Practical No. 3: Phase difference between voltage and current in inductive circuit

I Practical Significance:

Phase difference between voltage and current in resistive and inductive circuits plays an important role in electrical and electronic engineering. Because without these components such as relays, solenoids, inductors, chokes, coils, loudspeakers, motors, generators, transformers and electricity meters etc, would not work. Phase difference between voltage and current in a circuit depends on parameters of the circuit. Based on this, circuit has lagging, leading or unity power factor.

II Industry/ Employer Expected Outcomes(s):

Apply basic concept of electrical and electronic engineering in various applications in relevant technical fields.

III Course Level Learning Outcomes(s):

Calculate and measure basic electrical quantities and parameters.

IV Laboratory Learning Outcomes(s):

LLO Measure the phase difference between voltage and current in the AC circuit of the inductive circuit

V Relevant Affective Domain related outcome(s):

Follow safe practices when undertaking electrical works.

VI Minimum Theoretical Background:

The **phase difference** or phase shift as it is also called of a Sinusoidal Waveform is the angle Φ (Greek letter Phi), in degrees or radians that the waveform has shifted from a certain reference point along the horizontal zero axis. In other words, phase shift is the lateral difference between two or more waveforms along a common axis and sinusoidal waveforms of the same frequency can have a phase difference.

The phase difference, Φ of an alternating waveform can vary between 0 to its maximum time period, T of the waveform during one complete cycle and this can be anywhere along the horizontal axis between, $\Phi = 0$ to 2π (radians) or $\Phi = 0$ to $360°$depending upon the angular units used.

Then the equation for the instantaneous value of a sinusoidal voltage or current waveform for pure resistive circuit are

$I_r = I_m \sin\omega t$ and $V_r = V_m \sin\omega t$

And for pure inductive circuit are

$I_L = I_m \sin\omega t$ and $V_L = V_m \sin(\omega t + 90)$

And for R-L (resistive and inductive) circuit is

$I = I_m \sin\omega t$ and $V = V_m \sin(\omega t + \Phi)$,

Where Φ represents phase angle.

VIII Resources required:

S. No.	Particulars	Specification	Quantity
1	Rheostat	Suitable rating	1
2	Inductor	Suitable rating	1
4	Voltmeter	Suitable rating	2
5	Ammeter	Suitable rating	1
6	Wattmeter	Suitable rating	1
7	Single phase autotransformer	Suitable rating	1

IX Precautions to be followed:

1. All electrical connections should be neat and tight.
2. Check the power supply before connection.
3. Connect Ammeter in series.
4. Connect Voltmeter in parallel.

X Procedure:

1. Connect the circuit as per circuit diagram.
2. Set rheostat at maximum position.
3. By using autotransformer apply the voltage.
4. Measure the voltage across R and L, measure current and power
5. Repeat the procedure for different voltages.
6. Draw phasor diagram for above readings.

XI Resources used:

S. No.	Name of Resource	Broad Specifications	Quantity	Remarks (If any)
1.	Rheostat	Suitable rating	1	1
2.	Inductor	Suitable rating	1	1
3.	Voltmeter	Suitable rating	2	2
4.	Ammeter	Suitable rating	1	1
5.	Wattmeter	Suitable rating	1	1
7	single phase autotransformer	Suitable rating	1	1

XII Actual procedure followed:

1. Connect circuit as per circuit diagram.
2. Set Rheostat at maximum position.
3. By using auto transformer apply the voltage.
4. Measure the voltage across R & L, measure current and power.
5. Repeat the procedure for different voltages.
6. Draw phasor diagram for above readings.

XIII Observations and Calculations:

Sr. No.	Supply voltage V (volts)	Current I (amp)	Voltage across resistance VR volts	Voltage across choke coil VL volts	Power P (watts) P=V×I.
	12.2	0.2	26	105	2.44.
	17.9	0.3	40	158	5.37
	23.5	0.4	54	206	94.

Calculations:

Sr. No.	Vr= I*R	Voltage across pure inductance $V_L=\sqrt{V}coil^2 - Vr^2)$	$R=V_R/I$	$X_L=V_L/I$	Z=V/I	Cos(Φ)= P/VI	Φ	Reactive power Q (VAR)	Apparent power S (VA)
	0.213 ~~2.44~~	0.2	130.	525	61	0.04.	0.99	44.01	312 VA
39.9	~~5.37~~	0.3	133.33	526.66	59.66	0.09.	0.99	101.00	715 VA
54	9.4	0.5	135	515	587.5	0.16	0.99.	179.01	1269 VA.

XIV Results:

phase difference, voltage & current in a circuit depends on parameter of the circuit.

XV Interpretation of results:

Phase difference , voltage & current in a circuit depends on parameter of the circuit.

XVI Conclusions and Recommendations (if any):

Hence we studied to difference of phase voltage & current.

XVII Practical Related Questions:

Note: Below given are few sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO.

1. Give current, voltage relation in R, L and C element.
2. Draw phasor diagrams showing the relation of V_1, V_2 and V_3
3. Calculate the power factor of the circuit.
4. Obtain phase difference between supply voltage and current for your set-up.
5. Write the concept of lagging and leading power factor.

(Space to write answers)

1. Resistor (R) V = I X R. Inductor (L) V = L X (dI/dt) Capacitor (C) I = C X (dV/dt).

3. Power factor (PF) = R/Z , Power factor (PF) = cos (ϕ).

4. the phase difference depend on circuit components (RLC) In resistive circuit it is 0 , in RL circuit Voltage leads in an RC circuit.

5. A lagging power factor occurs in inductive loads where current lags voltage. A leading power factor occurs in capacitive loads where current leads voltage.

2. the phasor diagram represents the phase difference between voltage components in a circuit , Voltage , leads , for an AC circuit.