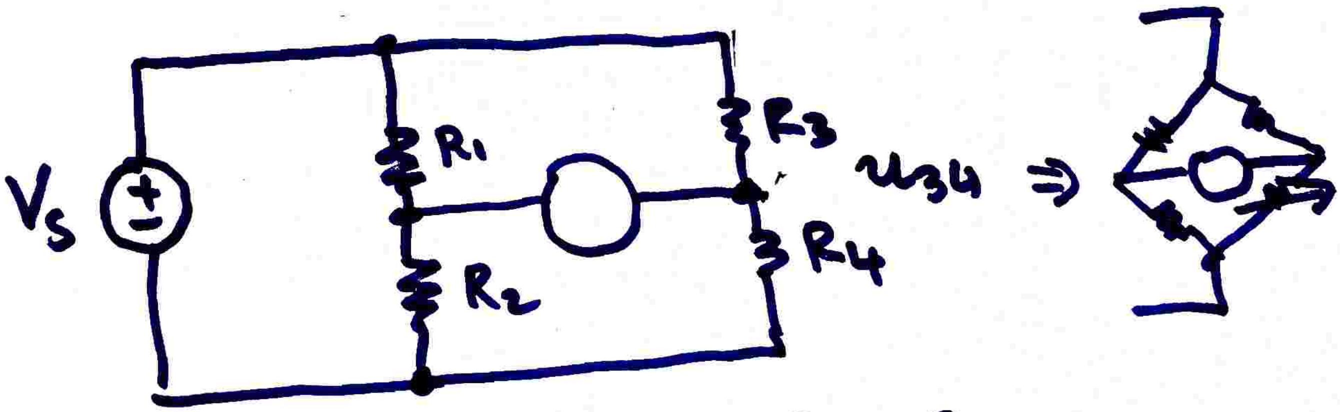
Step 2:



