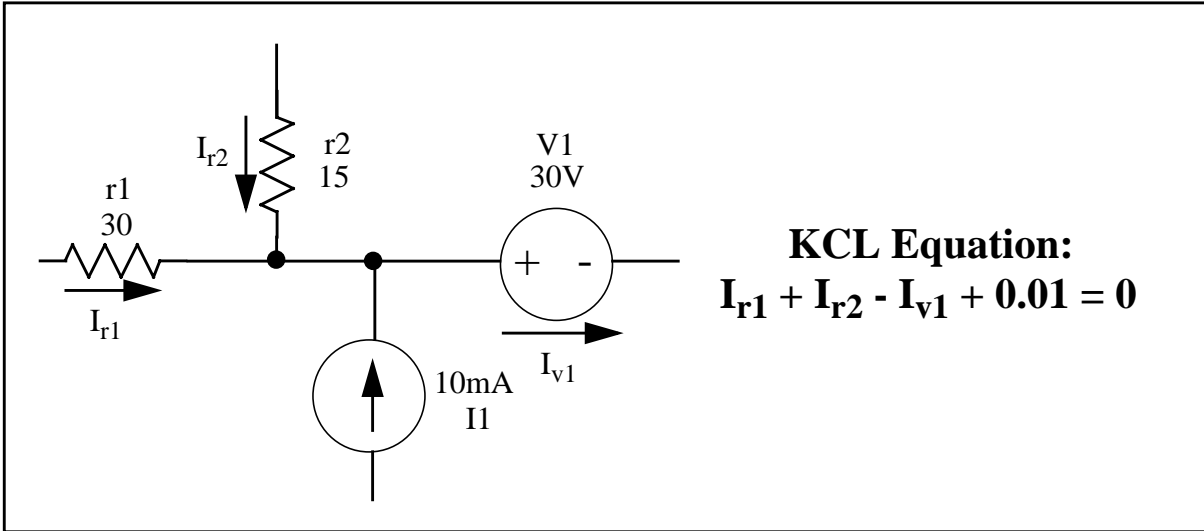# Kirchoff's Current Law

Kirchoff's Current Law states that the sum of the currents entering a node is equal to the sum of the currents leaving a node. i.e.;

$$\sum I_{entering} \quad - \quad \sum I_{leaving} \quad = 0$$

For example:

KCL Equation:

$$I_{r1} + I_{r2} - I_{v1} + 0.01 = 0$$

Why use Kirchoff's Current Law? (also known as nodal analysis) Suppose we have the circuit below. How many loops are there? Which loops do you use to solve for currents or voltages?

**How many loops?
What loops to use?**

**This circuit topology is
a nonplanar graph**
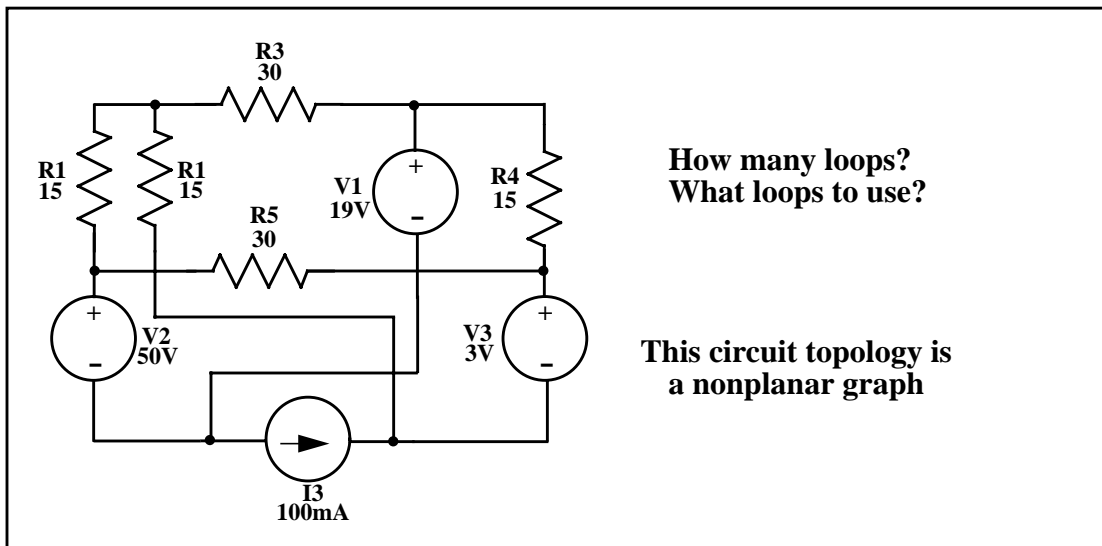
To allow us to easily solve for the voltages and currents, we want the set of independent simultaneous equations with the least number of variables.

A set of equations are linearly <u>dependent</u> when at least one of the equations can be expressed as a linear combination of the others. Example:

$$3I_1 + 2I_2 - I_3 = 4 \qquad \text{eqn. 1}$$
$$-I_1 + 5I_2 + 3I_3 = -2 \qquad \text{eqn. 2}$$
$$I_1 + 12I_2 + 5I_3 = 0 \qquad \text{eqn. 3}$$

Equation 3 may be obtained by multiplying equation 2 by 2 and adding equation 1 to it. Thus no unique solution for I_1, I_2 or I_3 may be found.

The node method usually gives us a smaller set of variables (nodes) by which we can find a set of independent equations quickly. Spice (a circuit simulator) uses this method to solve circuits.