NOTES – CLASS 10

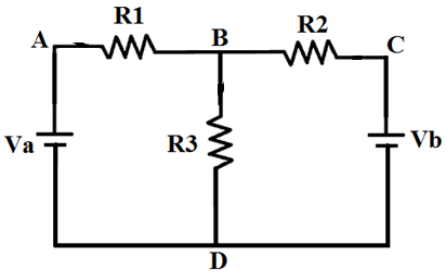
Mesh Analysis:

One of the widely used techniques to solve networks with more number of elements and multiple sources is Mesh Analysis.

A closed path in a network with current flow in every element in that path is defined as a **Loop.**

A mesh is a fundamental loop which does not contain any other smaller loops within itself.

For instance, consider the following network:



In this network, loops are

i) A-B-D-A
ii) B-C-D-B
iii) A-B-C-D-A

Out of these three loops, only (i) & (ii) are Meshes. Third one is just a loop but not a mesh since it loops (i) & (ii) embedded with in itself.

Thus, all meshes are loops but the converse need not be true.

Steps to apply Mesh Analysis:

Step 1: Identify the number of meshes in the network.

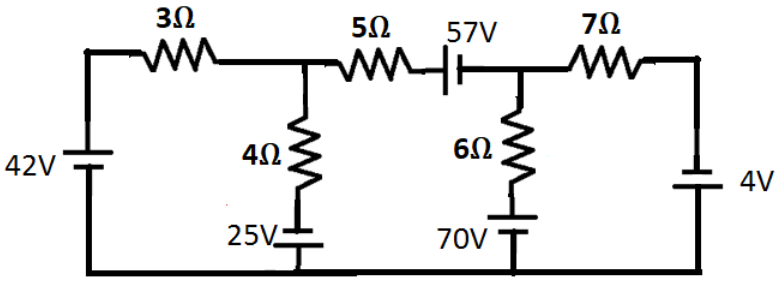
Step 2: Assign one mesh current in each mesh preferably in the same direction.

Step 3: Write KVL in every mesh.

Step 4: Solve simultaneous equations to obtain Mesh currents.

Note: After finding current in each mesh, current or voltage or power in any element of choice in the network can be obtained as a function of these mesh currents.

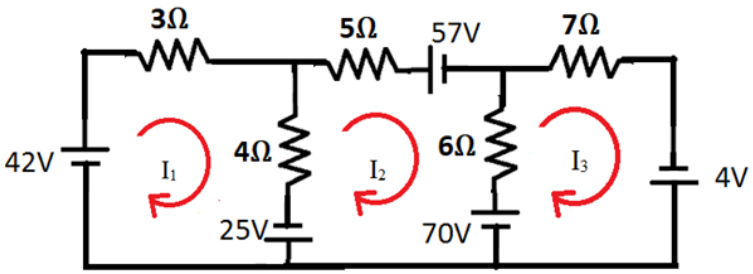
Numerical Example 1:
Obtain current through 6Ω resistor using Mesh Analysis.



Solution:

1. Number of Meshes = 3

2. Assign one mesh current in each mesh, all of them preferably either clockwise or anticlockwise.



3. Now, write KVL in every Mesh.

KVL (Mesh 1) : $-3I_1-4(I_1-I_2)+25+42 = 0$ ---- (1)

KVL (Mesh 2) : $-5I_2-57-6(I_2-I_3)-70-25-4(I_2-I_1) = 0$ ---- (2)

KVL (Mesh 3) : $-7I_3+4+70-6(I_3-I_2) = 0$ ---- (3)

4. Solving above equations (1), (2) & (3),

$I_1 = 5A$; $I_2 = -8A$; $I_3 = 2A$

Therefore, current through 6Ω resistor = $(I_2 \sim I_3) = (I_3-I_2) = 10A$

Mesh Analysis – Writing KVLs by Direct Inspection:

KVLs while applying mesh analysis can be written by inspecting the network and following a set of rules. This method is termed as Direct Inspection Method of writing KVLs.

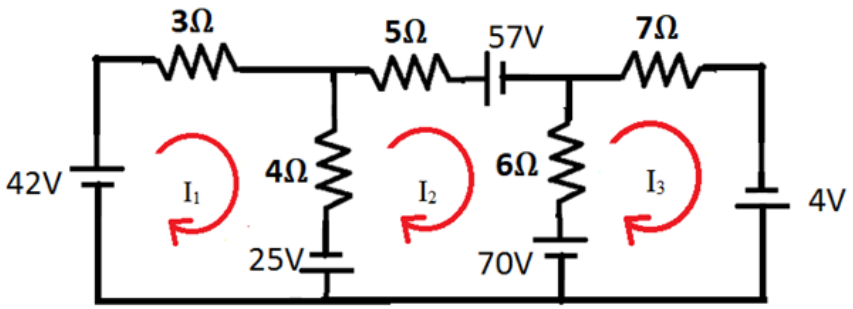
According to this method, while writing a KVL in a particular mesh,

i) Coefficient of same mesh current = Sum of all resistances in that mesh.

ii) Coefficient of other mesh current = Negative of Sum of all common resistances between the meshes.

iii) Constant is written on the right hand side and is algebraic sum of EMFs of all voltage sources in that mesh. These EMF of a voltage source must be taken as positive if that voltage source supports that mesh current (i.e., has a tendency to drive current in the same direction as the marked mesh current direction.). Otherwise, it must be taken as negative.

Let us consider the example we solved above.



KVL in Mesh 1 by direct inspection:

Coefficient of I_1 = Sum of all resistances in that Mesh = (3Ω + 4Ω) = 7

Coefficient of I_2 = Sum of common resistances between Mesh 1 & Mesh 2 considered with a negative sign = -4 (Since 4Ω is common between Mesh 1 & Mesh 2)

Coefficient of I_3 = Sum of common resistances between Mesh 1 & Mesh 3 considered with a negative sign = 0 (Since nothing is common between Mesh 1 & Mesh 3)

Constant term on Right hand side = +42 + 25 = 67 (Both EMFs are taken with positive sign since they support I_1 direction.)

Thus, KVL (Mesh 1) : $7I_1-4I_2-0I_3 = +25+42$

Similarly, we can write KVLs in Mesh 2 & Mesh 3.

KVL (Mesh 2) : $-4I_1+15I_2-6I_3 = -57-70-25$

KVL (Mesh 3) : $0I_1-6I_2+13I_3 = +4+70$