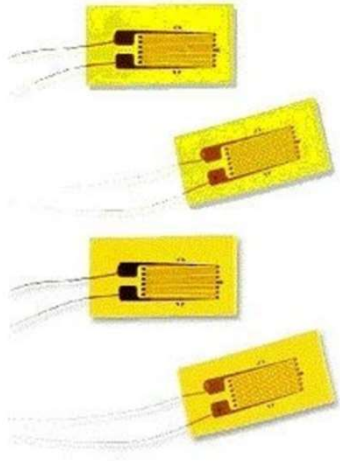


ESC 201AT: Introduction to Electronics

Lecture 4: Dependent Sources

B. Mazhari
professor, Dept. of EE
IIT Kanpur

Strain Gauge

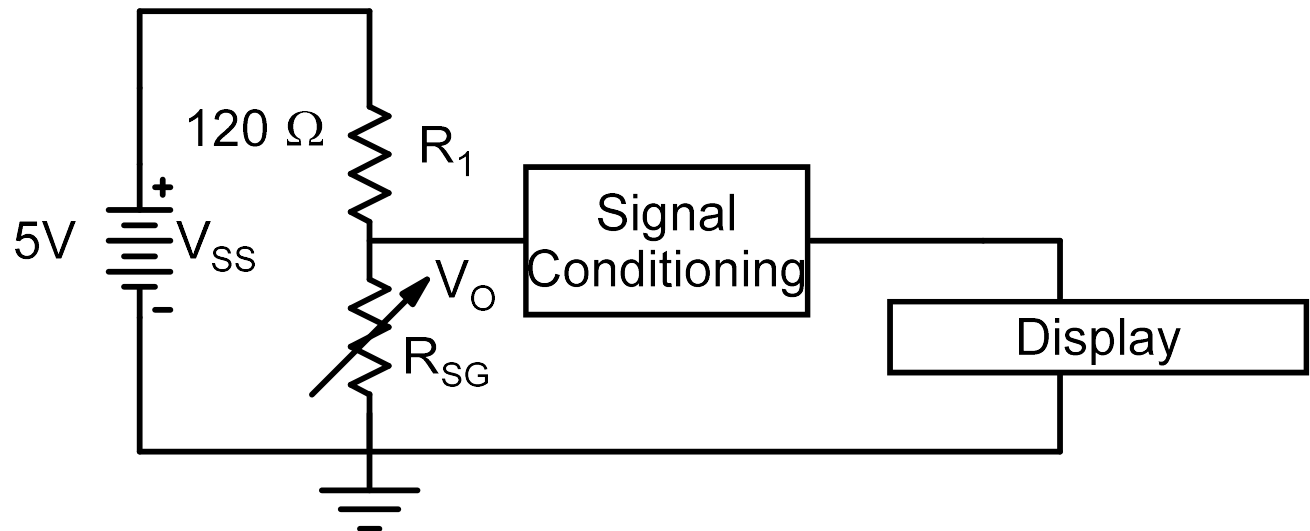


NIE Strain Gauge,
 $120 \pm 0.3 \Omega$, 10.0
mm, G.F. $-2.11 \pm 1\%$

$$\frac{\Delta R_{SG}}{R_{SG}} = \frac{1}{50} \cdot E (\%)$$



$$V_0 = \frac{R_{SG}}{R_1 + R_{SG}} \times V_{SS}$$



$$\frac{\Delta R_{SG}}{R_{SG}} = 0.02 \cdot E (\%)$$

$$V_0 = \frac{R_{SG}}{R_1 + R_{SG}} \times V_{SS}$$

$$V_0 = \frac{R_{SG0} + \Delta R_{SG}}{R_1 + R_{SG0} + \Delta R_{SG}} \times V_{SS}$$

$$V_0 = \frac{R_{SG0}}{R_1 + R_{SG0}} \times \frac{1 + \Delta R_{SG}/R_{SG0}}{1 + \Delta R_{SG}/(R_1 + R_{SG0})} \times V_{SS}$$

