3.4 Maximum Power Transfer.md

##### Maximum Power Transfer

In many practical situations, a circuit is designed to provide power to a load. There are applications in areas such as communications where it is desirable to maximize the power delivered to a load. We now address the problem of delivering the **maximum power to a load** when given a system with known **internal losses**. It should be noted that this will result in significant internal losses greater than or equal to the power delivered to the load.

The Thevenin equivalent is useful in finding the maximum power a linear circuit can deliver to a load. We assume that we can adjust the load resistance *RL*. If the entire circuit is replaced by its Thevenin equivalent except for the load, as shown in Fig. 4.48, the power delivered to the load is

For a given circuit, *VTh* and *RTh* are fixed. By varying the load resistance *RL*, the power delivered to the load varies as sketched in Fig. 4.49. We notice from Fig. 4.49 that the power is small for small or large values of *RL* but maximum for some value of *RL* between 0 and infinity. We now want to show that this maximum power occurs when *RL* is equal to *RTh*. This is known as the **maximum power theorem**.

Maximum power is transferred to the load when the load resistance equals the Thevenin resistance as seen from the load (*RL* = *RTh*).

$$\left. { \frac { d p } { d R \_ { L } } = V \_ { Th } ^ { 2 } [ \frac { ( R \_ { Th } + R \_ { L } ) ^ { 2 } - 2 R \_ { L } ( R \_ { Th } + R \_ { L } ) } { ( R \_ { Th } + R \_ { L } ) ^ { 4 } } ] }\\{ = V \_ { Th } ^ { 2 } [ \frac { ( R \_ { Th } + R \_ { L } - 2 R \_ { L } ) } { ( R \_ { Th } + R \_ { L } ) ^ { 3 } } ] = 0 } \right.$$

This implies that

which yields

The maximum power transferred is obtained as

Find the value of *RL* for maximum power transfer in the circuit of Fig. 4.50. Find the maximum power.

**Solution:**

We need to find the Thevenin resistance *RTh* and the Thevenin voltage *VTh* across the terminals *a*-*b.* To get *RTh*, we use the circuit in Fig. 4.51(a) and obtain

To get *VTh*, we consider the circuit in Fig. 4.51(b). Applying mesh analysis gives

Solving for *i*1, we get *i*1 =-2/3. Applying KVL around the outer loop

Solving for *i1*, we get *i1* =-2/3 A. Applying KVL around the **outer loop**

to get *VTh* across terminals *a*-*b*, we obtain

For maximum power transfer,

and the maximum power is