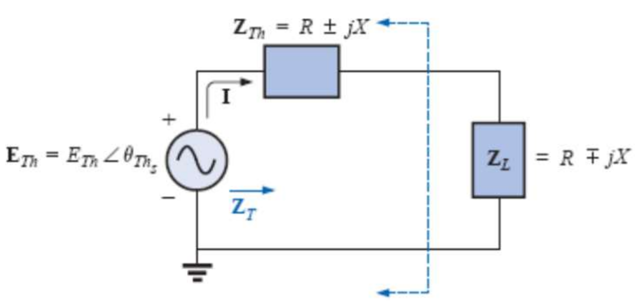
AC-circuits

Maximum Power Transfer Theorem

1

Maximum Power Transfer Theorem

Maximum power will be delivered to a load when the load impedance is the complex conjugate of the Thévenin impedance across its terminals.



$$R_L = R_{Th} \quad \text{and} \quad \pm j\, X_{\text{load}} = \mp j\, X_{Th}$$

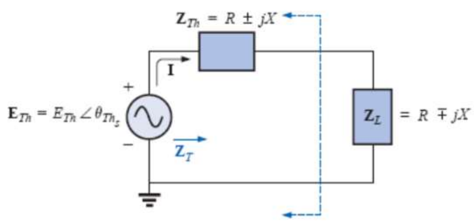
2

The total impedance of the circuit is purely resistive for Maximum power to be transferred to the load.

$$\mathbf{Z}_T = (R \pm jX) + (R \mp jX)$$

$$\boxed{\mathbf{Z}_T = 2R}$$

$$\boxed{F_p = 1} \quad \text{(maximum power transfer)}$$



The magnitude of the current **I**

$$I = \frac{E_{Th}}{Z_T} = \frac{E_{Th}}{2R}$$

The maximum power to the load is

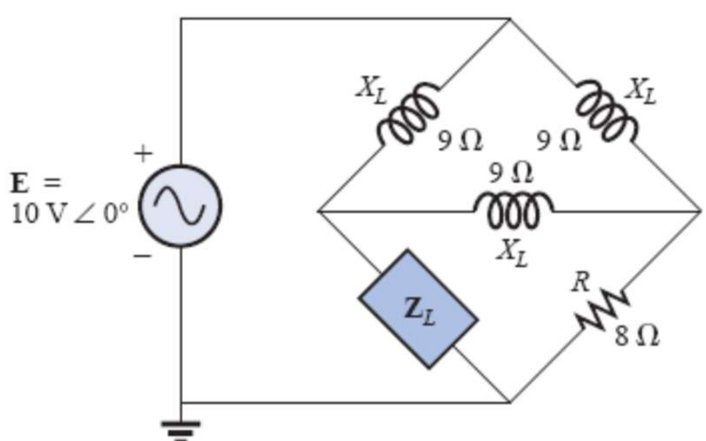
$$P_{max} = I^2 R = \left(\frac{E_{Th}}{2R}\right)^2 R$$

and

$$\boxed{P_{max} = \frac{E_{Th}^2}{4R}}$$

3

Find the load impedance in Fig. for maximum power to the load and find the maximum power delivered to it.



4

Star-Delta/ Y-Δ transformation

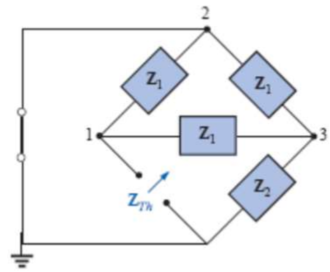


FIG. 18.84
Defining the subscripted impedances for the network of Fig. 18.83.

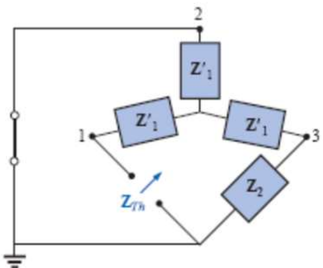


FIG. 18.85
Substituting the Y equivalent for the upper Δ configuration of Fig. 18.84.

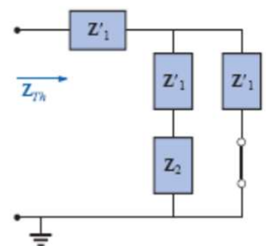


FIG. 18.86
Determining $\mathbf{Z}_{Th}$ for the network of Fig. 18.83.