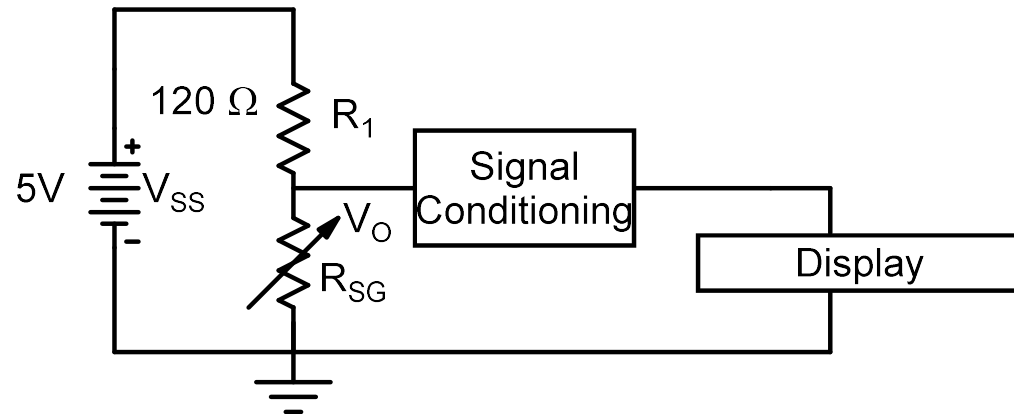
$$V_0 = 0.5 \times V_{SS} \times \frac{1 + 0.02 \times E}{1 + 0.01 \times E}$$

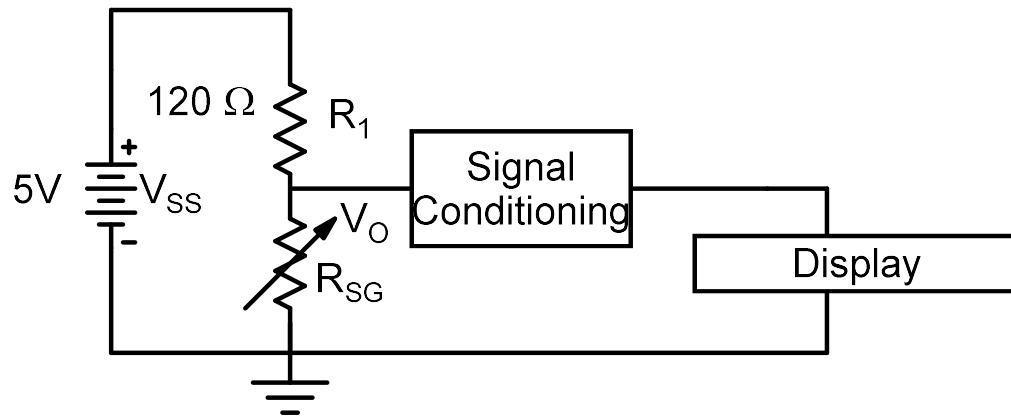
$$V_0 \cong 0.5 \times V_{SS} \times (1 + 0.02 \times E) \times (1 - 0.01 \times E)$$

$$V_0 \cong 0.5 \times V_{SS} \times (1 + 0.02 \times E - 0.01 \times E - 0.0002 \times E^2)$$

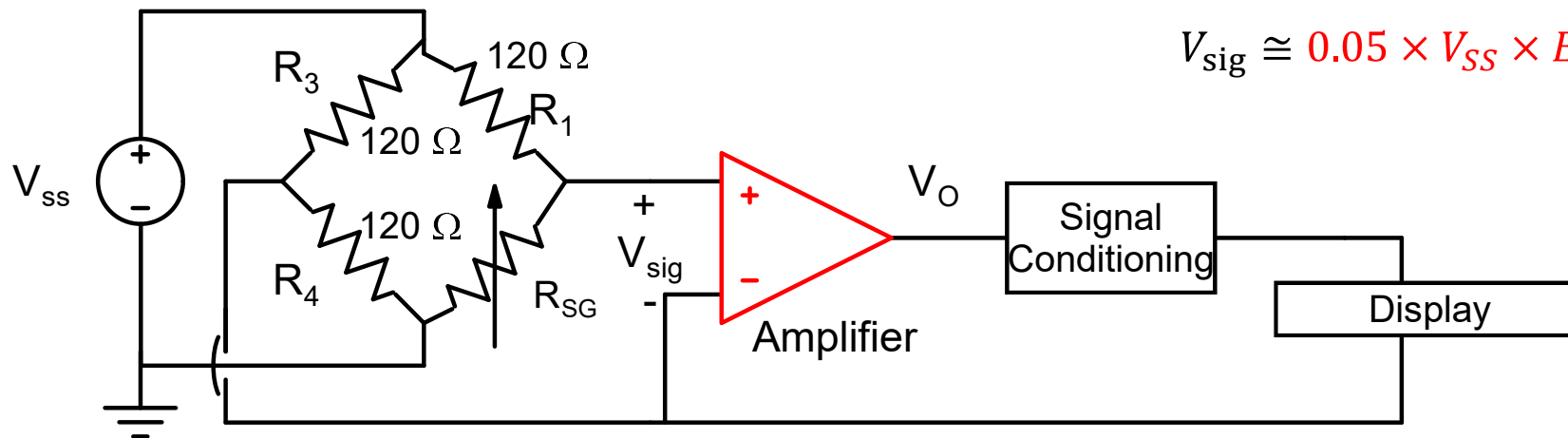
$$V_0 \cong 0.5 \times V_{SS} \times (1 + 0.01 \times E)$$

