Circuits II
EE221
Unit 11
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Complex Power, Power Conservation, Power Factor Correction, and Applications

Complex Power

- Complex power has real and reactive components.
- Denote the sinusoidal voltage and current in a load by:

$$\hat{V} = V_m \angle \theta_v \qquad \hat{I} = I_m \angle \theta_i$$

- Then the complex power is expressed as:

$$\hat{S} = \frac{\hat{V}\hat{I}^*}{2} = \left[\frac{V_m}{\sqrt{2}} \angle \theta_v\right]\left[\frac{I_m}{\sqrt{2}} \angle -\theta_i\right] = (V_{rms} \angle \theta_v)(I_{rms} \angle -\theta_i) = (V_{rms} I_{rms}) \angle (\theta_v - \theta_i)$$

Complex Power

- The real and imaginary terms of complex power represent the real (P) and reactive (Q) components of the power:

$$\hat{S} = (V_{rms} I_{rms}) \angle (\theta_v - \theta_i) = (V_{rms} I_{rms}) \cos(\theta_v - \theta_i) + j (V_{rms} I_{rms}) \sin(\theta_v - \theta_i)$$

$$\hat{S} = P + jQ$$

- Note that previously described power quantities can be obtained from complex power

$$\text{Apparent Power} = \left|\hat{S}\right| = S = (V_{rms} I_{rms}) \text{ units} \rightarrow \text{VAs}$$

$$\text{Real (Average) Power} = \text{Re}\left(\hat{S}\right) = P = (V_{rms} I_{rms}) \cos(\theta_v - \theta_i) \text{ units} \rightarrow \text{Watts}$$

$$\text{Reactive Power} = \text{Im}\left(\hat{S}\right) = Q = (V_{rms} I_{rms}) \sin(\theta_v - \theta_i) \text{ units} \rightarrow \text{VARs}$$

$$\text{Power Factor} = \frac{P}{S} = \cos(\theta_v - \theta_i)$$