1. Define Thevenin's theorem. Explain the steps to get Thevenin's equivalent voltage source and resistance.

Answer:

Thevenin's *theorem:*

Any two-terminal network containing a number of e.m.f sources and resistances can be replaced by an equivalent series circuit having a voltage source E_{TH} in series with a resistance R_{TH}, *where* E_{TH} is open circuited Thevenin's equivalent voltage between the two terminals by removing the load. R_{TH} is Thevenin's equivalent resistance measured between two terminals of the circuit obtained by looking "into" the terminals with load removed and voltage sources replaced by their internal resistances..

Procedure

Let us consider the figure (N.1). It consists of a DC source E with some resistance R_1, R_2 and R_3 with a load resistor (R_L) connected across the terminals A and B.

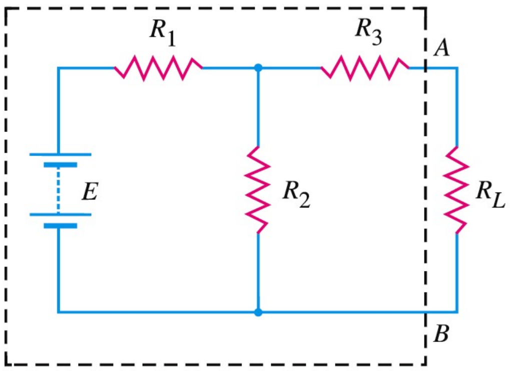

Figure (N.1), Active circuit used for analysis.

Step 1:

Finding Thevenin's equivalent voltage (E_{TH}):

If the active circuit under consideration contains a load resistor, then we have to remove it and measure the voltage across the open terminals for the Thevenin's equivalent source (E_{TH}) as shown in the figure (N.2).

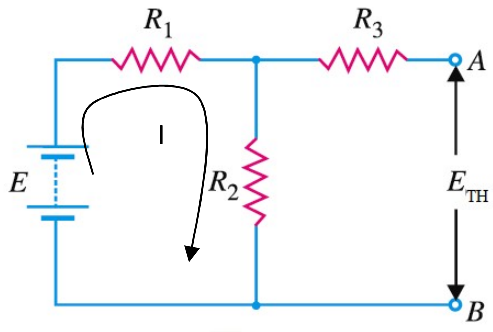

Figure (N.2), Measuring Thevenin's Equivalent voltage E_{TH}.

From the figure (N.2) we can see that the closed loop containing E, R_1 and R_2 will have a current flowing into it. Therefore by applying ohms law we can write;

$E = I\,.(R_1 + R_2)$ ……………………………………………… (1)

$I = \frac{E}{(R_1 + R_2)}$ ……………………………………………… (2)

From the circuit as shown in figure (N.2), no current flows through the resistor R_3 so there will be no drop across it and thus the potential drop across A and B will same as across resistor R_2. So again applying ohms law across the resistor R_2 we get;

$E_{TH} = I\,.(R_2)$ ……………………………………………… (3)

$I = \frac{E_{TH}}{(R_2)}$ ……………………………………………… (4)

Equating (2) and (4) we get;

$\frac{E_{TH}}{(R_2)} = \frac{E}{(R_1 + R_2)}$

$E_{TH} = \frac{E}{(R_1 + R_2)}\,.R_2$ ……………………………………………… (5)

Step 2:

Finding Thevenin's equivalent resistance (R_{TH}):

We have to remove the source E and replace it with its internal resistance, in this case it is considered to be zero as a very good voltage source will have a very less internal resistance almost negligible and hence we will replace E with a short circuit as shown in the figure (N.3).

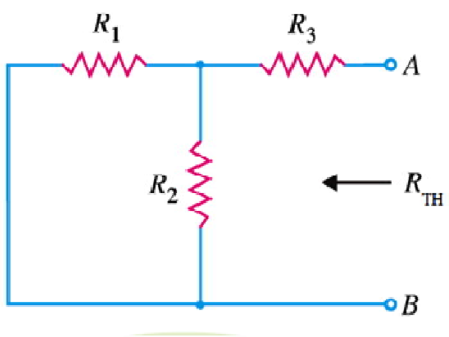

Figure (N.3), Measuring Thevenin's Equivalent Resistance R_{TH}.

We can see that R_1 and R_2 are in parallel and R_3 is in series with it so solving it we get,

$R_{TH} = R_3 + \frac{R_1 . R_2}{R_1 + R_2}$ ……………………………………………… (6)

Step 3:

Thevenin's equivalent Circuit:

The Thevenin's Voltage (E_{TH}) along with Thevenin's resistance (R_{TH}) in series connected to the load resistor has been shown in the figure (N.4).

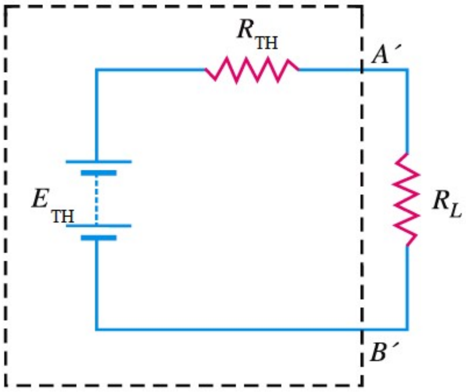

Figure (N.4), Measuring Thevenin's Equivalent Resistance R_{TH}.

If we know consider a current flowing into the circuit and applying ohms law we can write;

$E_{TH} = I\,.(R_{TH} + R_L)$ .... (7)

Replacing the value of R_{TH} in equation 7 we get;

$E_{TH} = I\,.\left\{(R_3 + \frac{R_1.R_2}{R_1+R_2}) + R_L\right\}$ .... (8)

References;

1. Electronic Devices and Ciruits, Boylested and Nashelsky, Pearson.
2. Elements of Electronics, Bagde Singh, S Chand.
3. Network Analysis, Van Valkenberg, PHI.
4. Principle of Electronics, Mehta & Mehta, S Chand.