$$V_0 \cong 0.5 \times V_{SS} + 0.05 \times V_{SS} \times E$$





$$V_0 \cong 0.5 \times V_{SS} + 0.05 \times V_{SS} \times E$$



$$V_{sig} \cong 0.05 \times V_{SS} \times E$$

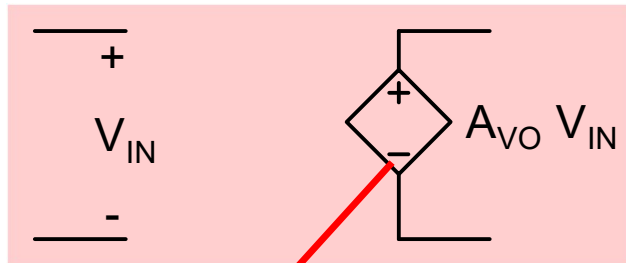
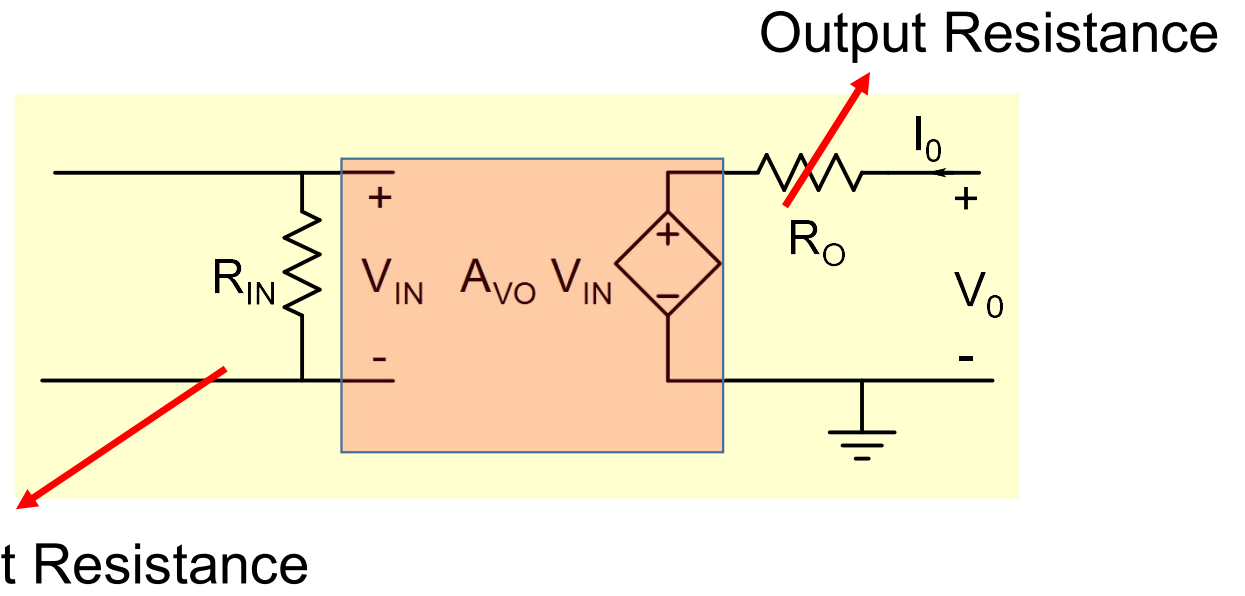
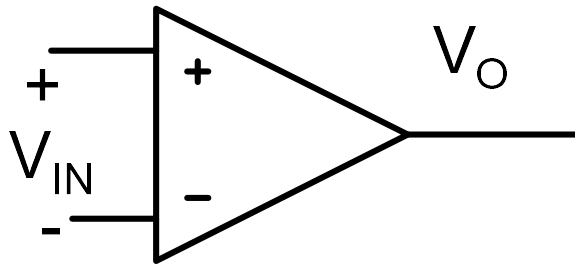
Need a model for the amplifier

