Class: 1st
Subject: Electrical Technology
Lecturer: Omar A. Alkawak
E-mail: OmarAhmed@mustaqbal-college.edu.iq

Lecture No. 4,5

“Kirchhoffs laws”

Lecture Four, Five

Kirchhoffs laws:

1. kirchhoffs voltage law:

The algebraic sum of voltages in any closed loop is zero .

$$\sum V = 0$$

Now , from fig. 1 , there are three equation according to kirchhoffs voltage law .

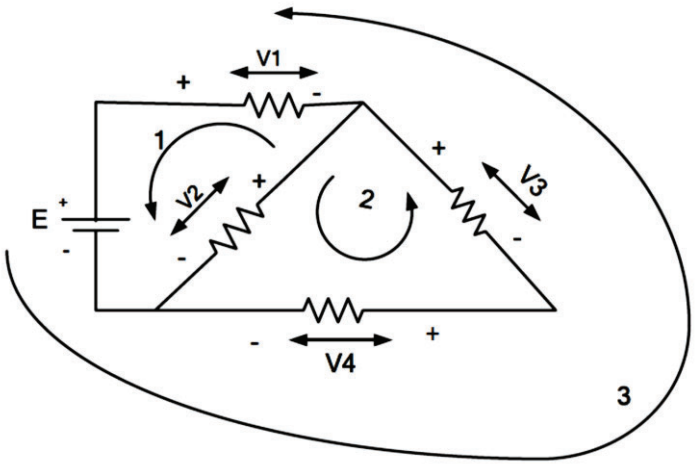

Fig. 1

Loop 1 :

E – V1 – V2 = 0

E = V1 + V2 ------- (1)

Loop 2 :

V2 – V3 – V4 = 0

V2 = V3 + V4 -------- (2 (

Loop 3 :

E – V1 – V3 – V4 = 0

E = V1 + V3 + V4 --------- (3)

Example : For the circuit shown in fig. 2 ,using kirchhoffs voltage law ,find V1 and V2 .

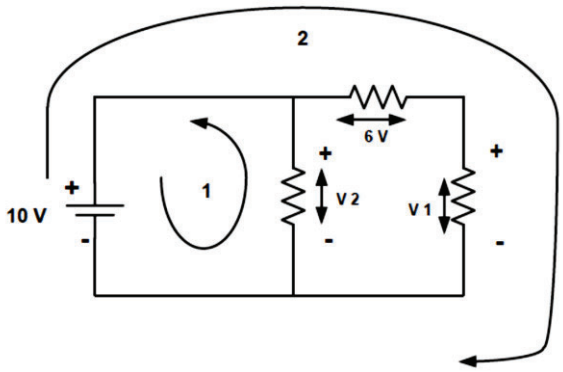

Fig. 2

Loop 1 :

10 – V2 = 0 V2 = 10 v

Loop 2 :

-10 + 6 + V1 = 0

V1 = 10 – 6 = 4 v

2. kirchhoffs current law:

In any electrical network , the algebraic sum of currents meeting at a point (junction) is zero as shown in fig. 3 .

∑ I = 0

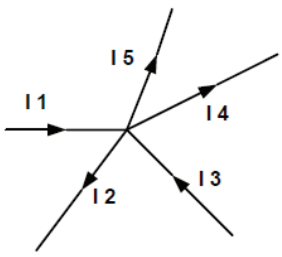

Fig. 3

I 1 + I 3 = I2 + I 4 + I 5

I 1 + I 3 - I2 - I 4 - I 5 =0

Example : Using kirchhoffs current lae , find I 5 from fig. 4 .

