ECE 215 Spring 2025

Objective 1.4: Apparent and Reactive Power

UNITED STATES
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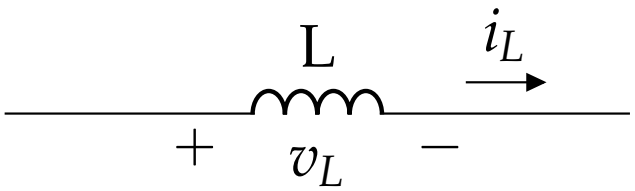
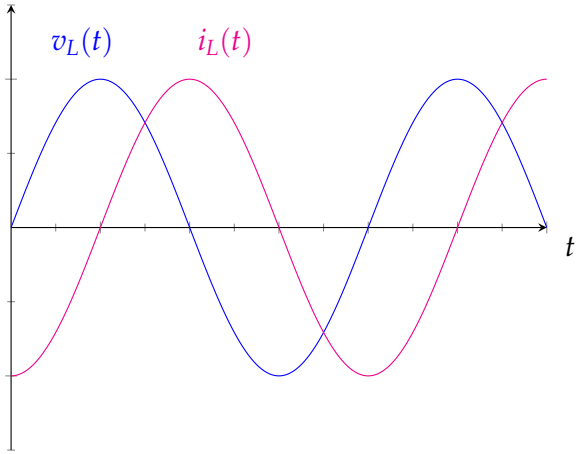
Objective 1.4

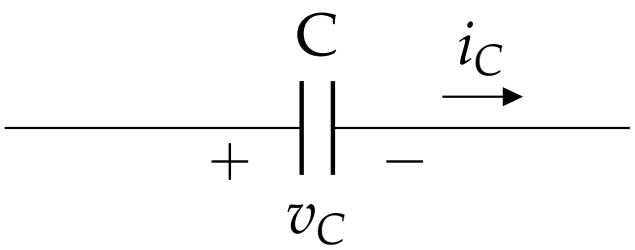
I can compute the reactive and apparent power values for an AC-powered circuit.

Other Circuit Elements

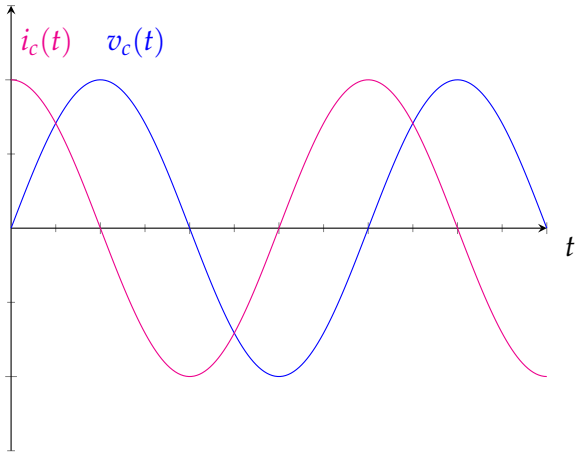


$V_L =$





$I_C =$



Other Circuit Components

Power of L and C

- Inductors and Capacitors consume no real power
- The angle between voltage & current can be between and

Consequences

If V and I are out of phase, not all $P = V_{rms} I_{rms}$ is available as real power.

General Expression for Real Power

$$P = V_{rms}\ I_{rms}\ \cos\theta_v - \theta_i$$

Where does the power go?

Definition

$S \rightarrow$ Apparent Power: the power we thought we would get, based on V_{rms} and I_{rms}.

$$S = V_{rms}\, I_{rms} \rightarrow \text{units of V-A}$$

$$\Longrightarrow \text{pF} = \cos\theta_v - \theta_i = \frac{P}{V_{rms} I_{rms}} = \frac{P}{S}$$

Definition

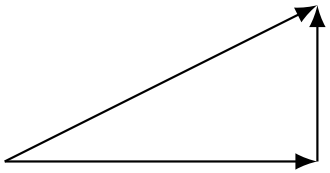
$Q \rightarrow$ Reactive Power: a quantity to account for inductive and capacitive effects in AC circuits.