Circuit Analysis

Apply KVL and KCL

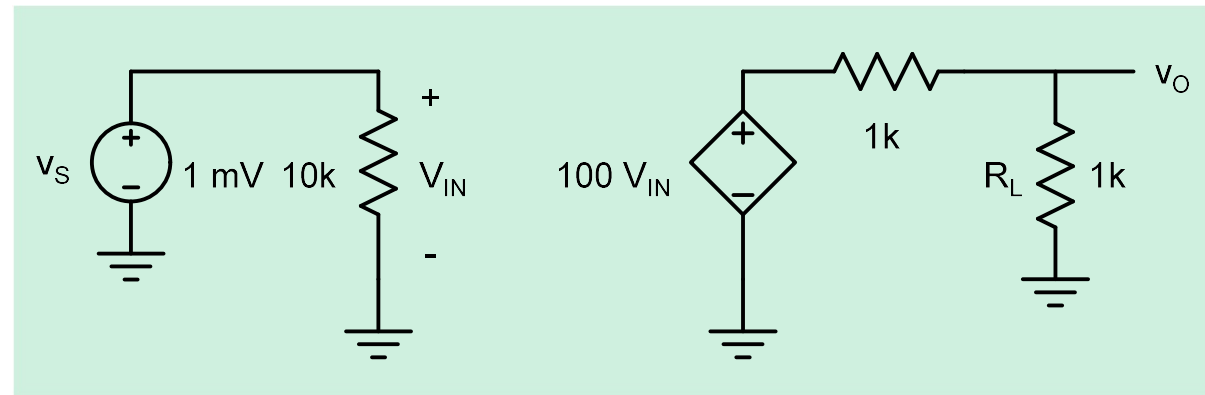
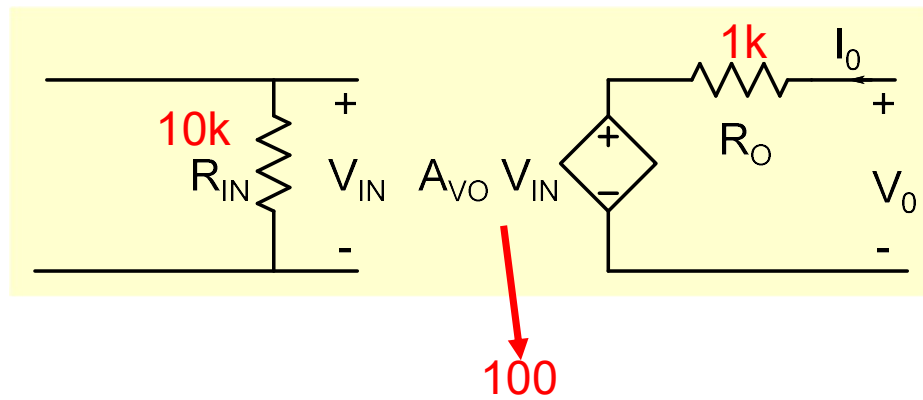
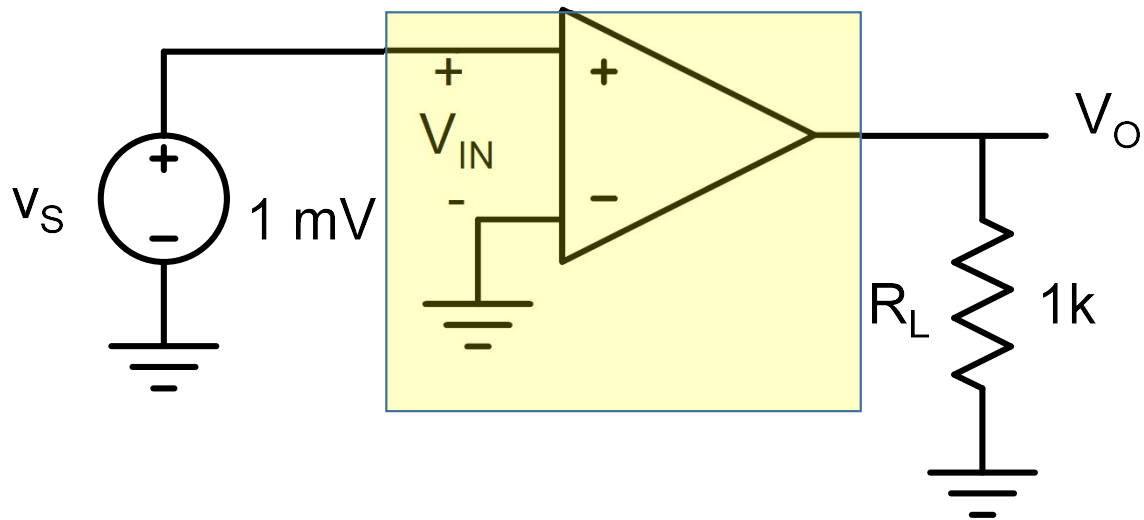
Use mathematical model of circuit elements