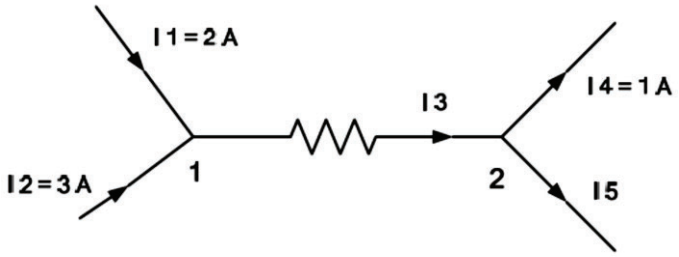

Fig. 4

At node 1 :

I 1 + I 2 = I 3

2 + 3 = 5 A , therefore I 3 = 3 A

At node 2 :

I 3 = I 4 + I 5

5 = 1 + I 5

I 5 = 5 – 1 = 4 A

Example : Using kirchhoffs law , find I 1 , I 2 and I 3 for the circuit shown in fig. 5 .

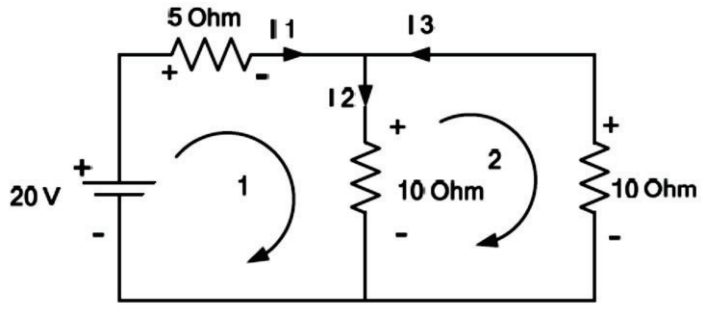

Fig. 5

I 1 = I 2 + I 3 ---------- (1) Loop 1 :

5 + 20 -I 1 + 10 I 2 = 0

5I 1 + 10 I 2 = 20

I 1 + 2 I 2 = 4 --------- (2 (

Loop 2 :

10 -I 2 + I 3 = 0

I 2 = I 3 ---------- (3)

From Equ . (2)

I 1 = 4 – 2 I 2 ---------- (4)

Sub. Equ. (3) and (4) in (1)

4 – 2 I 2 = I 2 + I 2

I 2 = 1 A

From Equ . (4)

I 1 = 4 – (2 x 1) = 2 A

I 3 = I 2

I 3 = 1 A

Maxwells Method :

In this method loop current is used instead of branch currents as in kirchhoffs laws . Here , the current in different meshes are assigned continuous paths so that they do not split at a junction into branch current . Basically , this method consists of writing loop voltage equation in terms of the unknown loop currents .

Example : Using maxwells method , calculate all currents for the circuit shown in fig. 6 .

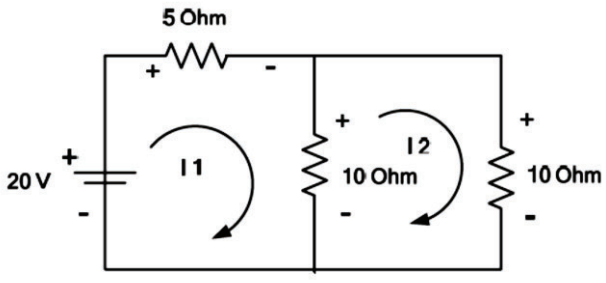

Fig. 6

Loop 1 :

- 20 + 5 I 1 + 10 (I 1 – I 2) 15 I 1 – 10 I 2 = 20

3 I 1 – 2 I 2 = 4 --------- (1)

Loop 2 :

$10 (I_2 – I_1) + 10 I_2 = 0$

$10 I_2 – 10 I_1 + 10 I_2 = 0$

$20 I_2 = 10 I_1$

$I_1 = 2 I_2$ ---------- (2)

Sub. Equ. (2) in (1)

$3 (2 I_2) – 2 I_2 = 4$

$6 I_2 - 2 I_2 = 4$

$I_2 = 1$ A

$I_1 = 2 I_2$ $I_1 = 2$ A

Now , branch current will be calculated as follows :

The current through 5 Ω resistor $I_{5\Omega} = I_1 = 2$ A .

The current through 10 Ω resistor $I_{10\Omega} = I_1 – I_2 = 2 – 1 = 1$ A .

The current through 10 Ω resistor $I_{10\Omega} = I_2 = 1$ A .