Electronics:- Electronics is the branch of science that deals with the study of flow and control of electrons (electricity) and the study of ~~the~~ their behaviour and effects in vacuums, gases, and semiconductors, and with the devices using such electrons.
The control flow of electrons is accomplished by devices (electronic components) that resists, carry, select, switch, store, manipulate and exploit the electrons.

Kirchhoff's law:- Gustav Robert Kirchhoff's derived two basic laws governing networks, one commonly known as Kirchhoff's current law KCL or point, whereas the second law is called Kirchhoff's voltage law.

i) **Kirchhoff's current law (KCL):-** Kirchhoff's current law (KCL) states that, the algebraic sum of all currents meeting at a point (or junction) is zero or the sum of incoming currents towards any points is equal to the sum of outgoing currents away from that point.

Note: i) Take incoming current as positive
ii) Take outgoing current as negative.

i.e $\sum I = 0$

If I_1, I_2, I_3, I_4, I_5, I_6 are the ~~inco~~ currents meeting at the junction O shown below

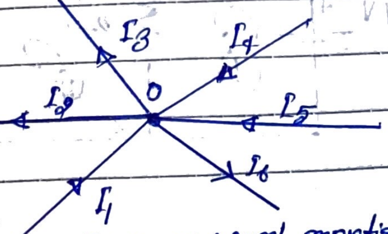


Fig: current meeting at O

Here $I_1 = +ve$
$I_2 = -ve$
$I_3 = -ve$
$I_4 = +ve$
$I_5 = +ve$
$I_6 = -ve$

∴ According to KCL we have,

$$I_1 - I_2 - I_3 + I_4 + I_5 - I_6 = 0$$

or,

$$I_1 + I_4 + I_5 = I_2 + I_3 + I_6$$

II) Kirchhoff's Voltage law: This law states that the algebraic sum of the emfs acting in a loop of circuit is equal to sum of the product of current and resistance init.

Mathematically,

$$\sum \Delta V = 0$$

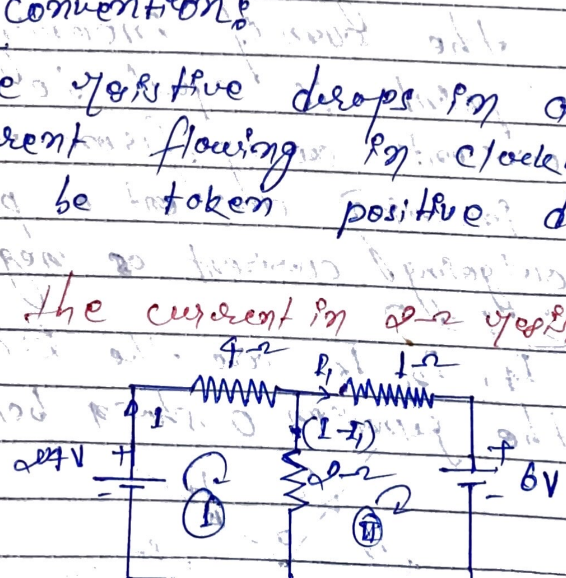
or

$$\sum \mathcal{E} = \sum IR$$

Sign conventions:

i) The resistive drops in a mesh due to current flowing in clockwise direction must be taken positive drops and vice versa.

Q) Find the current in 2Ω resistor.



STAR AND DELTA CONNECTION

PAGE:
DATE: / /

STAR AND DELTA CONNECTION:- star and delta are the two type of connection in a 3-phase circuits.

A single phase system consists of just two conductors (wires): one is called the phase (sometimes line, live or hot), through which the current flows and the other is called neutral which acts as a return path to complete the circuit.

Whereas in a three phase system, we have a minimum of three conductors or wires carrying AC voltages. It is more economical to transmit power using a 3-phase power supply when compared to a single phase power supply as a three phase supply can transmit three times the power with just three conductors when compared to two conductor single-phase power supply.