Solve the resulting system of Equations

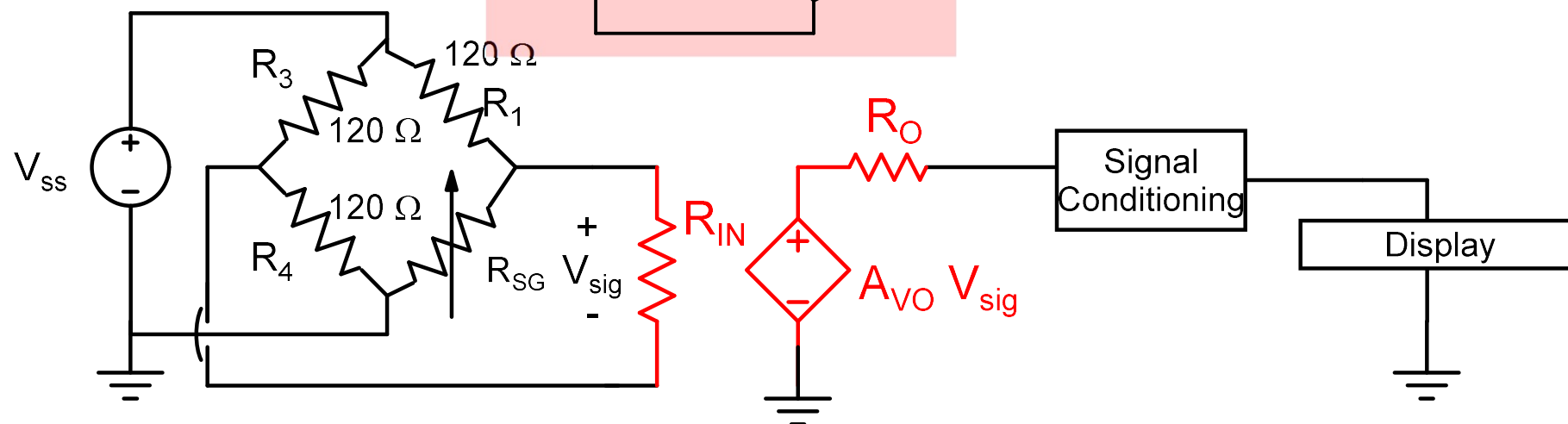
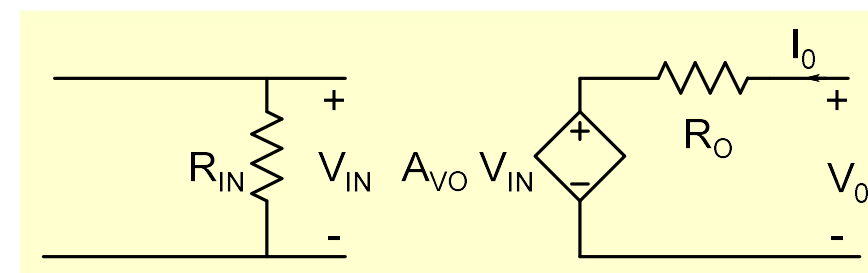
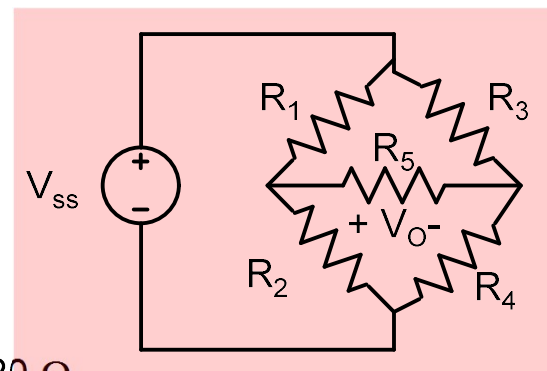
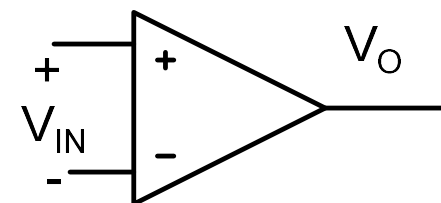
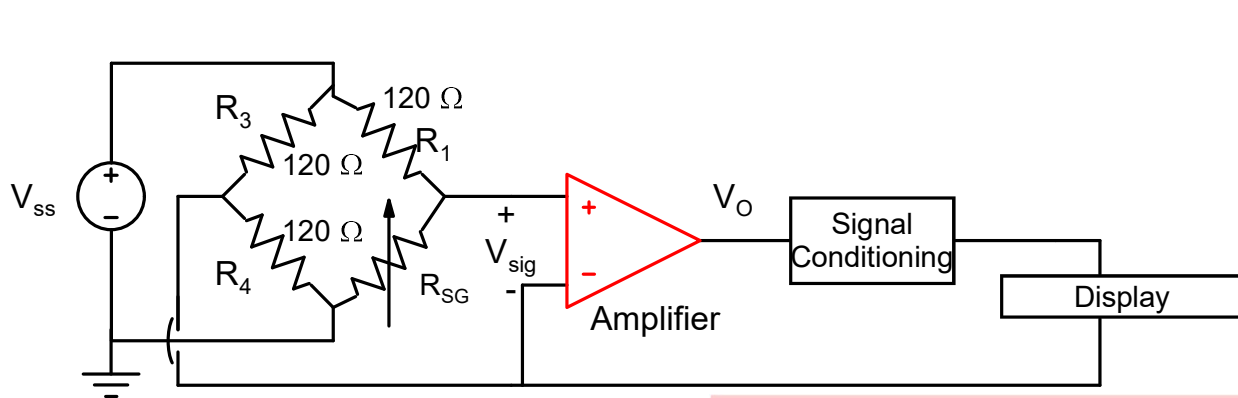


