What is Maximum Transfer Theorem? Illustrate with circuit diagram.

Answer:

Definition: When load is connected across a voltage source, power is transferred from the source to the load. The amount of power transferred will depend upon the load resistance. If load resistance R_L is made equal to the internal resistance R_i of the source, then maximum power is transferred to the load R_L. This is known as maximum power transfer theorem and can be stated as follows:

Maximum power is transferred from a source to a load when the load resistance is made equal to the internal resistance of the source. This applies to d.c. as well as a.c. power. Let us consider a voltage source (E) and internal resistance R_i and delivering power to a load resistance R_L [See figure (1) (i)]. The current I flowing through the circuit is given by:

$$I = \frac{E}{R_L+R_i} \text{ ---------- (1)}$$

Power delivered to the load R_L

$$P = I^2 \times R_L = \left(\frac{E}{R_L+R_i}\right)^2 \times R_L \text{ ---------- (2)}$$

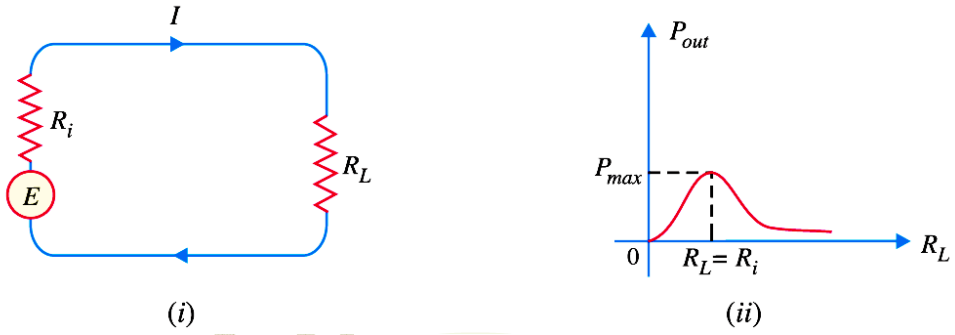

Figure (1). Maximum power transfer theorem.

For a given source, generated voltage E and internal resistance R_i are constant. Therefore, power delivered to the load depends upon R_L. In order to find the value of R_L for which the value of P is maximum, it is necessary to differentiate equation (2) with respect to R_L and set the result equal to zero.

$$\frac{dP}{dR_L} = E^2 \times \left[\frac{(R_L+R_i)^2-2\times R_L(R_L+R_i)}{(R_L+R_i)^4}\right] = 0 \text{ ---------- (3)}$$

$$(R_L + R_i)^2 - 2 \times R_L(R_L + R_i) = 0 \text{ ---------- (4)}$$

$$(R_L + R_i)(R_L - R_i) = 0 \text{ ---------- (5)}$$

$$(R_L - R_i) = 0 \text{ ---------- (6)}$$

Since $(R_L + R_i)$ cannot be zero,

$$R_L = R_i \text{ ---------- (7)}$$

i.e. Load resistance = Internal resistance

Thus, for maximum power transfer, load resistance RL must be equal to the internal resistance Ri of the source.

Under such conditions, the load is said to be matched to the source. Figure (1) (ii) shows a graph of power delivered to R_L as a function of R_L. It may be mentioned that efficiency of maximum power transfer is *50% as one-half of the total generated power is dissipated in the internal resistance R_i of the source. Applications. Electric power systems never operate for maximum power transfer because of low efficiency and high voltage drops between generated voltage and load. However, in the electronic circuits, maximum power transfer is usually desirable. For instance, in a public address system, it is desirable to have load (i.e. speaker) "matched" to the amplifier so that there is maximum transference of power from the amplifier to the speaker. In such situations, efficiency is sacrificed at the cost of high power transfer.

.