PARALLEL REACTIVE CIRCUITS

AC CIRCUITS

prepared by:

Gyro A. Madrona
Electronics Engineer

TOPIC OUTLINE

Phasor Diagram

Parallel R-L Circuit

Parallel R-C Circuit

Parallel R-L-C Circuit

Power Factor

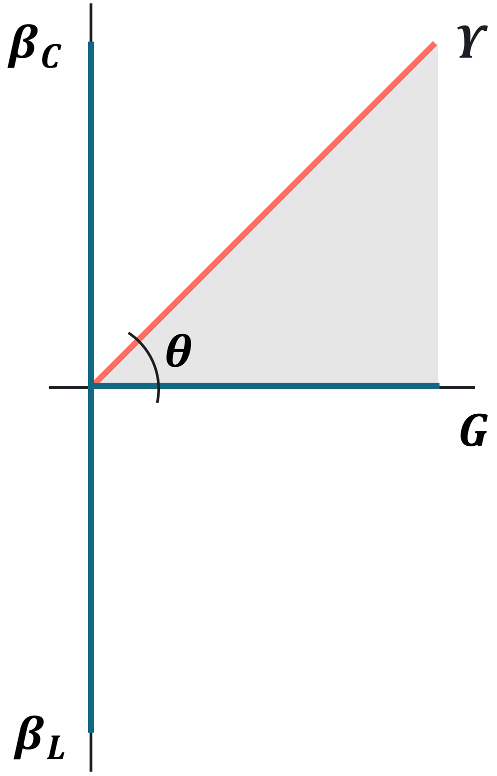
PHASOR DIAGRAM

R-X-Z COMPLEMENT

Ohms (Ω)	Siemens (S)
Resistance $\boldsymbol{R}$	Conductance $\boldsymbol{G = 1/R}$
Reactance $\boldsymbol{X}$	Susceptance $\boldsymbol{\beta = 1/X}$
Impedance $\boldsymbol{Z}$	Admittance $\boldsymbol{\Upsilon = 1/Z}$

PHASOR DIAGRAM

Phasor Diagram



Phasor diagram is a graphical representation of **magnitude** and **phase** relationship between sinusoidal quantities.

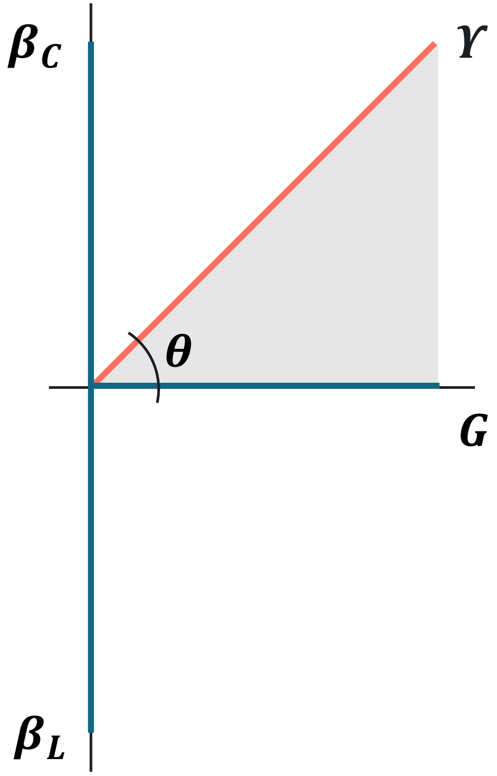
ADMITTANCE

The **admittance** (Υ) represents the **total** ability offered by circuit elements (including resistance and reactance) to **conduct** alternating current (AC).

Formula

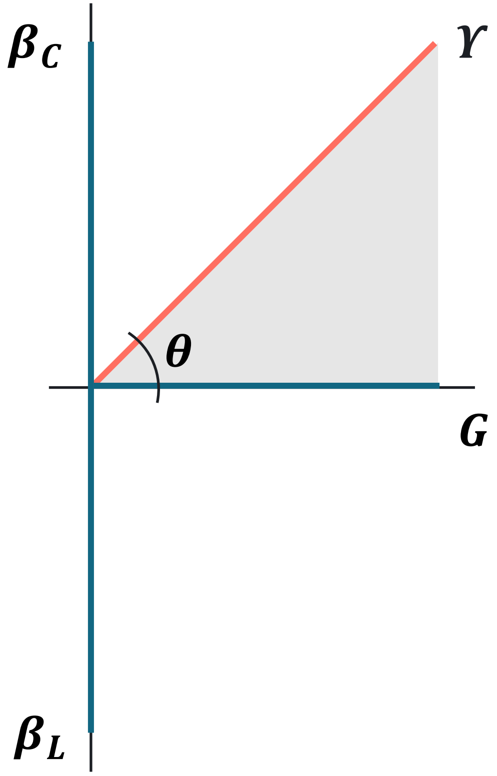
$$\Upsilon = \frac{1}{Z}$$

Phasor Diagram



CAPACITIVE SUSCEPTANCE

Phasor Diagram



The **capacitive susceptance** (β_C) represents the ability of **capacitor** to allow the flow of alternating current (AC).

