L. S. College, Muzaffarpur.

ON LINE LECTURE NOTES FOR. B. Sc. Physics Hons

Paper - Electronics.

By - Dr. Kumar Balwant Singh.
Deptt. of Physics.
L. S. College, Muz.

Topic:- * Thevenin's Theorem.

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State and Prove Thevenin's Theorem

Any two terminal linear network containing energy sources (generators) and impedances can be replaced with an equivalent circuit consisting of a voltage source E' in series with an impedance Z'. The value of E' is the open circuit voltage between the terminals of the network and Z' is the impedance measured between the terminals of the network with all energy sources eliminated (but not their impedances). This is also called the voltage source equivalent circuit.

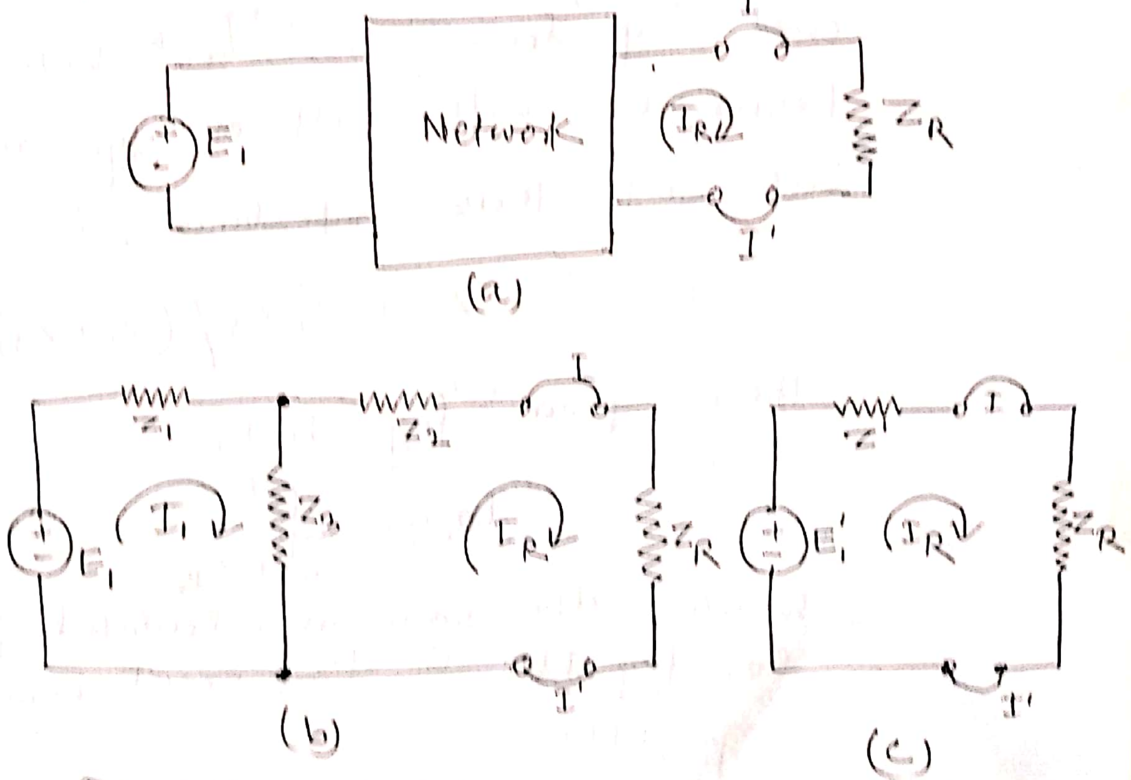

Fig: 1 Network illustrating Thevenin's theorem.