Voltage Controlled Voltage Source (VCVS)

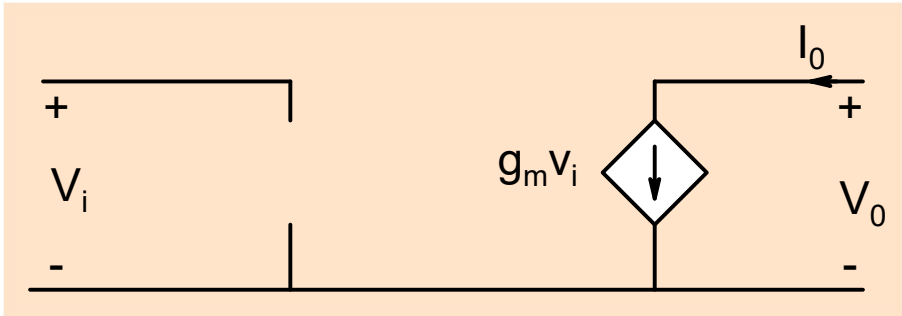
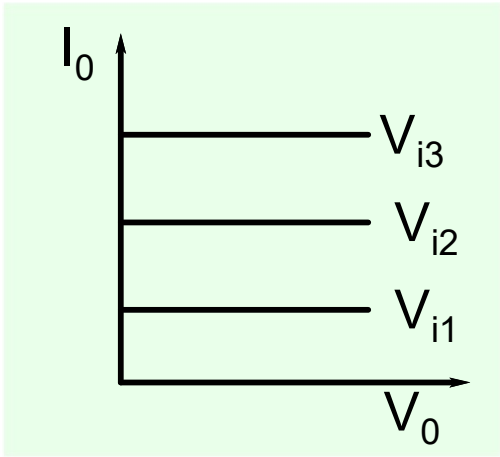
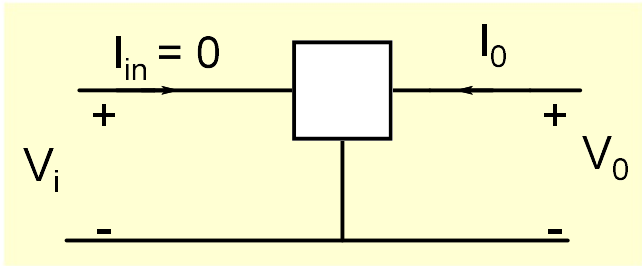
Dependent Voltage Source