Formula

$$\beta_C = \frac{1}{X_C}$$

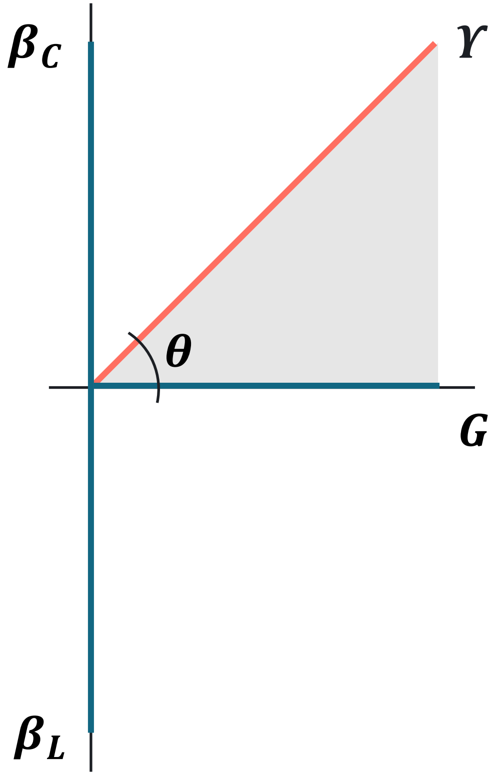
INDUCTIVE SUSCEPTANCE

The **inductive susceptance** (β_L) represents the ability of **inductor** to allow the flow of alternating current (AC).