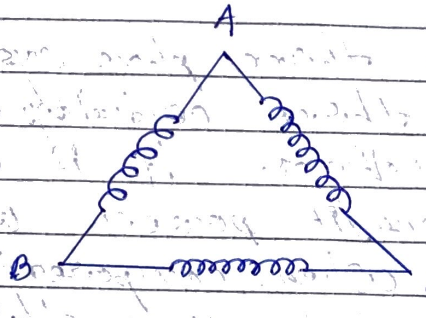
Star connection:- In star connection, the 3 phase wires are connected to a common point or star point and Neutral is taken from this common point. Due to its shape, the star connection is sometimes also called Y connection.

9 A (phase)

P A

Note: If only the phase wires are used, then it is called 3-phase 3 wire system. And if neutral wire is also used it is called 4 wires 3 phase system.

II) Delta connection: In delta connection, there are only 3 wires for distribution and all the 3 wires are phases. There is no neutral wire in delta connection.



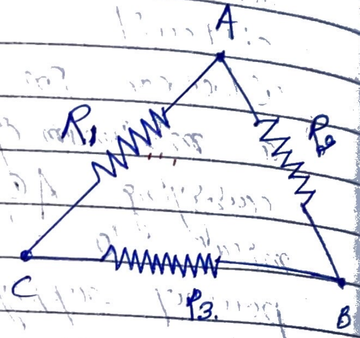


Fig: Delta connection.

Delta star transformation: The replacement of delta or mesh by equivalent star system is known as delta star transformation.
The two system will be equivalent or identical if the resistance measured between any pair of lines is same in both of the system, when third line is open.

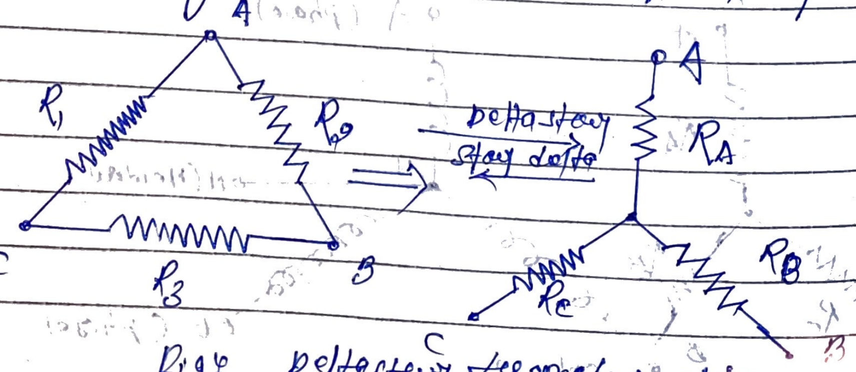


Fig: Delta-star transformation

PAGE:
DATE:

Now, from Δ figure,

$$R_{BC} = R_3 \,||\, (R_1+R_2)$$

$$= \frac{R_3\,(R_1+R_2)}{(R_1+R_2+R_3)}$$

$$\therefore R_{BC} = \frac{R_3(R_1+R_2)}{R_1+R_2+R_3} \quad \text{--- (I)}$$

Now, from star connection,

$$R_{BC} = R_B + R_C \quad \text{--- (II)}$$

Now equating equation (I) and (II) we get

$$R_B + R_C = \frac{R_3(R_1+R_2)}{(R_1+R_2+R_3)} \quad \text{--- (a)}$$

Similarly, the resistance between terminals A and B :

$$R_A + R_B = \frac{R_2(R_1+R_3)}{R_1+R_2+R_3} \quad \text{--- (b)}$$

also,

$$R_A + R_C = \frac{R_1(R_2+R_3)}{R_1+R_2+R_3} \quad \text{--- (c)}$$

Now, adding equation (a) (b) and (c) we get

$$2(R_A+R_B+R_C) = \frac{2(R_1R_2+R_2R_3+R_1R_3)}{(R_1+R_2+R_3)}$$

or, $$R_A+R_B+R_C = \frac{R_1R_2+R_2R_3+R_3R_1}{R_1+R_2+R_3} \quad \text{--- (d)}$$

PAGE:
DATE:

Now, on subtracting equations (a), (b) & (c) from (d) we get

$$R_A + R_B + R_C - R_B - R_C = \frac{R_1R_2 + R_2R_3 + R_3R_1}{R_1+R_2+R_3} - \frac{R_1R_3 - R_2R_3}{R_1+R_2+R_3}$$

$$\therefore R_A = \frac{R_1 \cdot R_2}{(R_1+R_2+R_3)} \quad \text{(III)}$$

similarly

$$R_B = \frac{R_2 \cdot R_3}{(R_1+R_2+R_3)} \quad \text{(IV)}$$

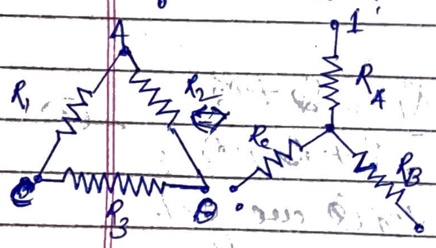
and

$$R_C = \frac{R_1 \cdot R_3}{(R_1+R_2+R_3)} \quad \text{(V)}$$

Thus the equivalent star resistance connected to a given terminal is equal to the product of two delta resistances connected to the same terminal divided by the sum of the delta connected resistances.

Star delta Transformation:-

$\therefore$ we have



$$R_A = \frac{R_1 \cdot R_2}{(R_1+R_2+R_3)}$$

$$R_B = \frac{R_2 \cdot R_3}{(R_1+R_2+R_3)}$$

$$R_C = \frac{R_1 \cdot R_3}{R_1+R_2+R_3}$$

On multiplying all three equations we get III by IV, IV by V and V by (I) we get.

PAGE:
DATE:

$$R_A R_B = \frac{R_1 \cdot R_2}{(R_1+R_2+R_3)} \cdot \frac{R_2 \cdot R_3}{} = \frac{R_1 R_2^2 R_3}{(R_1+R_2+R_3)^2}$$

similarly,

$$R_B R_C = \frac{R_2 \cdot R_3}{(R_1+R_2+R_3)} \cdot R_1 \cdot R_3 = \frac{R_1 \cdot R_2 R_3^2}{(R_1+R_2+R_3)^2}$$

$$R_A R_C = \frac{R_1 \cdot R_2 \cdot R_1 \cdot R_3}{(R_1+R_2+R_3)^2} = \frac{R_1^2 \cdot R_2 \cdot R_3}{(R_1+R_2+R_3)^2}$$

Now, adding above all the above three equations we get

$$R_A R_B + R_B R_C + R_A R_C = \frac{R_1 \cdot R_2^2 R_3 + R_1 R_2 R_3^2 + R_1^2 R_2 R_3}{(R_1+R_2+R_3)^2}$$

$$= \frac{R_1 \cdot R_2 R_3 (R_2 + R_3 + R_1)}{(R_1+R_2+R_3)^2}$$

$$R_A R_B + R_B R_C + R_A R_C = \frac{R_1 \cdot R_2 R_3}{(R_1+R_2+R_3)} \quad \text{(VII)}$$

Now, dividing equation (VI) by (III), (IV) and (V) separately we get

$$\frac{R_A \cdot R_B + R_B \cdot R_C + R_A R_C}{R_A} = \frac{\frac{R_1 \cdot R_2 R_3}{(R_1+R_2+R_3)}}{\frac{R_1 R_2}{(R_1+R_2+R_3)}}$$

$$R_B + \frac{R_B R_C}{R_A} + R_C = R_3$$

$$\therefore R_3 = R_B + R_C + \frac{R_B R_C}{R_A}$$

PAGE:
DATE:

Similarly

$$R_1 = R_A + R_C = \frac{R_A \cdot R_C}{R_B}$$

$$R_2 = R_A + R_B + \frac{R_A \cdot R_B}{R_C}$$

$$R_3 = R_B + R_C + \frac{R_B R_C}{R_A}$$

Thus the equivalent delta resistance b/w two terminal is the sum of the two star connected resistance to those terminals plus product of the same divided by third star resistance.