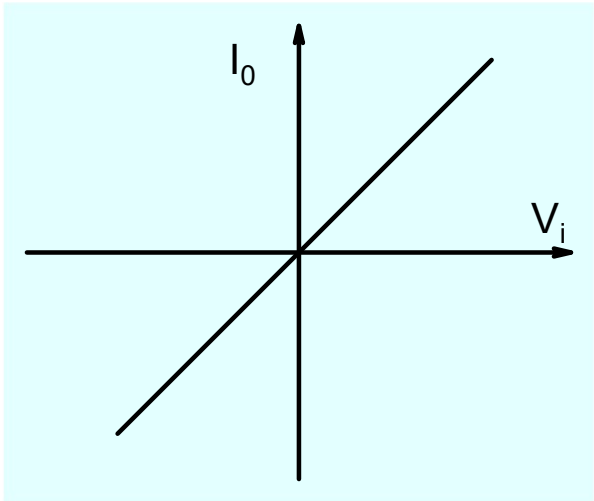
$$v_{IN} = v_S ; v_O = 100v_{IN} \times \frac{1\text{k}}{1\text{k} + 1\text{k}} \Rightarrow \frac{v_O}{v_S} \approx 50$$



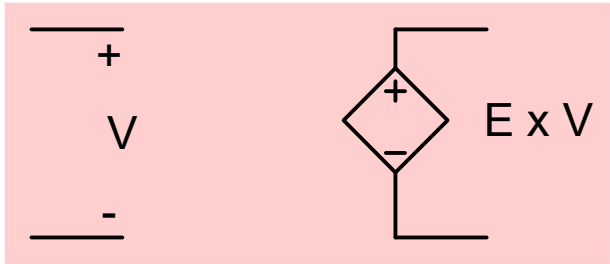
Ideal Transistor Characteristics



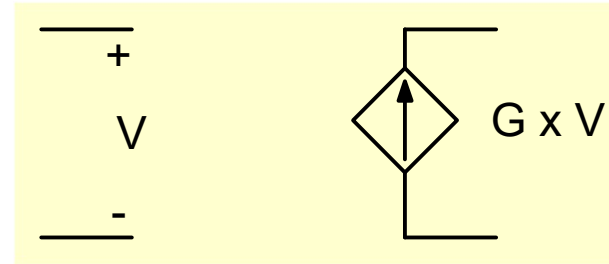
Voltage Controlled Current Source (VCCS)