Formula

$$\beta_L = \frac{1}{X_L}$$

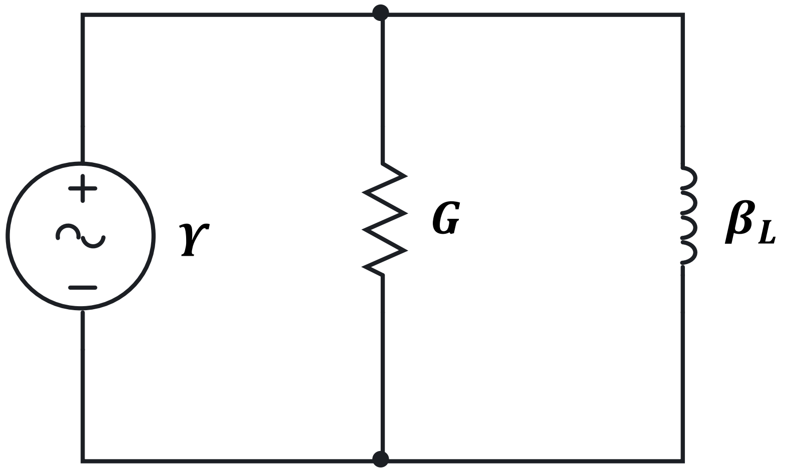
Phasor Diagram



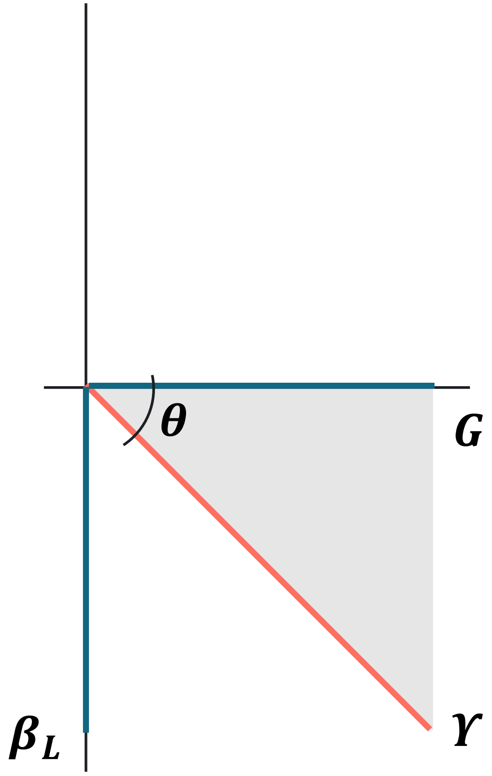
PARALLEL R-L CIRCUIT

PARALLEL R-L CIRCUIT

Circuit Diagram



Admittance Phasor Diagram

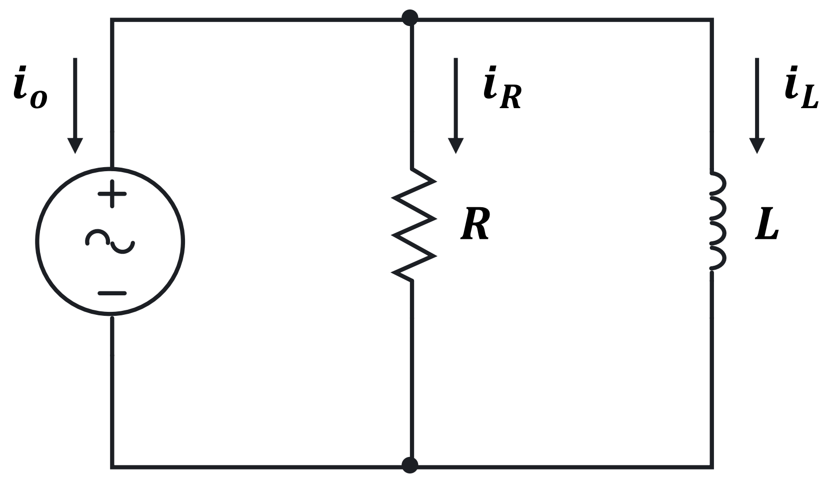


Formula

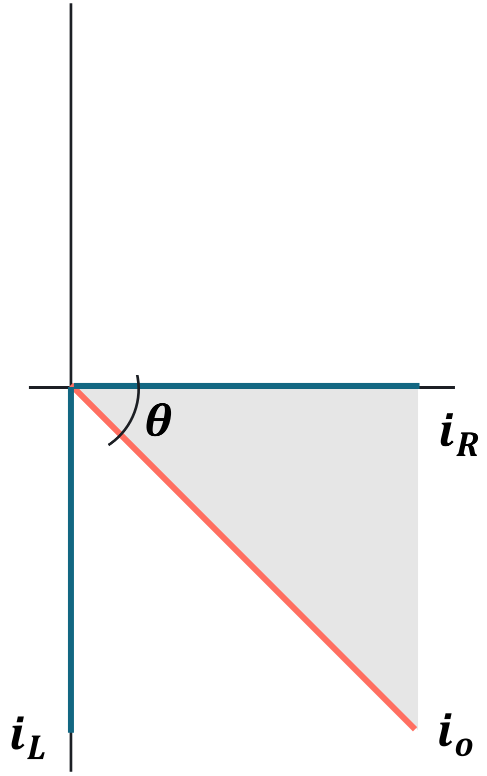
$$\Upsilon = G + j\beta_L$$

PARALLEL R-L CIRCUIT

Circuit Diagram



Current Phasor Diagram

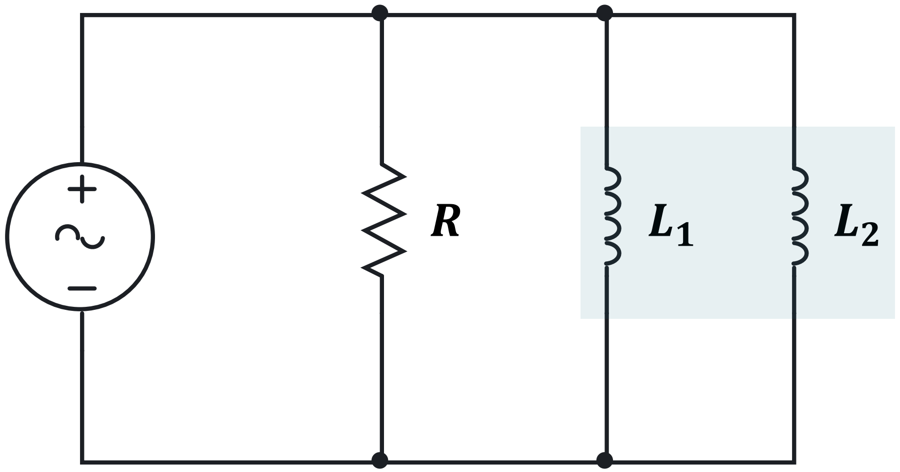


Formula

$$i_o = i_R + j i_L$$

TOTAL INDUCTANCE

Parallel network



In a parallel circuit, the **total inductance** (L_o) is analogous to the total resistance in parallel circuit.

Formula

$$\frac{1}{L_o} = \frac{1}{L_1} + \frac{1}{L_2} + \frac{1}{L_3} + \cdots \frac{1}{L_n}$$

EXERCISE

A $\mathbf{120}\ \boldsymbol{V},\ \mathbf{60}\ \boldsymbol{Hz}$ source is connected to a parallel combination of $\mathbf{30}\ \boldsymbol{\Omega}$ resistor and $\mathbf{100}\ \boldsymbol{mH}$ inductor.

Solution

Determine the following:

a. Equivalent impedance $(\boldsymbol{Z})$

b. Total current $(\boldsymbol{i_o})$

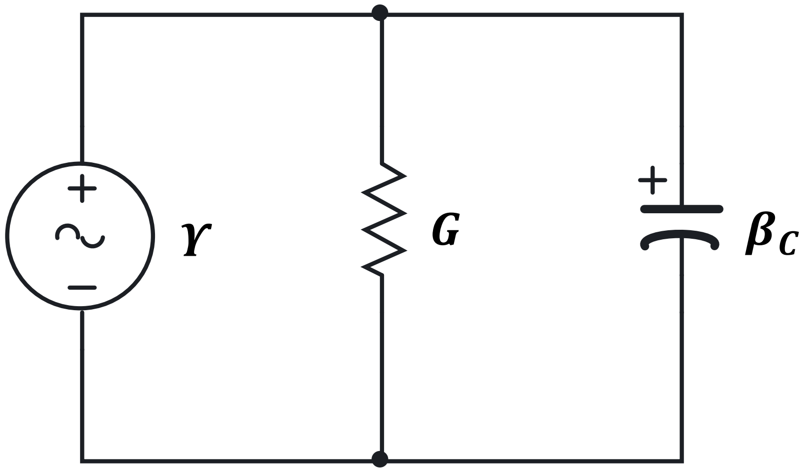
c. Current through the resistor $(\boldsymbol{i_R})$