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

Wheatstone Bridge



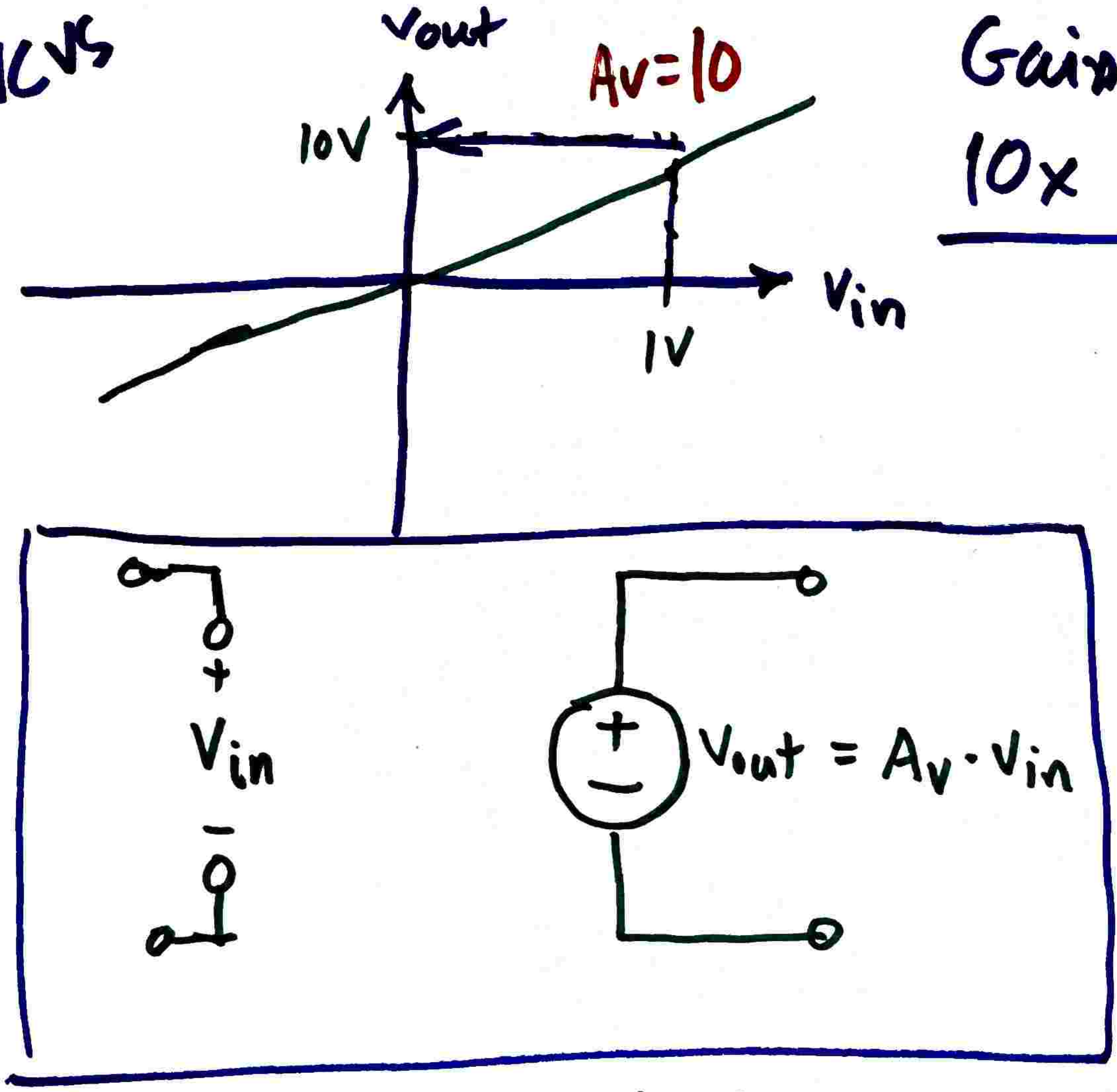


$R_1 = R_2$ $\quad$ $R_3 = R_4$

$$u_{34} = V_s \frac{R4}{R_3 + R4}$$

Controlled Sources

VCVS



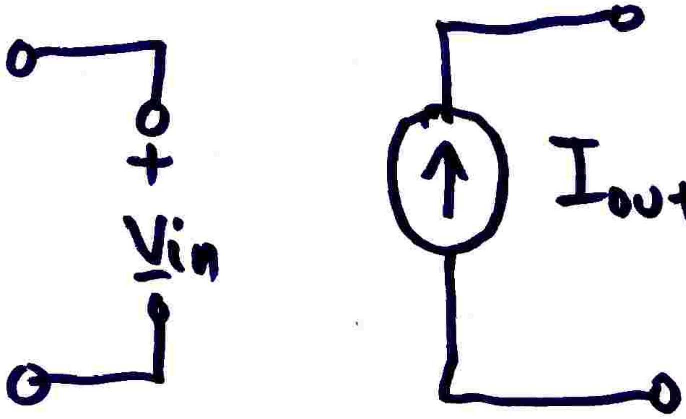
Gain: 10x

Voltage Controlled Voltage Source

VCVS

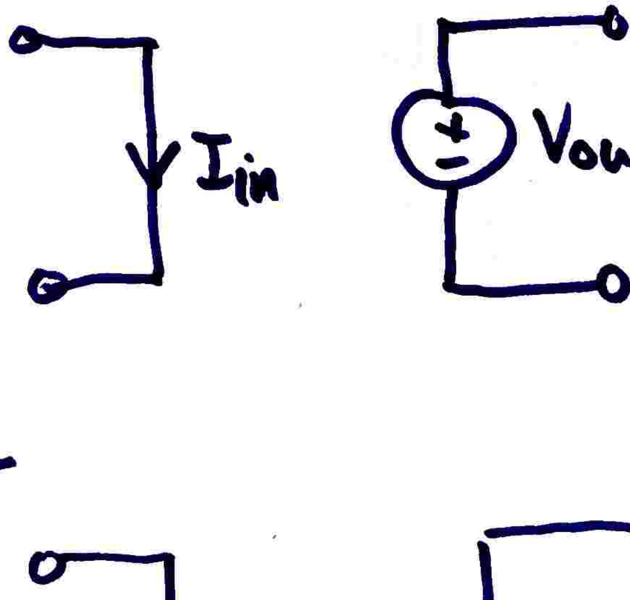
_C_S

VCCS



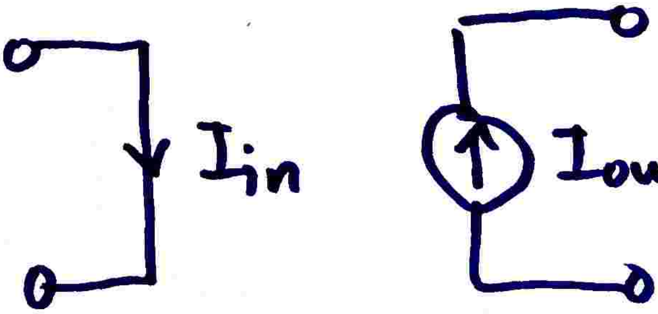
$$I_{out} = V_{in} \cdot \frac{1}{R_G}$$

