Mesh Analysis

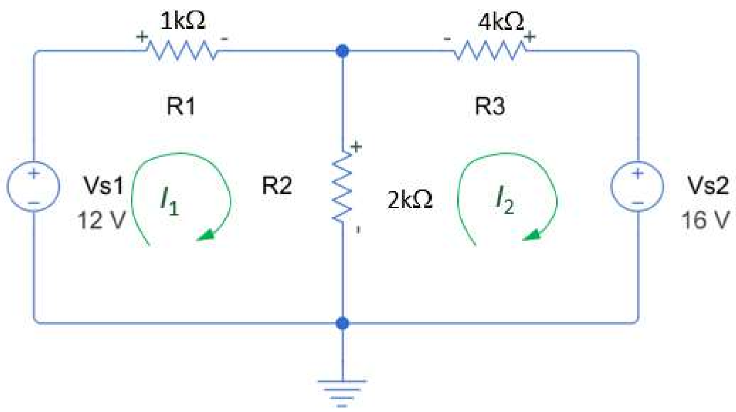
Mesh analysis is a method of finding all the mesh currents of a circuit . The method is based on Kirchhoff's Voltage Law (KCL). Mesh current can be assigned each loop and labeled as $I_1, I_2, ..., I_n$. We can write sum the voltage drops around the mesh and let that equal zero. A solution to the unknown mesh currents is obtained by solving the set of mesh current equations. Every branch current can be found from mesh ccurrent and the voltage across every branch can be found by applying Ohm's law.

Steps to Determine Mesh Currents

1. Assign mesh current variables such as $I_1, I_2, ..., I_n$ to the n meshes
2. Identifying any known mesh current. If a mesh contains a current source, the mesh current is the same as the current from the current source with attention to direction. We assume that any current sources exist only in one mesh.
3. Apply KVL to each unknown mesh current.
4. Solve the resulting simultaneous equations to obtain the unknown mesh currents.

Let's take the steps by considering the circuit below:

1. The circuit below has two independent loops. Let's select the directions and assign mesh current variables as I_1 and I_2



2. Look at the figure above to find any of the mesh currents are known. There is no any mesh contains a current source.

3. Apply KVL to each unknown mesh current I_1 and I_2

Loop 1 : $-V_{s1} + R_1I_1 + R_2(I_1 - I_2) = 0$

Loop 2 : $R_2(I_2 - I_1) + R_3I_2 + V_{s2} = 0$

We have two equations and two unknowns. One of the methods is to use MATLAB **solve** function to find I_1 and I_2 as follow.

```
% Given Values
Vs1 = 12;
Vs2 = 16;
R1 = 1e3;
R2 = 2e3;
R3 = 4e3;
% Unknown mesh currents
syms I1 I2;
% Mesh equations and solutions
[I1,I2] = solve (-Vs1+R1*I1+R2*(I1-I2)==0, R2*(I2-I1)+R3*I2+Vs2==0);
I1 = vpa(I1,3)
```

I1 = 0.00286

```
I2 = vpa(I2,3)
```

I2 = -0.00171

Alternative solution: Last two loop equations can be solved manually with some simple algebra. Let's reorginize these loop equations as

$$(R_1 + R_2)I_1 - R_2 I_2 = V_{s1}$$

$$-R_2 I_1 + (R_2 + R_3)I_2 = -V_{s2},$$

Substituting the component values

$$(1k + 2k)I_1 - 2kI_2 = 12$$

$$-2kI_1 + (2k + 4k)I_2 = -16,$$

The equations can be rearranged in unknown variables and put into a matrix form as

$$\begin{bmatrix} R_1 + R_2 & -R_2 \\ -R_2 & R_2 + R_3 \end{bmatrix} \begin{bmatrix} I_1 \\ I_2 \end{bmatrix} = \begin{bmatrix} V_{s1} \\ -V_{s2} \end{bmatrix} \quad \text{or} \quad \begin{bmatrix} 1k + 2k & -2k \\ -2k & 2k + 4k \end{bmatrix} \begin{bmatrix} I_1 \\ I_2 \end{bmatrix} = \begin{bmatrix} 12 \\ -16 \end{bmatrix}$$

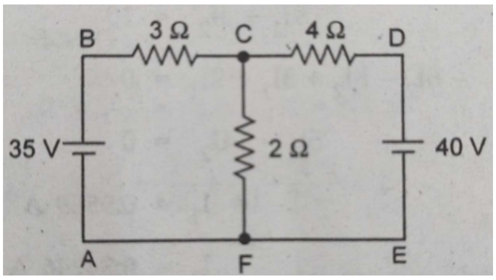
This matrix equation can be solved using MATLAB as shown

```
% Matrix AxI=b
A = [(R1+R2) -R2; -R2 (R2+R3)];
b = [Vs1; -Vs2];
I = A\b;
I=inv(A)*b
```

```
I = 2×1

    0.0029
   -0.0017
```

Calculate the current in 2Ωresister

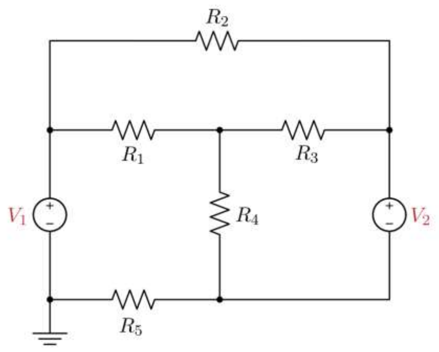


```
R1=3; R2=2; R3=4;
Vs1=35; Vs2=40;
A = [(R1+R2) -R2; -R2 (R2+R3)];
b = [Vs1; -Vs2];
I = A\b;
%I=inv(A)*b;

I1 = I(1);
I2 = I(2);
I_2=I1-I2
```

```
I_2 = 10
```

Find the current through the circuit



R1=10Ω, R2=20Ω, R3=50Ω, R4=2Ω, R5=330Ω,

V1=1.5V,V2=6V

```
% Given values
R1 = 10;
R2 = 20;
R3 = 50;
R4 = 2;
R5 = 330;
V1 = 1.5;
V2 = 6;
% Matrix system
A = [R1+R4+R5, -R1, -R4;
 -R1, R1+R2+R3, -R3;
 -R4, -R3, R3+R4];
b = [V1; 0; -V2];
I = A\b;
I1=I(1)
```

```
I1 = -0.0026
```

```
I2=I(2)
```

```
I2 = -0.1817
```

```
I3=I(3)
```

```
I3 = -0.2902
```