A.

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4.) State and prove Maximum power transfer theorem.

Ans:- **Statement:**

A resistance load, being connected to a dc network, receives maximum power when the load resistance is equal to the internal resistance (Thevenin's equivalent resistance) of the source network as seen from the load terminals.

Explanation:-

A variable resistance R_L is connected to a dc source network as shown in Fig-① while Fig-② represents the Thevenin voltage V_0 and Thevenin's resistance R_{Th} of the source network. The aim is to determine the value of R_L such that it receives max^m power from the dc source.

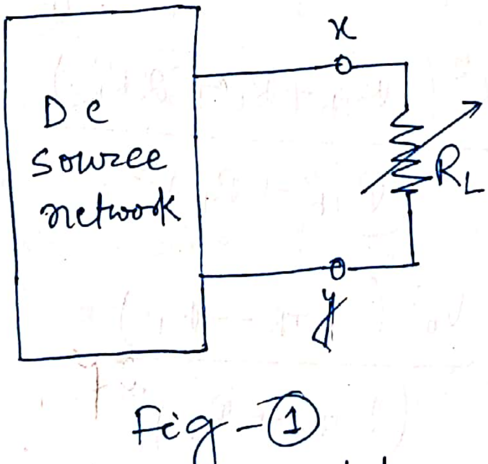

Fig-① Load connected to the dc source network.

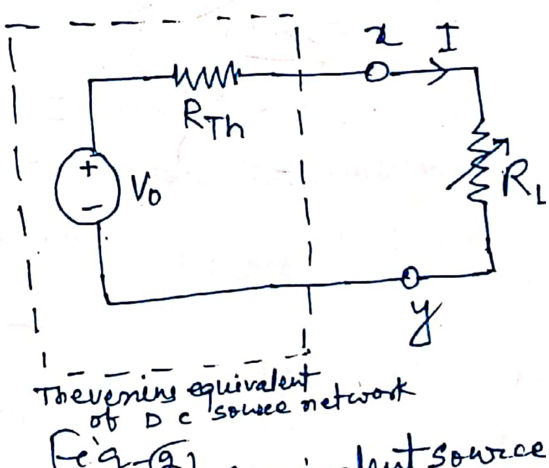

Fig-② Equivalent source network and load.

With reference to fig (2),

$$I = \frac{V_0}{R_{Th} + R_L}$$

While the power delivered to the resistive load is

$$P_L = I^2 R_L = \left(\frac{V_0}{R_{Th} + R_L}\right)^2 \times R_L$$

P_L can be maximised by varying R_L and hence, maximum power can be delivered when $(dP_L / dR_L) = 0$.

However,

$$\frac{dP_L}{dR_L} = \frac{1}{[(R_{Th} + R_L)^2]^2} \times$$

$$\left[(R_{Th} + R_L)^2 \frac{d}{dR_L}(V_0^2 R_L) - V_0^2 R_L \frac{d}{dR_L}(R_{Th} + R_L)^2\right]$$

$$= \frac{1}{(R_{Th} + R_L)^4}\left[(R_{Th} + R_L)^2 V_0^2 - V_0^2 R_L \times 2(R_{Th} + R_L)\right]$$

$$= \frac{V_0^2 (R_{Th} + R_L - 2R_L)}{(R_{Th} + R_L)^3}$$

$$= \frac{V_0^2 (R_{Th} - R_L)}{(R_{Th} + R_L)^3}$$

But $\frac{dP_L}{dR_L} = 0$

∴ Finally,

$$\frac{V_0^2(R_{Th} - R_L)}{(R_{Th} + R_L)^3} = 0$$

which gives,

$$(R_{Th} - R_L) = 0$$

or, $$R_{Th} = R_L$$

Hence, it has been proved that power transfer from a dc source network to a resistive network is maximum when the internal resistance of the dc source network is equal to the load resistance.