d. Current through the inductor $(\boldsymbol{i_L})$

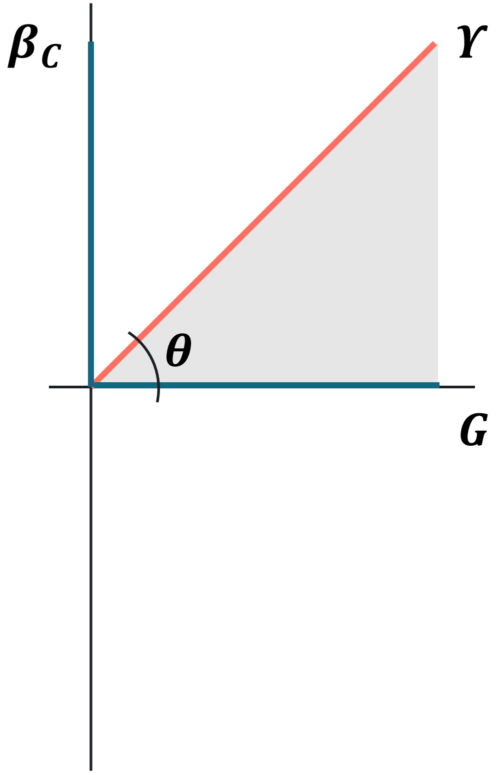
PARALLEL R-C CIRCUIT

PARALLEL R-C CIRCUIT

Circuit Diagram



Admittance Phasor Diagram

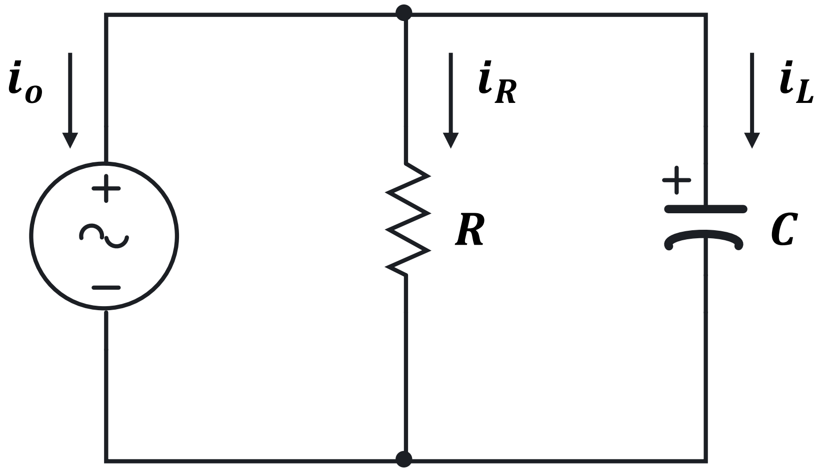


Formula

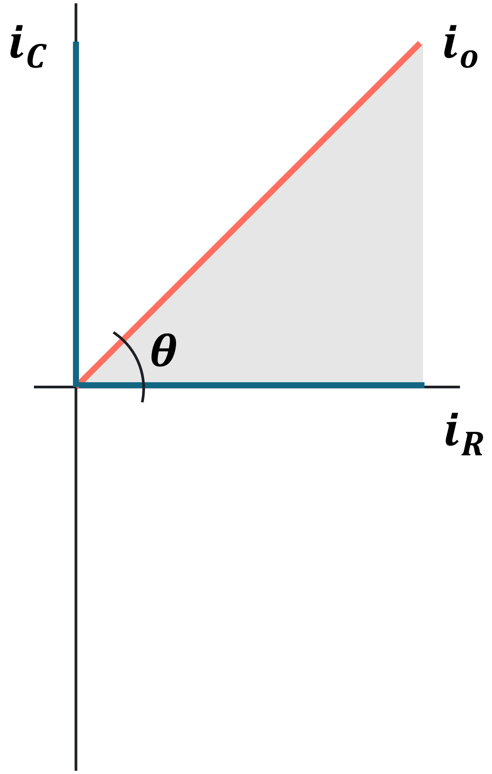
$$\Upsilon = G + j\beta_C$$

PARALLEL R-C CIRCUIT

Circuit Diagram



Current Phasor Diagram



Formula

$$i_o = i_R + ji_C$$

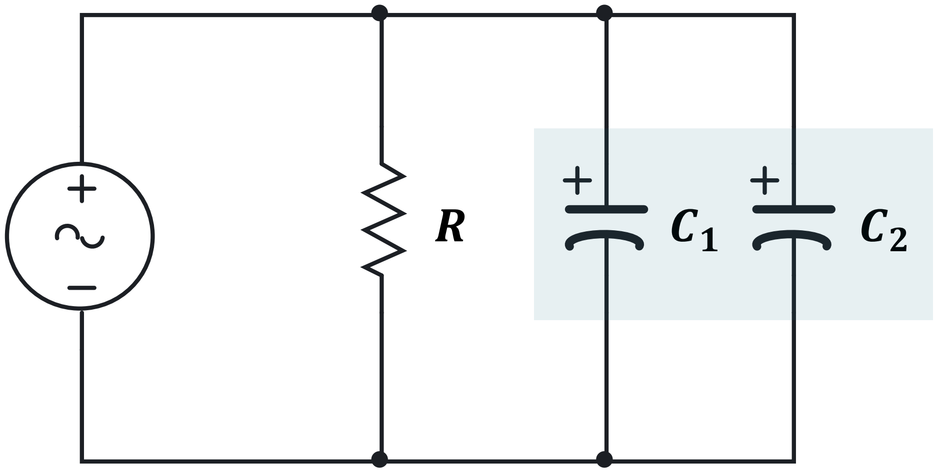
TOTAL CAPACITANCE

In a parallel circuit, the **total capacitance** (C_o) is the **sum** of all individual capacitances.

Formula

$$C_o = C_1 + C_2 + C_3 \ldots C_n$$

Series network



EXERCISE

A $\mathbf{120}\ \boldsymbol{V},\ \mathbf{60}\ \boldsymbol{Hz}$ source is connected to a parallel combination of $\mathbf{10}\ \boldsymbol{\Omega}$ and a $\mathbf{120}\ \boldsymbol{\mu F}$ capacitor.

