Maximum Power Transfer Theorem
Objective of Lecture

- Explain the maximum power transfer theorem.

- Chapter 5.4
  Basic Engineering Circuit Analysis by J.D. Irwin and R.M. Nelms
Maximum Power Transfer

- For any power source, the maximum power transferred from the power source to the load is when the resistance of the load $R_L$ is equal to the equivalent or input resistance of the power source ($R_{in} = R_{Th}$ or $R_N$).
- The process used to make $R_L = R_{in}$ is called impedance matching.
Power Transfer Calculation

\[ P_L = \frac{V_L^2}{R_L} \]

\[ P_L = \left( \frac{R_L}{R_L + R_{Th}} V_{Th} \right)^2 \]

![Circuit Diagram](image)

![Graph](image)
Application

- When developing new circuits for a known application, optimize the power transfer by designing the circuit to have an input resistance close to the load resistance.
- When selecting a source to power a circuit, one of the selection criteria is to match the input impedance to the load resistance.
Example Seen in Labs

- Function generator that is used in a number of laboratories. Measurements of $V$, the voltage across the load resistor $R_L$, can be well below the voltage specified on the function generator.
  - $R_{in} = R_{Th} = 50\Omega$
  
- This is observed as $R_L$ approaches or smaller than $R_{Th}$.

[Diagram of electrical circuit]

http://www.vellemanusa.com
Other Examples

- Selection of wire –
  - Antenna wire is designed to match a 75 Ω load.
  - Coaxial cable is designed to act like a 50 Ω load.
- Most electronic and electrical equipment are designed to have an $R_{Th}$ of 50 Ω.
- The speakers used in some of the ECE labs are designed to act like an an 8 Ω load while microphones are designed to act like a 600 Ω load.
  - It is important that the resistance of the wire that runs to the speaker is very low or the power will be dissipated in the wire rather than used to create sound.
  - For best audio quality, the input impedance of the circuit connected to the speaker (or the microphone) should be equal to the resistance of the speaker (or the microphone).
Summary

- Maximum power transfer theorem is used frequently to insure that the greatest power can be transferred from a power source to a load.