Simple AC Circuits

Spoken Tutorial Project
https://spoken-tutorial.org
National Mission on Education through ICT

Script: Dr. Jagdish Kaur
Narration: Amardeep Kaur
DAV College, Amritsar

21 July 2024

We will learn to,

We will learn to,

▶ **Build simple AC circuits**

Learning Objectives

We will learn to,

► **Build simple AC circuits**

► **Find the phase relation between voltage and current for different AC circuits**

▶ **Calculate capacitive reactance and inductive reactance of the circuits**

System Requirement

System Requirement

- **Windows 11**

System Requirement

- **Windows 11**
- **Google Chrome v123.0.63**

Learners should be familiar with topics in,

Learners should be familiar with topics in,

▶ **Basic science**

Prerequisites

Learners should be familiar with topics in,

▶ **Basic science**

▶ **Simple AC Components**

Alternating Current

Alternating Current

► **Magnitude of AC current changes continuously with time, and its direction reverses periodically**

Alternating Current

- **Alternating Current can be represented by Sine or Cosine curve**

Alternating Current

▶ **Alternating Current can be represented by Sine or Cosine curve**

▶ $I = I_o Sin \, \omega t$

Alternating Current

▶ **Alternating Current can be represented by Sine or Cosine curve**

▶ $I = I_o Sin\,\omega t$

▶ $I = I_o Cos\,\omega t$

Capacitive Reactance

▶ **Capacitive reactance (X_C)**

Capacitive Reactance

▶ **Capacitive reactance (X_C)**

▶ **It is the opposition offered by a capacitor to the change in current**

Capacitive Reactance

► **Capacitive reactance (X_C)**

► **It is the opposition offered by a capacitor to the change in current**

► **It depends inversely on the frequency of the ac source**

Capacitive Reactance

▶ **Capacitive reactance (X_C)**

▶ **It is the opposition offered by a capacitor to the change in current**

▶ **It depends inversely on the frequency of the ac source**

▶ $X_C = \frac{1}{2\pi\nu C}$

Capacitive Reactance

▶ **Capacitive reactance (X_C)**

▶ **It is the opposition offered by a capacitor to the change in current**

▶ **It depends inversely on the frequency of the ac source**

▶ $X_C = \frac{1}{2\pi\nu C}$

▶ **Unit of X_C is ohm(Ω)**

Inductive Reactance

- **Inductive reactance (X_L)**

Inductive Reactance

▶ **Inductive reactance (X_L)**

▶ **It is the opposition offered by an inductor to the change in current**

Inductive Reactance

► **Inductive reactance (X_L)**

► **It is the opposition offered by an inductor to the change in current**

► **It varies directly with the frequency of the ac source**

Inductive Reactance

- Inductive reactance (X_L)
- It is the opposition offered by an inductor to the change in current
- It varies directly with the frequency of the ac source
- $X_L = 2\pi\nu L$

Inductive Reactance

▶ **Inductive reactance** (X_L)

▶ **It is the opposition offered by an inductor to the change in current**

▶ **It varies directly with the frequency of the ac source**

▶ $X_L = 2\pi\nu L$

▶ **Unit of X_L is ohm(Ω)**

Link for PhET Simulation

► **Please use the given link for the Circuit construction kit: AC Virtual Lab https://phet.colorado.edu/sims/html/construction-kit-ac-virtual-lab**