Solution

Determine the following:

a. Equivalent impedance $(\boldsymbol{Z})$

b. Total current $(\boldsymbol{i_o})$

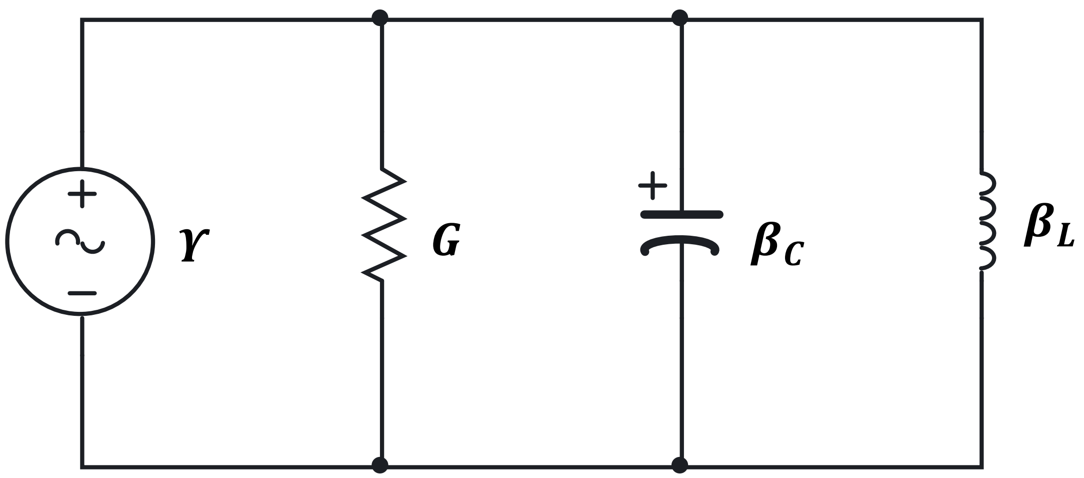
c. Current through the resistor $(\boldsymbol{i_R})$

