# Mesh Analysis

concept; examples

## **General Methods to Analyze Circuits**

- What to do first?
  - KVL?
  - KCL?
  - Ohm's Law?



- We need a more direct approach:
  - Nodal analysis (KCL based)
  - Mesh analysis (KVL based, NOW)

# **Mesh Analysis**

• Mesh refers to the simple loops visible in a circuit



• Method – define the "mesh" currents  $v_1 \stackrel{t}{\leftarrow} \stackrel{R_1}{\leftarrow} \stackrel{R_2}{\leftarrow} \stackrel{R_2}{\leftarrow} \stackrel{t}{\leftarrow} v_2$  • Write KVL on these meshes

$$v_1 + v_3 = V_1$$
  
 $v_3 = v_2 + V_2$ 



 Use Ohm's Law for voltages on resistive branches

$$v = R i$$

- Careful on current directions
- Result is a set of simultaneous equations to solve

Example (details on next slide)





$$60 - 12i_1 - 12(i_1 - i_2) = 0$$
  
-12(i\_2 - i\_1) - 6i\_2 + 24 = 0

 $24i_1 - 12i_2 = 60$ 

$$-12i_1 + 18i_2 = 24$$

$$i_{1} = \frac{\begin{vmatrix} 60 & -12 \\ 24 & 18 \end{vmatrix}}{\begin{vmatrix} 24 & -12 \\ -12 & 18 \end{vmatrix}} = \frac{1368}{288} = 4.75 \text{ amps}$$
$$i_{2} = \frac{\begin{vmatrix} 24 & 60 \\ -12 & 24 \end{vmatrix}}{\begin{vmatrix} 24 & -12 \\ -12 & 18 \end{vmatrix}} = \frac{1296}{288} = 4.5 \text{ amps}$$

#### **Example:**





$$i_L = 6.26 A$$
,  $i_T = 3.69 A$ ,  $i_B = 1.96 A$ 

# **Extensions**

- Treat dependent sources the same way as in node analysis
- Current sources are either trivial or require a "supermesh"

• Works for phasors



### Limitation

Circuit must be"planar"





## Node vs Mesh?

• Non-planar  $\rightarrow$  node only



- Could count # of nodes/loops; select smaller
- Personal preference



#### **Example:**





$$i_1 = 1.22 A, i_2 = 0.174 A$$







$$i_o = \frac{105}{104} A$$

#### **Example:** find *i*





**Practice problem:** Which of these circuits are planar (i.e. would allow for mesh analysis)?





#### **Practice problem:** Find the currents $i_1$ , $i_2$ , and $i_3$ .





#### **Practice problem:** Find the current $i_0$





#### **Practice problem:** Find the current $i_0$

$$i_0 = \frac{45}{26} A$$



**Practice problem:** Find the currents  $i_1$ ,  $i_2$ ,  $i_3$ , and  $i_4$ 



**Practice problem:** For the circuit below which method appears easier, mesh or node? Use your preference to find the power dissipated in the 10 k $\Omega$  resistor. 100  $\mu W$ 



**Practice problem:** Find  $v_0(t)$  assumin that  $v_1(t) = 120 \cos(100t + 90^\circ)$  V and  $v_2(t) = 80 \cos 100t$  V

 $v_o(t) = 29.9 \cos(100t + 46^\circ) V$ 



**Practice problem:** Find the power in the 10  $\Omega$  resistor 0 W



i = 1.18 A

#### **Practice problem:** Find *i*



 $i_o = 0.4 A$ 

#### **Practice problem:** Find $i_0$

