UTM UNIVERSITI TEKNOLOGI MALAYSIA

Sekolah Pendidikan Profesional dan Pendidikan Berterusan (SPACE)

JABATAN KEJURUTERAAN ELEKTRIK
PUSAT PENGAJIAN DIPLOMA (PPD), SPACE
UNIVERSITI TEKNOLOGI MALAYSIA
KUALA LUMPUR

ELECTRICAL ENGINEERING LABORATORY 2

(DDWE 2701)

CIRCUIT THEORY 2

<u>THEORY & PRELIMINARY LABORATORY 2</u>

AC CIRCUIT ANALYSIS

Student name	:
Lecturer	:
Date	:

No.	PO	CO	Student Marks	Marks
1	PO1	CO1		/20

Submit the completed preliminary report to the lecturer in the lab before the lab session starts.

THEORY

When a sine wave at some frequency is applied to a circuit that contains passive elements, the voltage and current waveforms in all elements of the circuit are also sine waves of the same frequency.

The sinusoidal voltage as a function of time is given by $V(t)=V_p \sin \omega t$. Voltage across capacitor and inductor as a function of time given by $V(t) = V_p \sin (\omega t \pm \theta)$.

Passive elements like inductor and capacitor introduce phase shifts between voltages and currents in the circuit. The current in the circuit is given by $i(t) = I_p \sin (\omega t \pm \theta)$. The phase relation between the voltages and currents of the same frequency can be easily determined using phasor quantities. Phasors are very useful for representing sine waves in terms of their magnitude and phase angle and for analysis of reactive circuits.

$$\boldsymbol{V} = \frac{\boldsymbol{V_p}}{\sqrt{\boldsymbol{2}}} \angle \pm \emptyset^\circ = \boldsymbol{V_{rms}} \angle \pm \emptyset^\circ$$

1. SERIES RL CIRCUIT

The inductance causes a phase shift between the voltage and current that depends on the relative values of the resistance and the inductive reactance. Consider the circuit of Figure 1.

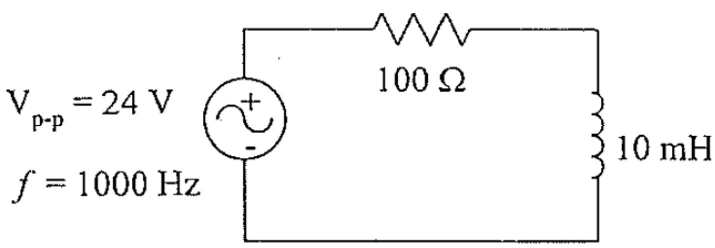


Figure 1

The inductive reactance is

$$X_L = 2\pi f L = 2\pi(1000)(10\ m) = 62.84\ \Omega$$

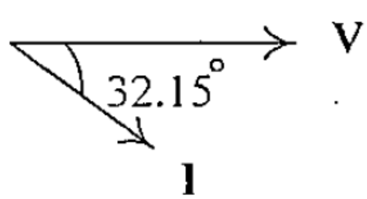
The total impedance is

$$Z = R + jX_L = 100\ \Omega + j\ 62.84\ \Omega = 118.11 \angle 32.15^\circ\ \Omega$$

The total current in the circuit is

$$I = \frac{V}{Z} = \frac{8.48\angle 0^\circ}{118.11\angle 32.15^\circ} = 71.80\angle -32.15^\circ\ mA$$

The phasor diagram for V and I is shown below. Taking V as reference, I lags V by 32.15°.



Using Ohm's law, the voltage across the inductor is

$$V_L = I \times Z_L = (71.80 \angle{-32.15^\circ}\ \text{m})(62.84 \angle 90^\circ\ \Omega) = 4.51 \angle 57.85^\circ$$

2. SERIES RC CIRCUIT

The capacitance causes a phase shift between the voltage and current that depends on the relative values of the resistance and the capacitive reactance. Consider the circuit of Figure 2.