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Fig. 1(b) is equivalent of fig. 1(a). From fig. 1(b);

$$E = I_1(Z_1 + Z_3) - I_R Z_3 \quad \text{--- (1)}$$

$$0 = -I_1 Z_3 + I_R(Z_2 + Z_3 + Z_R) \quad \text{--- (2)}$$

Then

$$I_1 = I_R \frac{Z_2 + Z_3 + Z_R}{Z_3} \quad \text{--- (3)}$$

$$I_R = \frac{E Z_3}{Z_2(Z_1 + Z_3) + Z_1 Z_3 + (Z_1 + Z_3) Z_R} = \frac{E\left(\frac{Z_3}{Z_1 + Z_3}\right)}{Z_2 + \frac{Z_1 Z_3}{Z_1 + Z_3} + Z_R} \quad \text{--- (4)}$$

from fig. 1(b), the open circuit voltage at I, I' terminals is

$$E' = E(Z_3)/(Z_1 + Z_3) \quad \text{--- (5)}$$

and impedance measured between I, I' terminals, with all energy sources eliminated but not their impedances, is

$$Z' = Z_2 + Z_1 Z_3/(Z_1 + Z_3) \quad \text{--- (6)}$$

Then, from fig. 1(c),

$$I_R = \frac{E'}{Z' + Z_R} \quad \text{--- (7)}$$

which is the same as calculated from fig 1(b). So, fig 1(c) is the exact equivalent of fig. 1(b).

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Example :- From the circuit in fig 2(a), draw the Thevenin's equivalent circuit.

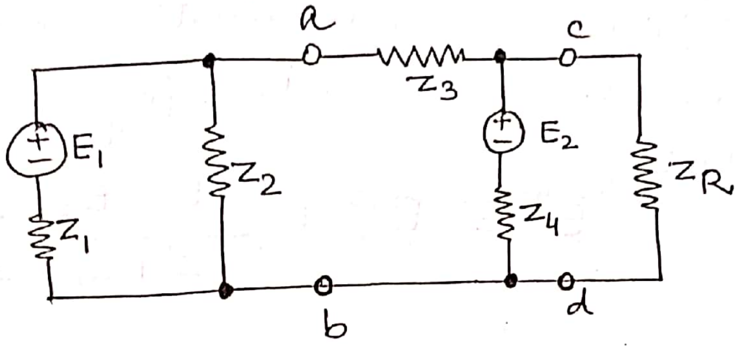
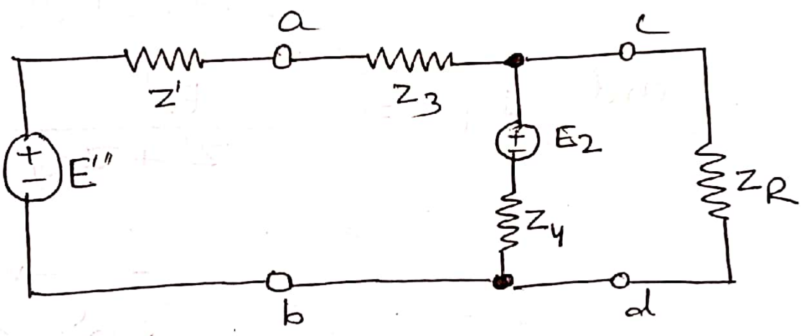
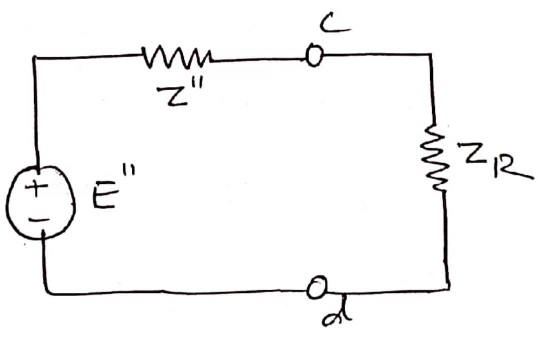


Fig -2(a)



(b)



(c)

Fig- 2(a) Network of example (b) Thevenin equivalent at terminals a, b (c) Thevenin's equivalent at c, d.

The Thevenin equivalent circuit at terminals a, b is shown in fig. 2 (b); where

$$E' = E_1 \left(\frac{Z_2}{Z_1 + Z_2} \right)$$

$$Z' = \frac{Z_1 Z_2}{Z_1 + Z_2}$$

Finally, the equivalent circuit at c, d terminals is shown in fig. (2) (c).

where,

$$E'' = E_2 + \frac{(E' - E_2) Z_4}{Z' + Z_3 + Z_4}$$

$$Z'' = \frac{Z_4 (Z' + Z_3)}{Z_4 + Z_3 + Z'}$$

and $$I_R = \frac{E''}{Z'' + Z_R}$$

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