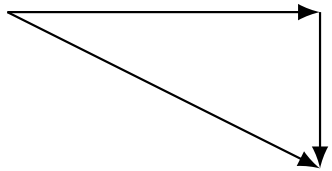
$$Q = V_{rms}\, I_{rms} \sin\theta_v - \theta_i \rightarrow \text{units of VAR}$$

Power Triangle

Putting it all together

$$[V_{rms}I_{rms}\cos\theta_v - \theta_i]^2 + [V_{rms}I_{rms}\sin\theta_v - \theta_i]^2 = [V_{rms}I_{rms}]^2$$
$$\Longrightarrow P^2 = Q^2 = S^2$$



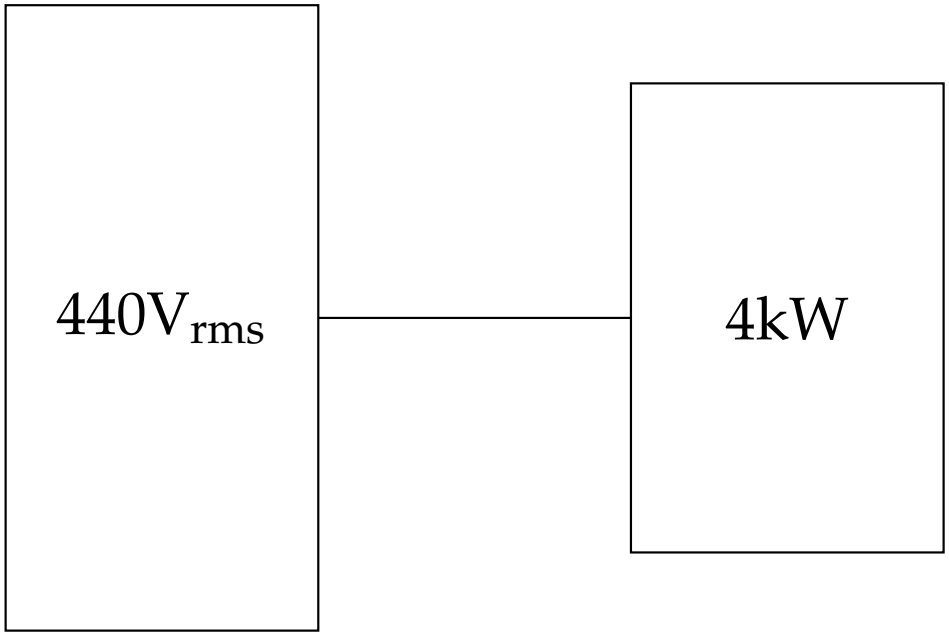


Q =

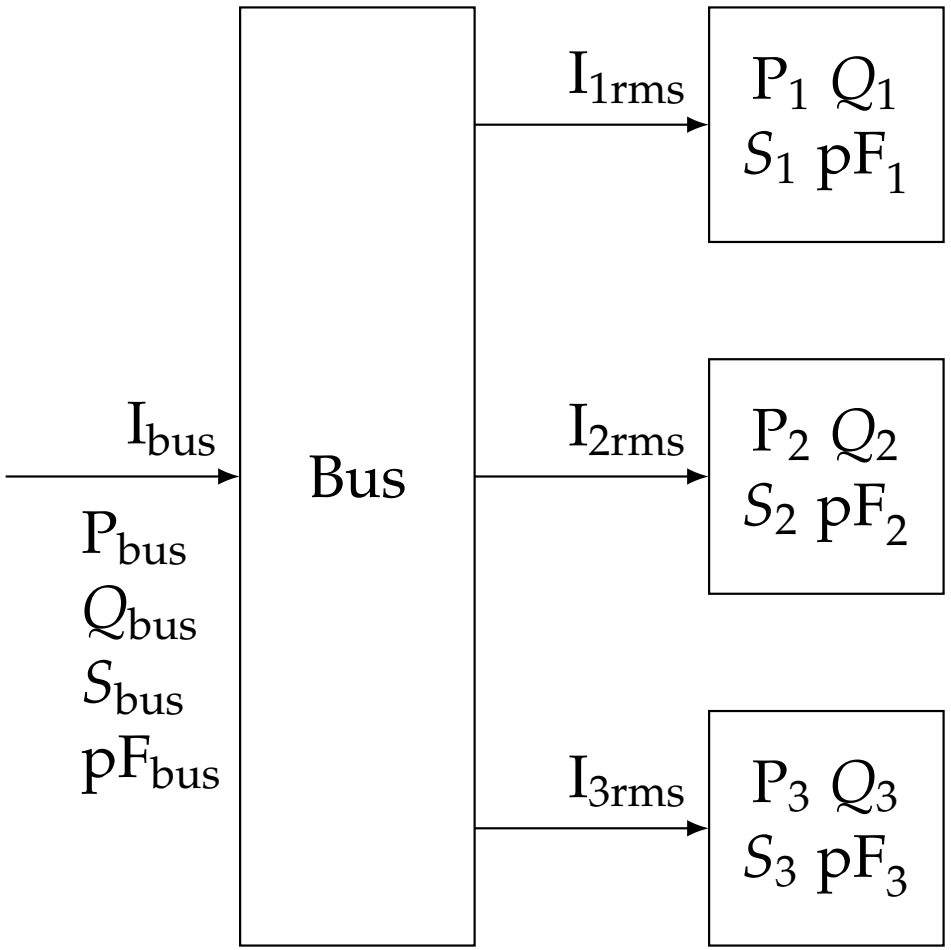
pF is

AC Power Example

A compressor is hooked to a $440V_{rms}$ bus. It is rated at 4kW and has a lagging pF of 0.8. What I_{rms} is drawn from the bus and what reactive power (Q) is consumed by the compressor?



WARNING!



Equalities:

$P_{bus} =$

$Q_{bus} =$