d. Current through the capacitor $(\boldsymbol{i_C})$

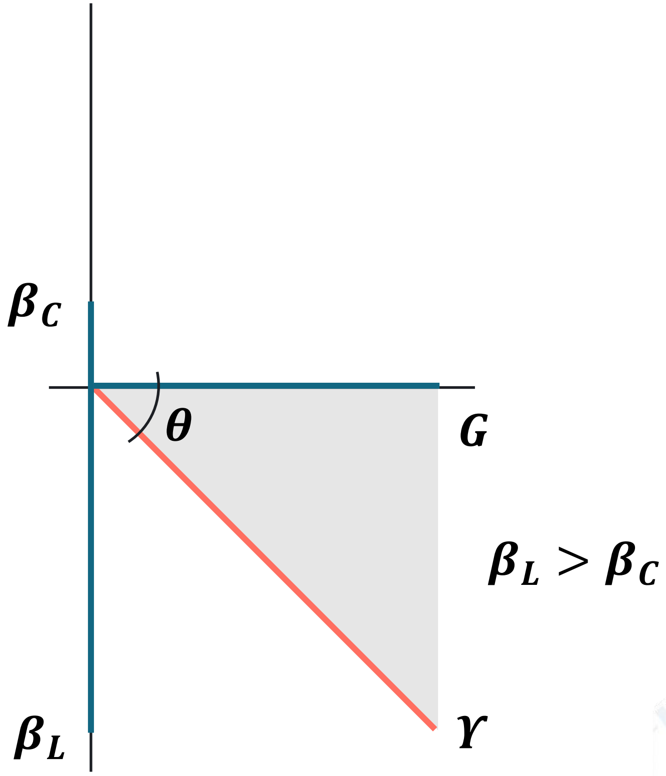
PARALLEL R-L-C CIRCUIT

PARALLEL R-L-C CIRCUIT

Circuit Diagram



Admittance Phasor Diagram

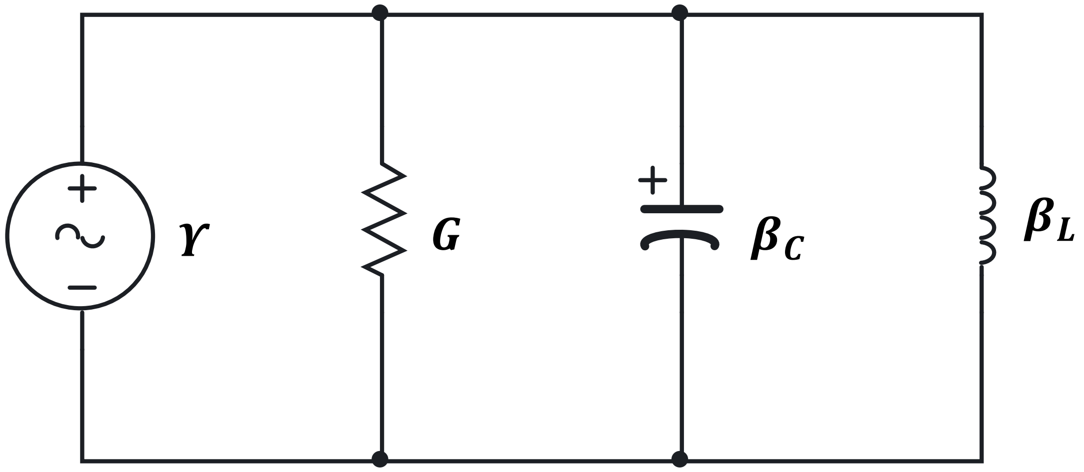


Formula

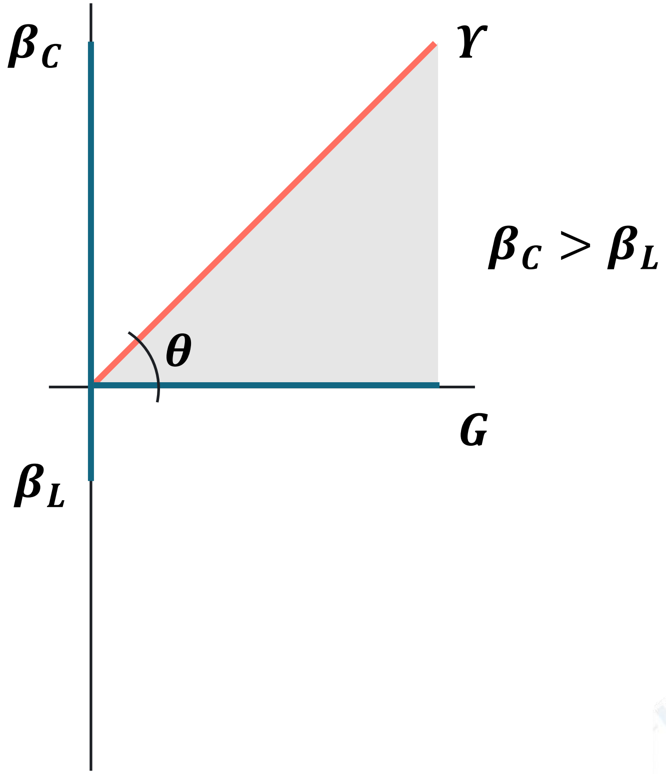
$$Y = G + j(\beta_C - \beta_L)$$

PARALLEL R-L-C CIRCUIT

Circuit Diagram



Admittance Phasor Diagram

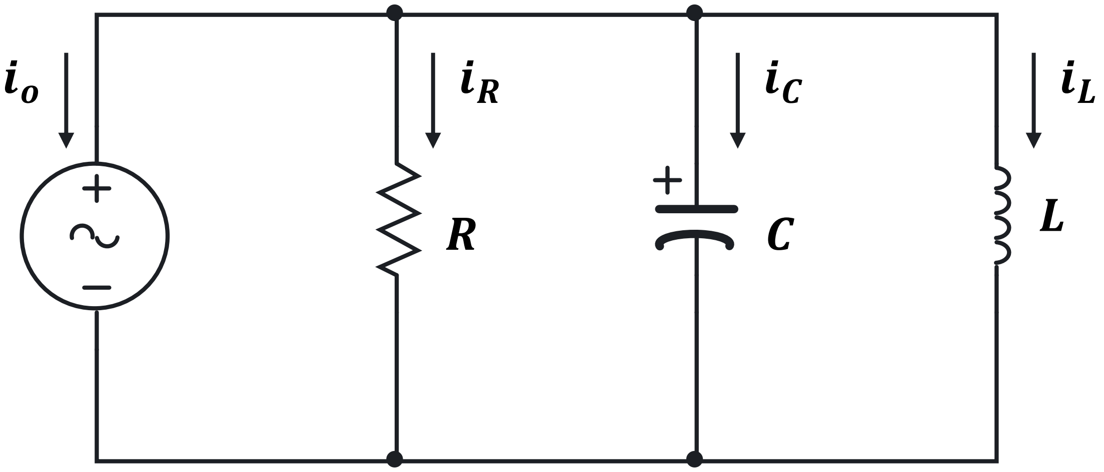


Formula

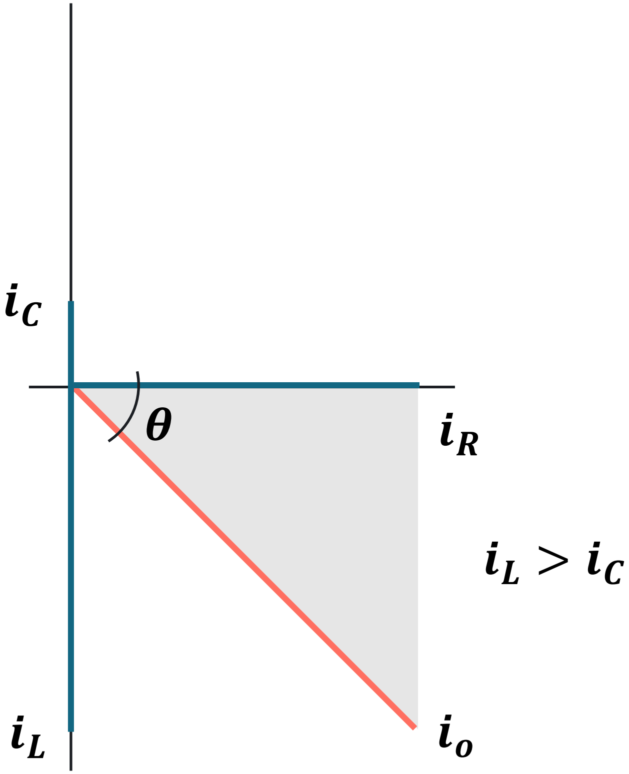
$$\Upsilon = G + j(\beta_C - \beta_L)$$

PARALLEL R-L-C CIRCUIT

Circuit Diagram



Current Phasor Diagram

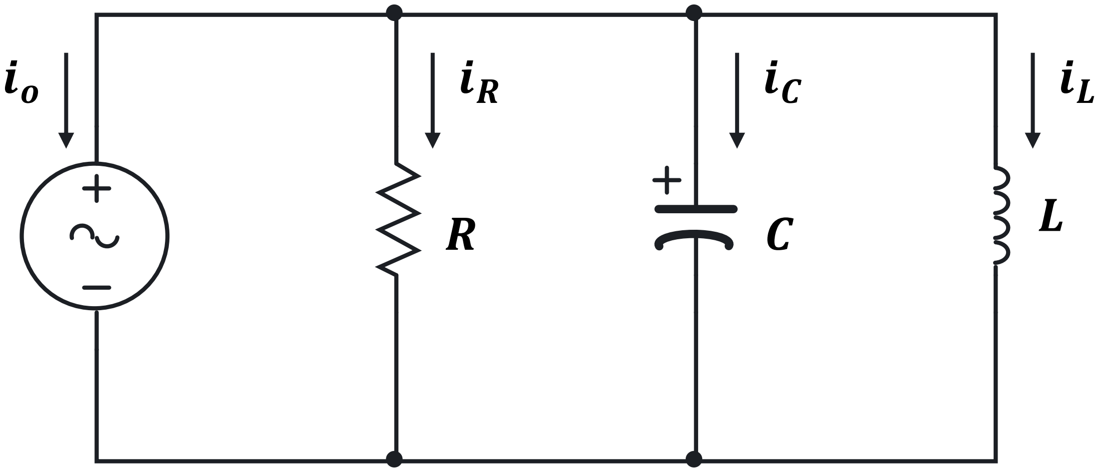


Formula

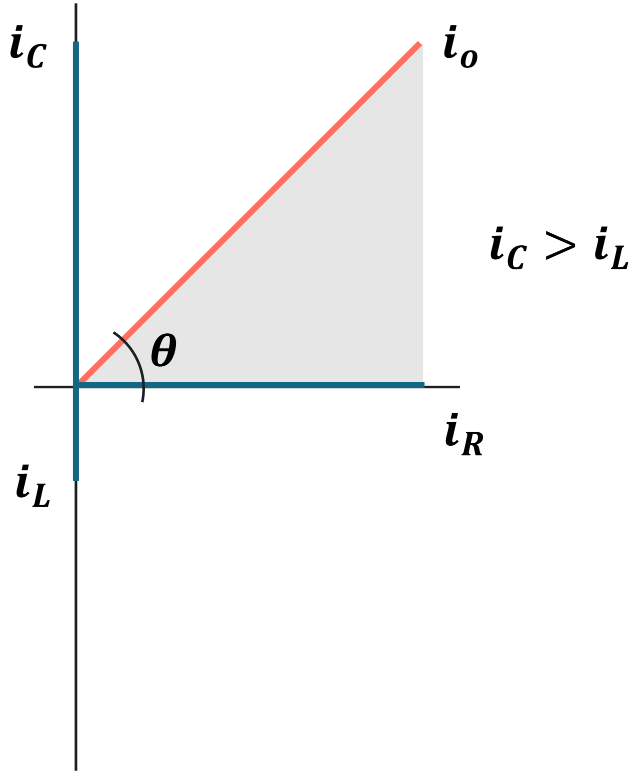
$$i_o = i_R + j(i_C - i_L)$$

PARALLEL R-L-C CIRCUIT