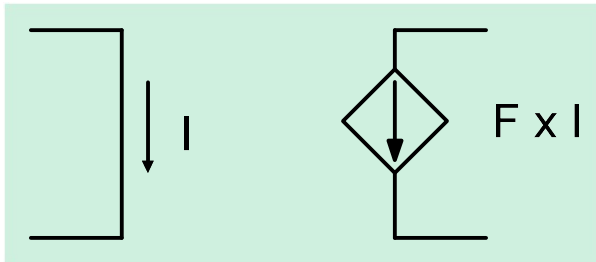
Ideal MOS Transistor Characteristics



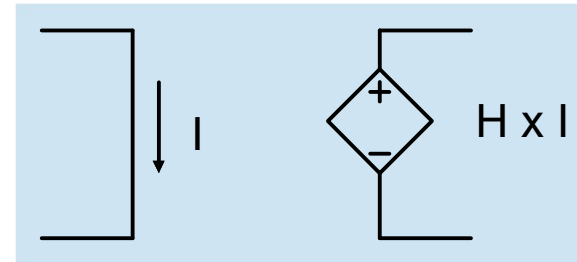
VCVS



VCCS

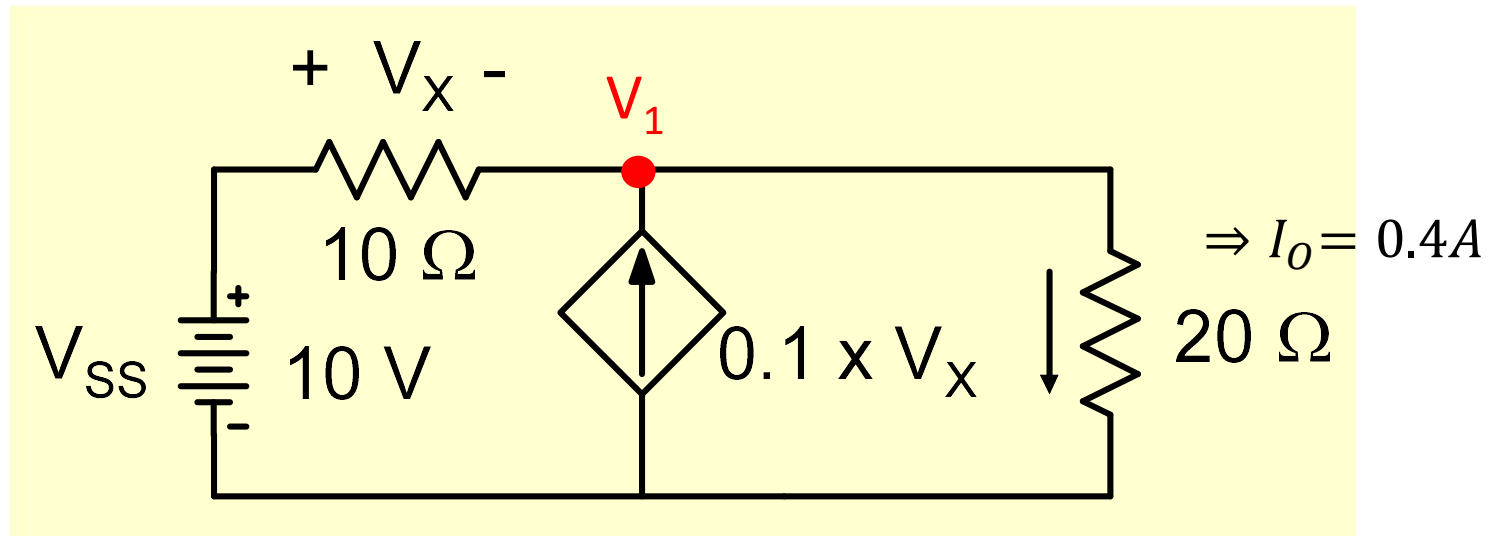


CCCS



CCVS

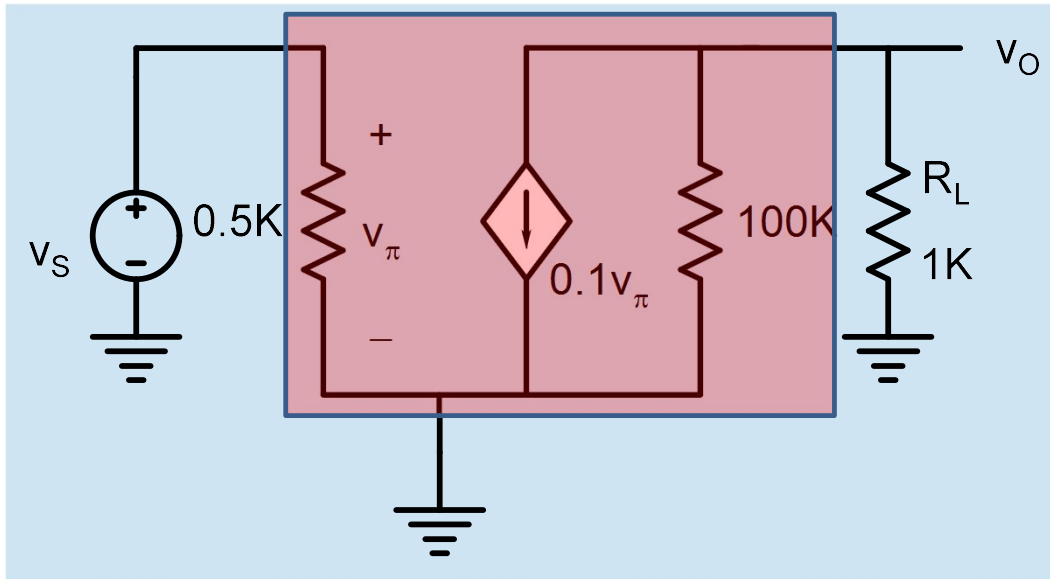
Determine the current through the 2 k resistor in the circuit shown below



$$\frac{V_{SS} - V_1}{10} + 0.1V_X - \frac{V_1}{20} = 0 \quad V_X = V_{SS} - V_1 \quad \Rightarrow V_1 = 8V$$

Note that current goes to zero if independent supply voltage is reduced to zero. If there is no independent voltage or current source in the circuit, then all voltages and currents will be zero

Equivalent Circuit of a BJT Amplifier



Determine voltage gain v_O/v_S

$$v_\pi = v_S$$

$$v_O = -0.1v_\pi \times 100k \parallel 1K$$

$$\frac{v_O}{v_S} \approx -100$$