Inequalities:

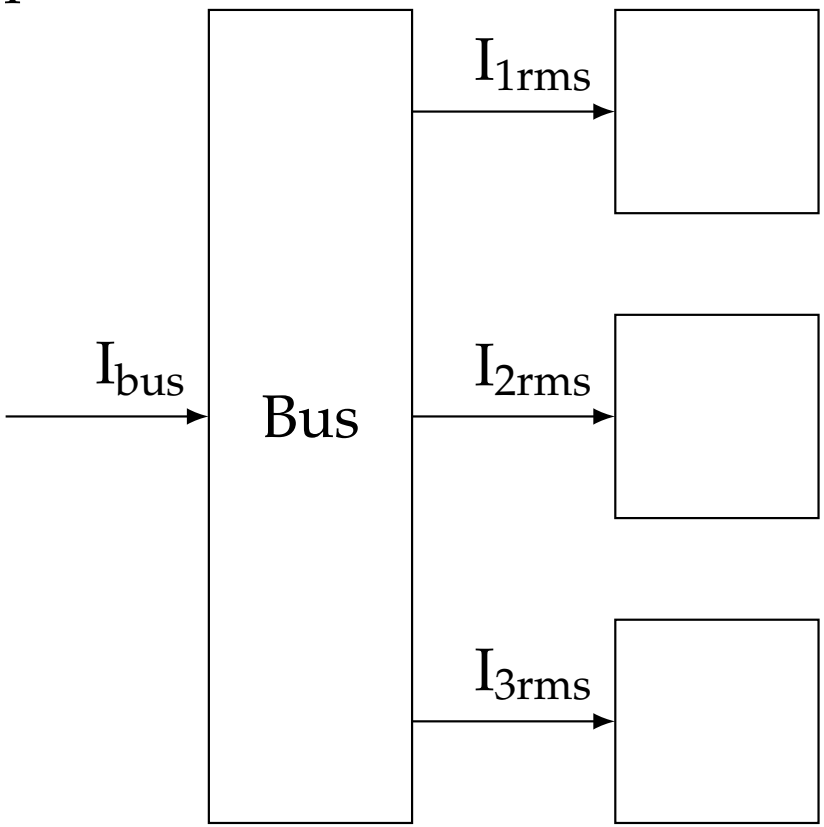
$S_{bus} \neq$

$I_{bus} \neq$

$pF_{bus} \neq$

EXAMPLE 1

There are three loads connected to a $230V_{RMS}$ bus. Load 1 is rated for 800W at a 0.7 lagging power factor. Load 2 is rated for 900W at a 0.9 lagging power factor. Load 3 is rated for 600W at a 0.8 leading power factor. Find the AC RMS current drawn from the bus.



Example 1 (cont'd)

Step 1: Find individual load apparent powers.

Step 2: Find individual reactive powers.

Step 3: Mind your P's and Q's.

Example 1 (cont'd)

Step 4: Find bus apparent power.

Step 5: Find bus I_{rms}

EXAMPLE 2

What value of Q_2 is required to reduce I_{bus} to 9.88A ?