1996 Rajsh
1994 (11)
1992

Q. State and proved Thevenin's theorem. Discuss the A/D and D/A converter.

Ans: Thevenin's theorem states that any linear active network terminals can be replaced by a single voltage source in series with single impedance.

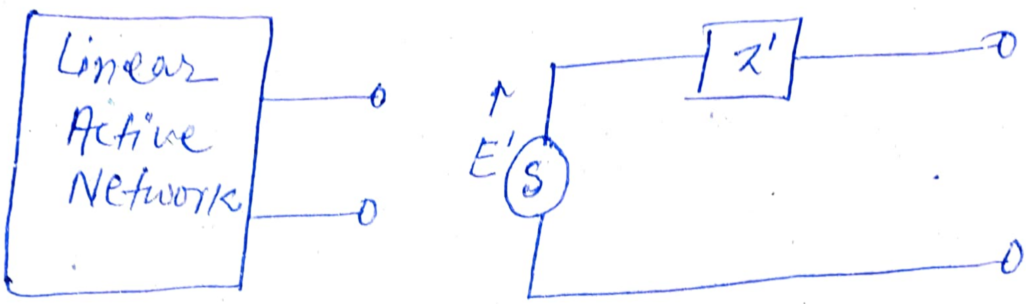

Fig-1.

Proof:- Let us consider the following ckts.

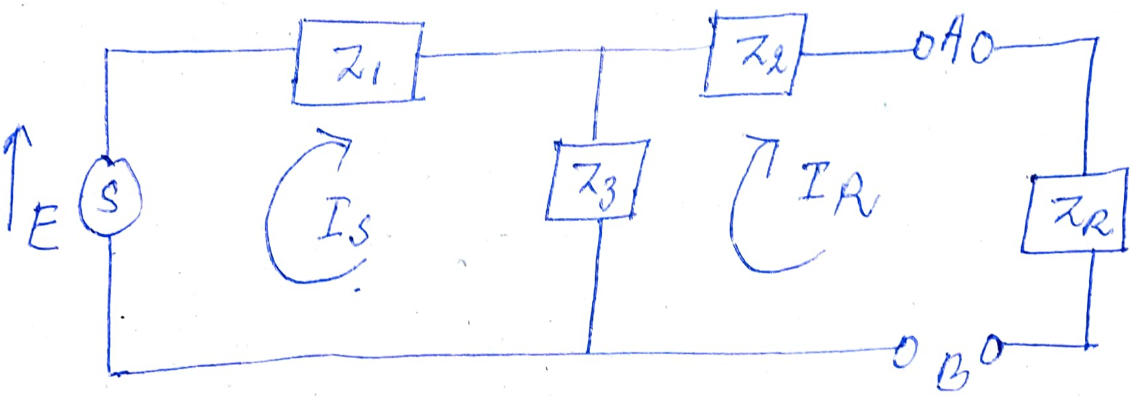

Fig. 2.

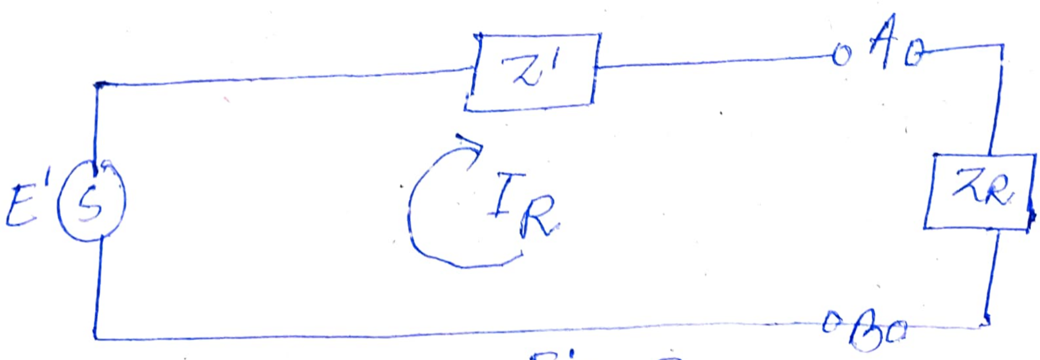

Fig-3.

Let us consider two terminal network having one active circuit and other passive circuit.

Let us suppose that the load impedance Z_R appears at between two terminals as shown in fig 2.

Fig 3 represents the thevenin's equivalent circuit.

Let

I_S = loop current in active ckt.

I_R = loop current in passive ckt.

Let us ~~say~~ now calculate the value of E' and Z' from fig 2. Then we shall show that it is equivalent to a ckt shown in fig 3.

Now from fig ckt 2,

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

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

Now from eqn (2).

$$(Z_2 + Z_3 + Z_R) I_R = Z_3 I_S$$

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

putting the value of eqn (3) in eqn (1)

We get,

$$\frac{(Z_1+Z_3)(Z_2+Z_3+Z_R)I_R}{Z_3} - Z_3 I_R = E$$

$$\text{or, } E = \frac{(Z_1+Z_3)(Z_2+Z_3+Z_R)I_R - Z_3^2 I_R}{Z_3}$$

$$\text{or, } EZ_3 = (Z_1+Z_3)(Z_2+Z_3+Z_R)I_R - Z_3^2 I_R$$

$$\text{or, } EZ_3 = \left[(Z_1+Z_3)(Z_2+Z_3+Z_R) - Z_3^2\right] I_R$$

$$\therefore I_R = \frac{EZ_3}{(Z_1+Z_3)(Z_2+Z_3+Z_R) - Z_3^2}$$

$$\text{or, } I_R = \frac{EZ_3}{(Z_1+Z_3)Z_2 + (Z_1+Z_3)Z_R + Z_1Z_3 + \cancel{Z_3^2} - \cancel{Z_3^2}}$$

$$\text{or, } I_R = \frac{EZ_3/(Z_1+Z_3)}{Z_2 + Z_R + \frac{Z_1Z_3}{(Z_1+Z_3)}} \tag{4}$$

$$\therefore I_R = \frac{E'}{Z' + Z_R} \tag{5}$$

$$\text{where, } E' = \frac{EZ_3}{(Z_1+Z_3)} \tag{6}$$

$$Z' = Z_2 + \frac{Z_1Z_3}{(Z_1+Z_3)} \tag{7}$$

Now from fig ckt 3. The current

$$I_R = \frac{E'}{Z' + Z_R} \quad \text{---} \quad (8)$$

Hence eqn. (8) is as same as eqn. (5) then the thevenin's theorem is proved.
Here the value of E' and Z' from eqn. (6) and (7) are called thevenin's components.