Circuit Diagram



Current Phasor Diagram



Formula

$$i_o = i_R + j(i_C - i_L)$$

EXERCISE

A $\mathbf{50\ \Omega}$ resistor, a $\boldsymbol{20\ mH}$ coil and a $\boldsymbol{5\ \mu F}$ capacitor are all connected in parallel across a $\boldsymbol{50\ V}$, $\boldsymbol{100\ Hz}$ supply.

Solution

Determine the following:

a. Equivalent impedance $(\boldsymbol{Z})$

b. Total current $(\boldsymbol{i_o})$

c. Current through the resistor $(\boldsymbol{i_R})$

d. Current through the inductor $(\boldsymbol{i_L})$

e. Current through the capacitor $(\boldsymbol{i_C})$

POWER FACTOR

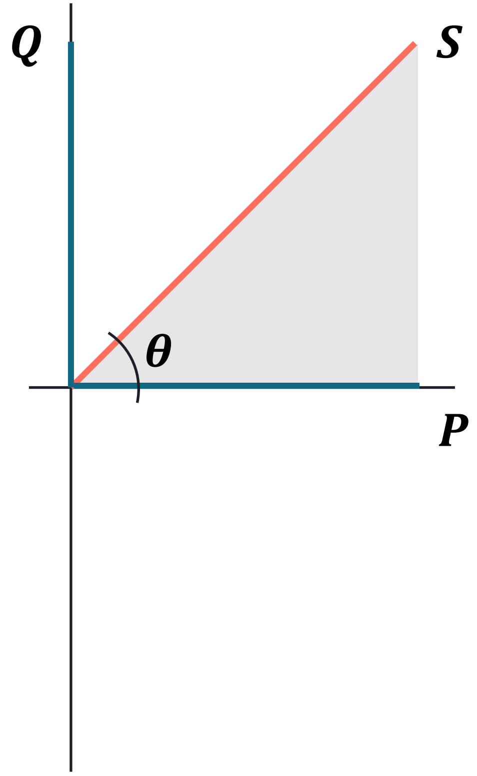
POWER FACTOR

The **power factor** $(\cos\theta)$ represents the ratio of true power to apparent power.