CCVS



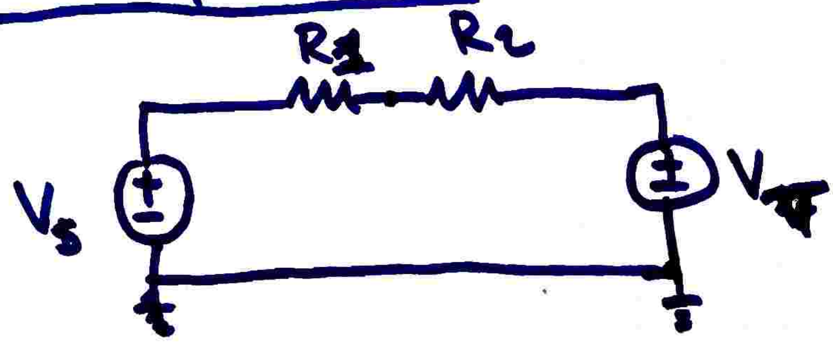
$$V_{out} = R_G \cdot I_{in}$$

CCCS



$$I_{out} = G_I \cdot I_{in}$$

Superposition



$$A\vec{x} = \vec{b}$$

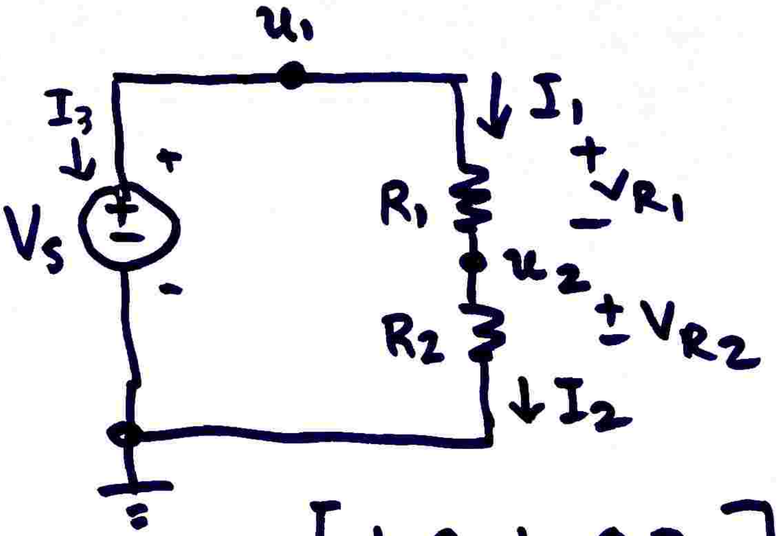
$$A^{-1}A\vec{x} = A^{-1}\vec{b}$$

$$\vec{x} = A^{-1}\vec{b}$$

Given a circuit w/ multiple sources

1) Zero all the sources except one, and then solve
2) Repeat for each source
3) Sum the results

2.4.9.a



KCL:

$$I_1 + I_3 = 0$$

$$-I_1 + I_2 = 0$$

KVL + sub:

