

**Method of Node Voltages**

1. Identify the nodes and select a reference node
2. Define the node voltages
3. Write the KCL equations \*
4. Solve the equations
- \* (to handle dependent sources, write the controlling signal in terms of the node voltages)

**Method of Mesh Currents**

1. Identify the meshes
2. Define the mesh currents
3. Write the KVL equations \*
4. Solve the equations
- \* (to handle dependent sources, write the controlling signal in terms of the mesh currents)

**Superposition** (to determine the value of a voltage or current) Turn on **one** independent source at a time and solve for the value of the signal. Add the results from each source to obtain the answer. Keep dependent sources on all times.

To turn off voltage sources, replace it with a short To turn off current sources, replace with an open circuit.

**Equivalent Circuits**

Thevenin equivalent:  $V_{TH}$  in series with  $R_{TH}$

$V_{TH} = V_{oc}$  is the open circuit voltage

Norton equivalent:  $I_N$  in parallel with  $R_N$

$I_N = I_{sc}$  is the short circuit current

Relationships:  $R_{TH} = R_N =$  (equivalent resistance)

$V_{TH} = R_{TH} I_{sc}$

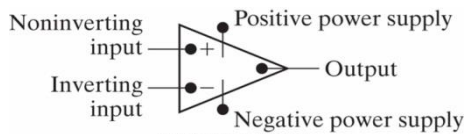
Source transformation: Replace a Thevenin equivalent with a Norton equivalent; or vice versa.

**Maximum Power Transfer:**

A load resistor  $R_L$  draws maximum power from a circuit when  $R_L = R_{TH}$ , where  $R_{TH}$  is the Thevenin equivalent resistance of the circuit to which the load is attached.

$$P_{max} = \frac{V_{TH}^2}{4R_{TH}}$$

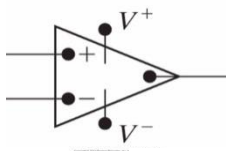
**Ideal Op Amps**



$$V^- \leq v_o \leq V^+$$

$$i_p = i_n = 0$$

$$v_p = v_n$$



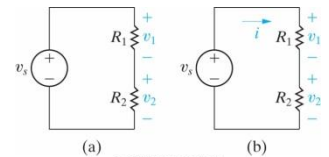
Voltage Division  $v_j = iR_j = \left(\frac{R_j}{R_{eq}}\right)v$

Current Division  $i_j = \frac{v}{R_j} = \left(\frac{R_{eq}}{R_j}\right)i$

**Voltage Divider**

$$v_1 = iR_1 = \left(\frac{R_1}{R_1 + R_2}\right)v_s$$

$$v_2 = iR_2 = \left(\frac{R_2}{R_1 + R_2}\right)v_s$$



**Current Divider**

$$i_1 = \left(\frac{R_2}{R_1 + R_2}\right)i_s$$

$$i_2 = \left(\frac{R_1}{R_1 + R_2}\right)i_s$$