5

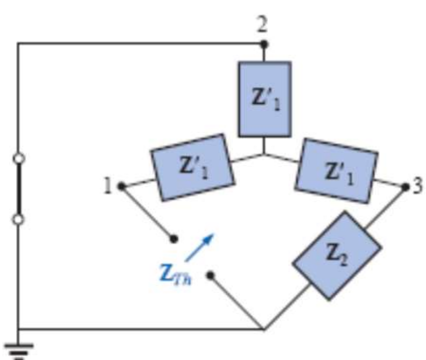


FIG. 18.85
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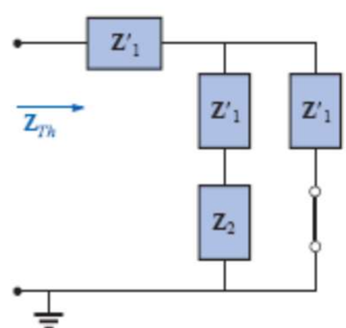


FIG. 18.86
Determining $\mathbf{Z}_{Th}$ for the network of Fig. 18.83.

6

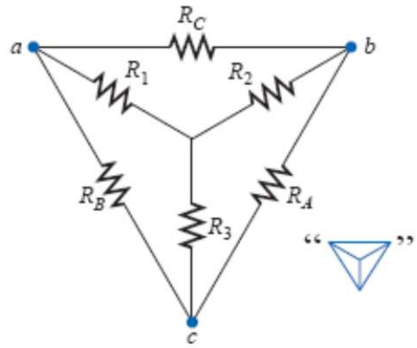


FIG. 8.73
Introducing the concept of Δ-Y or Y-Δ conversions.

7

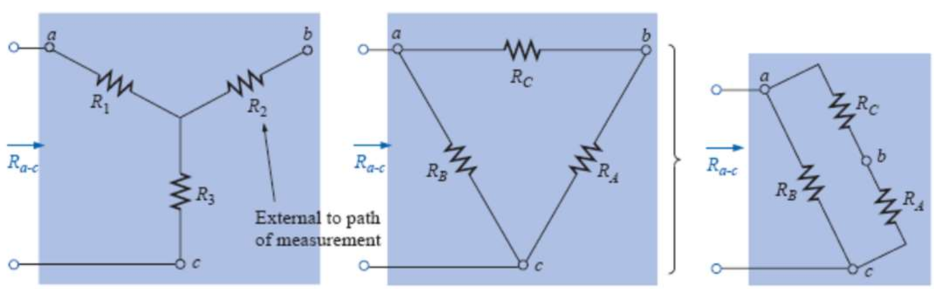


FIG. 8.74
the resistance R_{a-c} for the Y and Δ configurations.

$$R_A = \frac{R_1R_2 + R_1R_3 + R_2R_3}{R_1}$$

$$R_B = \frac{R_1R_2 + R_1R_3 + R_2R_3}{R_2}$$

$$R_C = \frac{R_1R_2 + R_1R_3 + R_2R_3}{R_3}$$

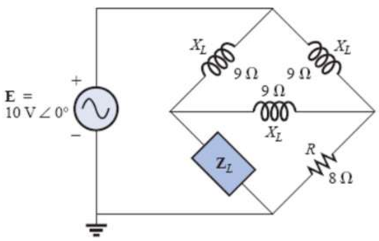
$$R_1 = \frac{R_B R_C}{R_A + R_B + R_C}$$

$$R_2 = \frac{R_A R_C}{R_A + R_B + R_C}$$

$$R_3 = \frac{R_A R_B}{R_A + R_B + R_C}$$

8

Find the load impedance (X_L)in Fig. for maximum power to the load and find the maximum power delivered to it.



$$\mathbf{Z}_{Th} = \mathbf{Z}'_1 + \frac{\mathbf{Z}'_1(\mathbf{Z}'_1 + \mathbf{Z}_2)}{\mathbf{Z}'_1 + (\mathbf{Z}'_1 + \mathbf{Z}_2)}$$

$$= j\,3\,\Omega + \frac{3\,\Omega\,\angle 90°(j\,3\,\Omega + 8\,\Omega)}{j\,6\,\Omega + 8\,\Omega}$$

$$= j\,3 + \frac{(3\,\angle 90°)(8.54\,\angle 20.56°)}{10\,\angle 36.87°}$$

$$= j\,3 + \frac{25.62\,\angle 110.56°}{10\,\angle 36.87°} = j\,3 + 2.56\,\angle 73.69°$$

$$= j\,3 + 0.72 + j\,2.46$$

$$\mathbf{Z}_{Th} = 0.72\,\Omega + j\,5.46\,\Omega$$

$\mathbf{Z_L = Z_{Th}^{*}}$ **=>** $\mathbf{Z}_L = \mathbf{0.72\,\Omega - j\,5.46\,\Omega}$

Thanks