$$R_1 I_1 - u_1 + u_2 = 0$$

$$R_2 I_2 - u_2 = 0$$

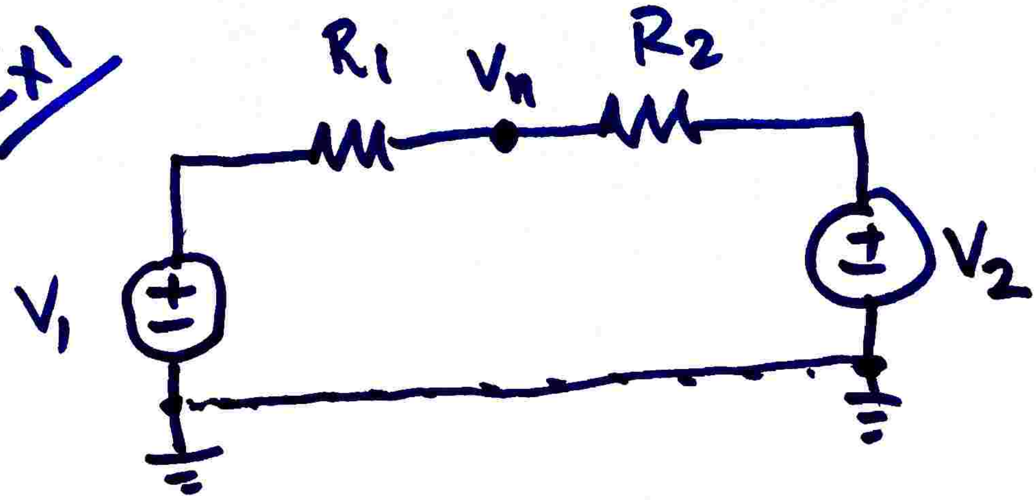
$$u_1 = V_s$$

$$\underbrace{\begin{bmatrix} 1 & 0 & 1 & 0 & 0 \\ -1 & 1 & 0 & 0 & 0 \\ R_1 & 0 & 0 & -1 & 1 \\ 0 & R_2 & 0 & 0 & -1 \\ 0 & 0 & 0 & 1 & 0 \end{bmatrix}}_{A} \begin{bmatrix} I_1 \\ I_2 \\ I_3 \\ u_1 \\ u_2 \end{bmatrix} = \begin{bmatrix} 0 \\ 0 \\ 0 \\ 0 \\ V_s \end{bmatrix}$$

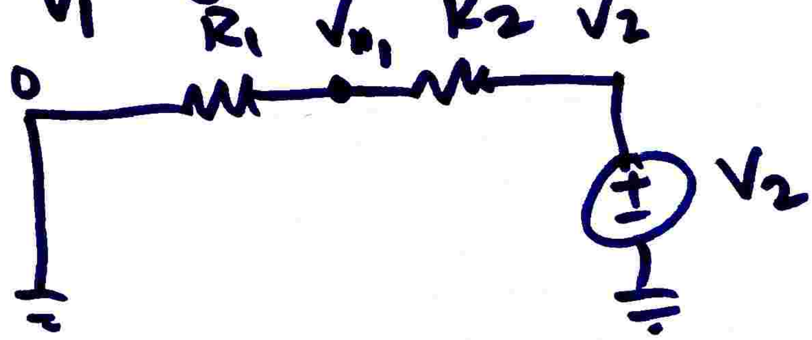
$$A \vec{x} = \vec{b}$$

2.4.10

Ex1

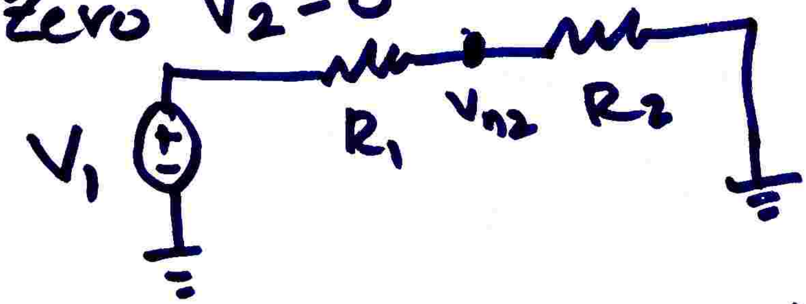


1) Zero $V_1 = 0$



$$V_{n_1} = V_2 \cdot \left(\frac{R_1}{R_1 + R_2}\right)$$

2) Zero $V_2 = 0$



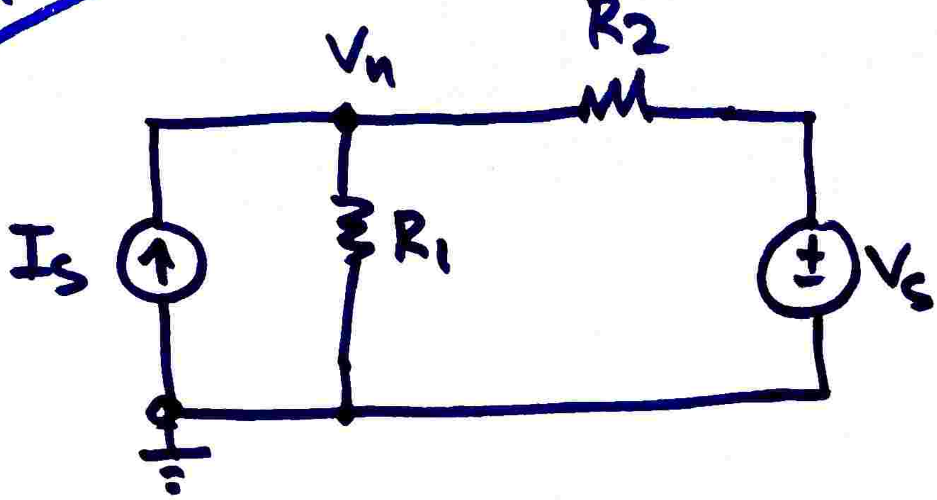
$$V_{n_2} = V_1 \cdot \left(\frac{R_2}{R_1 + R_2}\right)$$