► **The frequency of AC voltage source is 0.5 Hz**

Capacitive Reactance

▶ **The frequency of AC voltage source is 0.5 Hz**

▶ **Capacitance of the capacitor is 0.1 F**

Capacitive Reactance

▶ **The frequency of AC voltage source is 0.5 Hz**

▶ **Capacitance of the capacitor is 0.1 F**

▶ $X_C = \frac{1}{2\pi\nu C} = \frac{1}{2\times 3.14 \times 0.5 \times 0.1}$

Capacitive Reactance

▶ **The frequency of AC voltage source is 0.5 Hz**

▶ **Capacitance of the capacitor is 0.1 F**

▶ $X_C = \frac{1}{2\pi\nu C} = \frac{1}{2\times3.14\times0.5\times0.1}$

▶ $X_C = 3.18\,\Omega$

► **The frequency of AC voltage source is 0.5 Hz**

Inductive Reactance

▶ **The frequency of AC voltage source is 0.5 Hz**

▶ **Inductance of the inductor is 5 H**

Inductive Reactance

▶ **The frequency of AC voltage source is 0.5 Hz**

▶ **Inductance of the inductor is 5 H**

▶ $X_L = 2\pi\nu L = 2 \times 3.14 \times 0.5 \times 5$

Inductive Reactance

- **The frequency of AC voltage source is 0.5 Hz**

- **Inductance of the inductor is 5 H**

- $X_L = 2\pi\nu L = 2 \times 3.14 \times 0.5 \times 5$

- $X_L = 15.7\,\Omega$

Series AC Circuits

▶ **In AC Circuits resistor, capacitor and inductor are connected in series**

Series AC Circuits

▶ **In AC Circuits resistor, capacitor and inductor are connected in series**

▶ **The impedance (Z) is the total opposition to the flow of current in the AC circuit**

Series AC Circuits

▶ **In AC Circuits resistor, capacitor and inductor are connected in series**

▶ **The impedance (Z) is the total opposition to the flow of current in the AC circuit**

▶ $Z = \sqrt{R^2 + (X_L - X_C)^2}$

For,

For,

▶ **LC circuit, R = 0,**

For,

▶ **LC circuit, R = 0,**

▶ **RC circuit, $X_L = 0$ and**

For,

▶ **LC circuit, R = 0,**

▶ **RC circuit, $X_L = 0$ and**

▶ **LR circuit, $X_C = 0$**

► **The resistance of the resistor is 10** Ω

Series AC Circuits

▶ **The resistance of the resistor is 10** Ω

▶ **The capacitance is 0.10 F**

Series AC Circuits

- ▶ **The resistance of the resistor is 10 Ω**

- ▶ **The capacitance is 0.10 F**

- ▶ **Capacitive reactance, $X_C = 3.18\,\Omega$**

Series AC Circuits

▶ **The resistance of the resistor is 10 Ω**

▶ **The capacitance is 0.10 F**

▶ **Capacitive reactance, $X_C = 3.18\,\Omega$**

▶ **Impedance(Z) $= \sqrt{(R^2 + X_C^2)}$**

Series AC Circuits

- **The resistance of the resistor is 10 Ω**

- **The capacitance is 0.10 F**

- **Capacitive reactance, $X_C = 3.18\,\Omega$**

- **Impedance(Z) $= \sqrt{(R^2 + X_C^2)}$**

- $Z = 4.48\,\Omega$

Summary

Using this simulation we,

▶ Built simple AC circuits

▶ Found the phase relation between voltage and current for different AC circuits

▶ Calculated capacitive reactance & inductive reactance of the circuits

Assignment

▶ **Change the frequency of the AC voltage source to 0.75 hertz and 1.0 hertz**

▶ **Find capacitive reactance and inductive reactance at these frequencies**

Assignment

Find the phase relation between voltage and current for:

▶ **Series LC circuit**

▶ **Series RL circuit**

About the Spoken Tutorial Project

- ▶ **Watch the video available at**
  https://spoken-tutorial.org /What_is_a_Spoken_Tutorial

- ▶ **It summarises the Spoken Tutorial project**

About the Spoken Tutorial Project

- ▶ **Watch the video available at https://spoken-tutorial.org /What_is_a_Spoken_Tutorial**

- ▶ **It summarises the Spoken Tutorial project**

- ▶ **If you do not have good bandwidth, you can download and watch it**

Spoken Tutorial Workshops

The Spoken Tutorial Project Team

▶ **Conducts workshops using spoken tutorials**

▶ **Gives certificates to those who pass an online test**

▶ **For more details, please write to contact@spoken-tutorial.org**

Forum questions

▶ **Questions in THIS Spoken Tutorial?**

▶ **Visit https://forums.spoken-tutorial.org**

▶ **Choose the minute and second where you have the question**

▶ **Explain your question briefly**

▶ **The Spoken Tutorial project will ensure an answer**

You will have to register to ask questions

Acknowledgements

The `Spoken Tutorial` **project was established by the** `Ministry of Education,` **Govt. of India**

Thank You!

- ▶ **This tutorial is contributed by Dr. Jagdish Kaur and Muskandeep Kaur from DAV College Amritsar**
- ▶ **Thank you for joining**