**KVL – Kirchoff’s Voltage Law**

****

The sum of the voltages around any closed loop is zero (signs determined by polarity).



V1 + V2 - V3 = 0

**KCL – Kirchoff’s Current Law**

****

The sum of the currents leaving a node is zero (signs determined by polarity).



I1 - I2 + I3 = 0

**Node** – a connection between two or more components

**Loop** – a closed path through which current can flow

**Power**

 **P = V I**

P – Power, Watts [W]



Using the above polarities (which may ot be correct)

For P > 0, the component consumes power

For P < 0, the component produces power

**Ohm’s Law** – Linear relationship between voltage and current in a resistor

 **V = I R**

V – Voltage, Volts [V]

I – Current, Amps [A]

R – Resistance, Ohms [Ω]

**Resistors in series –** 



**Resistors in parallel -** 



Voltage divider (two resistors in series)

VR1= Vsource x [R1/(R1+R2)]

**Current divider (two resistors in parallel)**

IR1 = Isource x [R2/ (R1+R2)]

Source transformation

**Summing amplifier circuit**





**Non-inverting amplifier circuit**





**Inverting amplifier circuit**





**Comparator**



If V1 < V2 , Vout = V+saturation

If V1 > V2 , Vout = V-saturation

Superposition – For each **independent** source, turn off all other **independent** sources ***(to turn off: Voltage source becomes a short circuit and Current source becomes an open circuit)*** and find the contribution from that source. Sum the contribution from each source to get the parameter of interest.

Mesh Analysis

# of KVL Equations =Total # mesh loops – current sources

Node Analysis

# of KCL Equations =Total # of nodes –voltage sources -1



Example includes a Current Controlled Voltage Source (CCVS) as a dependent source and I1 as an independent source.

















Thevenin voltage (**VTH**) – **Open** circuit the load, find the voltage across the load nodes

Norton current (**IN**)– **Short** circuit the load, find the current through that short circuit

Thevenin resistance (**RTH**) – Turn off all **independent** sources, replace the load with a test voltage (Vtest), find the current (Itest) through the test voltage, RTH = Vtest/Itest.

**VTH = IN RTH** (Ohm’s Law relationship)

**Summing amplifier circuit**





**Non-inverting amplifier circuit**





**Inverting amplifier circuit**





**Comparator**



If V1 < V2 , Vout = V+saturation

If V1 > V2 , Vout = V-saturation

Ideal op amp equations

IN = IP = 0 no current draw Rin = ∞

VP = VN (A -> ∞)

Rout = 0