3) $V_n = V_{n_1} + V_{n_2} = V_2\left(\frac{R_1}{R_1+R_2}\right) + V_1\left(\frac{R_2}{R_1+R_2}\right)$

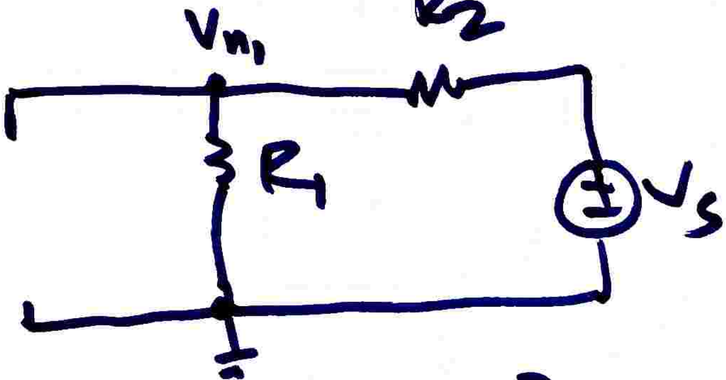
$$V_n = \frac{V_1 R_2 + V_2 R_1}{R_1 + R_2}$$

Ex 2

2.4.11

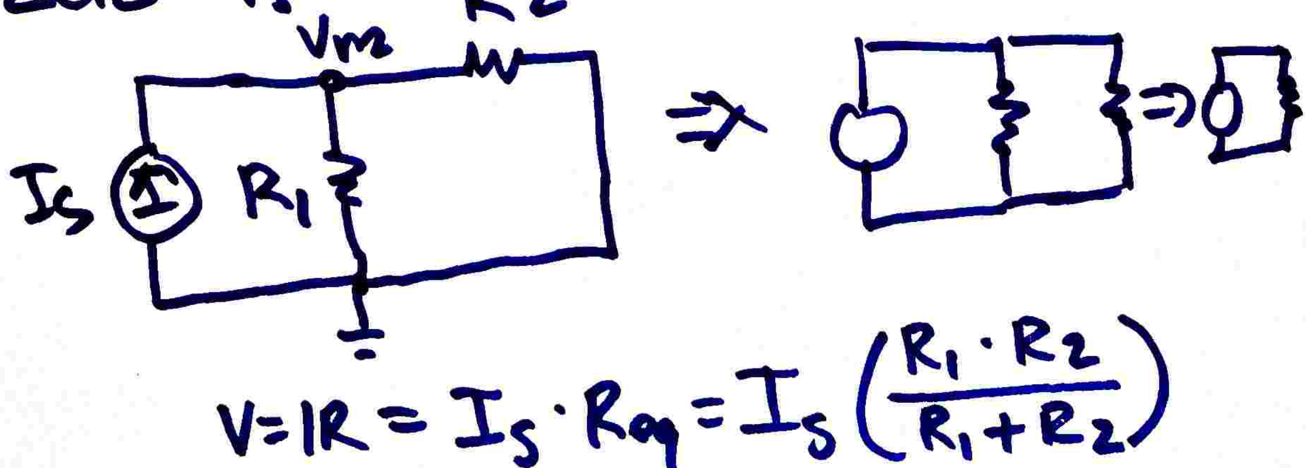


1) Zero I_s



$$V_{n1} = V_s\left(\frac{R_1}{R_1+R_2}\right)$$

2) Zero V_s



$$V = IR = I_s \cdot R_{eq} = I_s\left(\frac{R_1 \cdot R_2}{R_1+R_2}\right)$$

2.4.12

3)

$$V = V_{n_1} + V_{n_2}$$

$$V = V_S\left(\frac{R_1}{R_1+R_2}\right) + I_S\left(\frac{R_1 \cdot R_2}{R_1+R_2}\right)$$

$$V = \left(\frac{R_1}{R_1+R_2}\right)\left(V_S + I_S \cdot R_2\right)$$