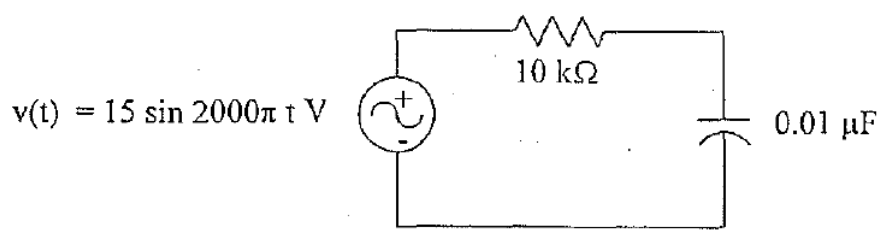


Figure 2

The capacitive reactance is

$$X_C = \frac{1}{2\pi f C} = \frac{1}{2\pi(1000)(0.01\mu)} = 15.91\ k\Omega$$

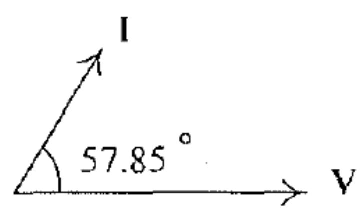
The total impedance of the circuit is

$$Z = R - jX_C = 10\ \text{k}\Omega - j15.91\ \text{k}\Omega = 18.79 \angle{-57.85^\circ}\ \text{k}\Omega$$

The total current in the circuit is

$$I = \frac{V}{Z} = \frac{10.61\angle 0^\circ}{18.79\angle -57.85^\circ\ k} = 564.66\angle 57.85^\circ\ \mu A$$

The phasor diagram for V and] is as shown where] leads V by 57.85



Using Ohm's law, the voltage across the capacitor is

$$V_c = I \times Z_c = (564.66 \angle 57.85^\circ\ \mu)(15.91\angle{-90^\circ}\ \text{k}) = 8.98 \angle{-32.15^\circ}\ \text{V}$$

PRELIMINAHY WORK: SERIES RL CIRCUIT

1. Given a series RL circuit as shown in Figure 3. Calculate

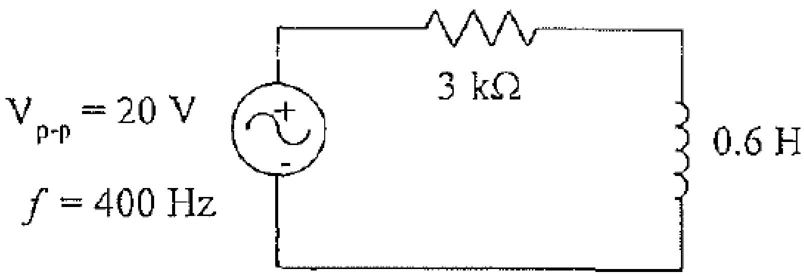


Figure 3

i. the inductive reactance, X_L.

PO1	CO1	.... /2m

ii. the total impedance of the circuit, Z.

PO1	CO1	.... /2m

iii. the total current in the circuit. I.

PO1	CO1	.... /2m

iv. the voltage across the inductor, V_L.

PO1	CO1	.... /2m

v. draw the phasor diagram for V_L and I.

PO1	CO1	.... /2m

PRELIMINARY WORK SERIES RC CIRCUIT

1. Given a series RC circuit as shown in Figure 4. Calculate

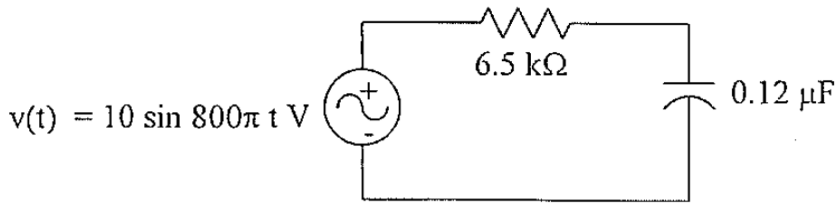


Figure 4

i. the capacitive reactance, Xc.

PO1	CO1	……… /2m

ii. the total impedance of the circuit, Z.

PO1	CO1	……… /2m

iii. the total current in the circuit, I.

PO1	CO1	……… /2m

iv. the voltage across the capacitor, Vc.

PO1	CO1	……… /2m

v. draw the phasor diagram for Vc and I.

PO1	CO1	……… /2m