Formula

$$\cos\theta = \frac{P}{S}$$

Power Triangle



TRUE POWER

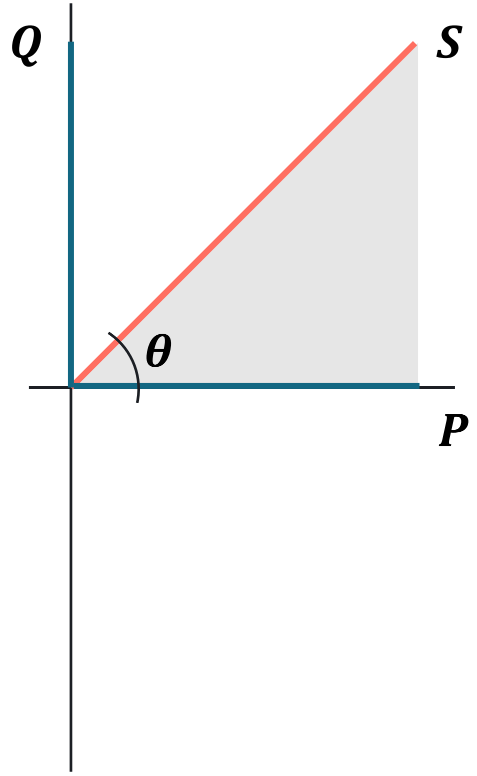
The **true power** ($\boldsymbol{P}$) is the **actual power** consumed by resistive components of a circuit.

Formula

$$\boldsymbol{P = vi\cos\theta}$$

unit: Watt (W)

Power Triangle



REACTIVE POWER

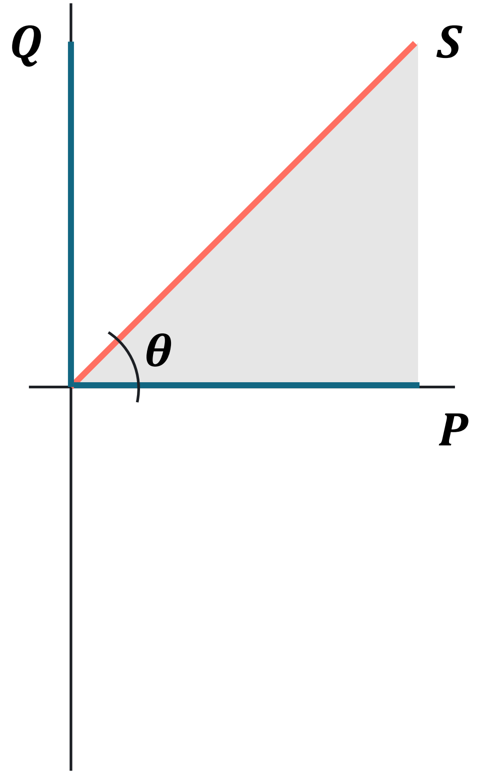
The **reactive power** (Q) is the power consumed by **inductive** or **capacitive** components of a circuit.

Formula

$$Q = vi\sin\theta$$

unit: Volt-Ampere Reactive (VAR)

Power Triangle



APPARENT POWER

The **apparent power** (S) is the vector sum of true power and reactive power, representing the **total power** supplied by the source.

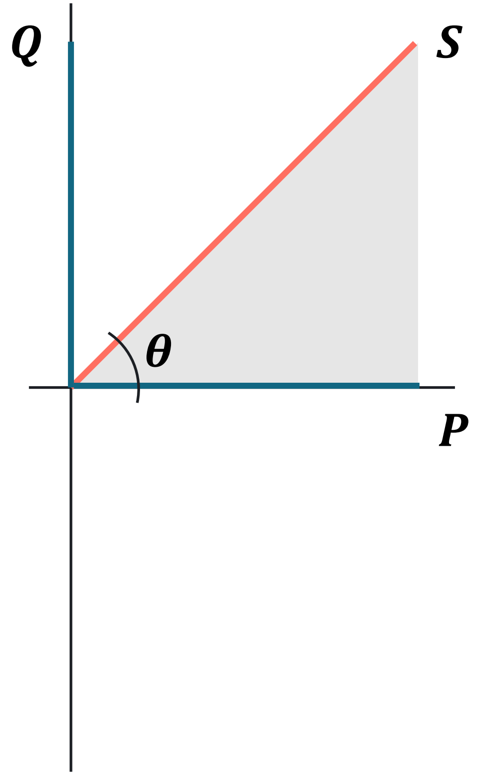
Formula

$$S = P + jQ$$

$$S = vi$$

unit: Volt-Ampere (VA)

Power Triangle



EXERCISE

A $\mathbf{50\ \Omega}$ resistor, a $\boldsymbol{20\ mH}$ coil and a $\boldsymbol{5\ \mu F}$ capacitor are all connected in parallel across a $\boldsymbol{50\ V,\ 100\ Hz}$ supply.

Solution

Determine the following:

a. The power factor $(\boldsymbol{\cos\theta})$

b. The true power $(\boldsymbol{P})$

c. The reactive power $(\boldsymbol{Q})$

d. The apparent power $(\boldsymbol{S})$

LABORATORY