Q **Calculate the power dissipated by a 560 Ω resistor, when connected to a $v = 35 \sin 314t$ volt supply.**

A

$R = 560\,\Omega$; $V_m = 35\text{V}$

The r.m.s. value for the voltage, $V = 0.707\,V_m$ volt

so, $V = 0.707 \times 35 = 24.75$ V

$$P = \frac{V^2}{R} \text{ watt} = \frac{24.75^2}{560}$$

therefore, $P = 1.09$ W **Ans**

Q **A pure 20 mH inductor is connected to a 30 V, 50 Hz supply. Calculate (a) the reactance at this frequency, and (b) the resulting current flow.**

A

$L = 20 \times 10^{-3}$ H; $V = 30$ V; $f = 50$ Hz

(a) $X_L = 2\pi fL$ ohm $= 2 \times \pi \times 50 \times 20 \times 10^{-3}$

so $X_L = 6.283\,\Omega$ **Ans**

(b) $I = \dfrac{V}{X_L}$ amp $= \dfrac{30}{6.283}$

so $I = 4.77$ A **Ans**

Q **A current of 250 mA flows through a perfect inductor, when it is connected to a 5 V, 1 kHz supply. Determine the inductance value.**

A

$I = 0.25$ A; $V = 5$V; $f = 1000$ Hz

Firstly, the inductive reactance must be calculated:

$$X_L = \frac{V}{I} \text{ ohm} = \frac{5}{0.25}$$

therefore, $X_L = 20\Omega$

Since $X_L = 2\pi fL$ ohm, then $L = \dfrac{X_L}{2\pi f}$ henry

$$L = \frac{20}{2 \times \pi \times 1000}$$

therefore, $L = 3.18$ mH **Ans**

Q A coil of inductance 400 μH, and of negligible resistance, is connected to a 5 kHz supply. If the current flow is 15 mA, determine the supply voltage.

A

$L = 400 \times 10^{-6}$ H; $f = 5 \times 10^{3}$ Hz; $I = 15 \times 10^{-3}$ A

$$X_L = 2\pi f L \text{ ohm} = 2 \times \pi \times 5 \times 10^{3} \times 400 \times 10^{-6}$$

$$\text{so, } X_L = 12.57\,\Omega$$

$$V = I X_L \text{ volt} = 15 \times 10^{-3} \times 12.57$$

$$\text{so, } V = 188.5 \text{ mV} \textbf{ Ans}$$

Q A 0.47 μF capacitor is connected to a variable frequency signal generator, which provides an output voltage of 25 V. Calculate the current flowing when the frequency is set to (a) 200 Hz, and (b) 4 kHz.

A

$C = 0.47 \times 10^{-6}$ F; $V = 25$ V; $f_1 = 200$ Hz; $f_2 = 4000$ Hz

(a)
$$X_{C_1} = \frac{1}{2\pi f_1 C} \text{ ohm} = \frac{1}{2 \times \pi \times 200 \times 0.47 \times 10^{-6}}$$
$$X_{C_1} = 1.693 \text{ k}\Omega$$
$$I_1 = \frac{V}{X_C} \text{ amp} = \frac{25}{1693}$$
therefore, $I_1 = 14.77$ mA **Ans**

(b)
$$X_{C_2} = \frac{1}{2\pi f_2 C} \text{ ohm} = \frac{1}{2 \times \pi \times 4000 \times 0.47^{-6}}$$
$$X_{C_2} = 84.66 \ \Omega$$
$$I_2 = \frac{V}{X_{C_2}} \text{ amp} = \frac{25}{84.66}$$
therefore, $I_2 = 295.3$ mA **Ans**

Alternatively, we can say that since

$f_2 = 5 \times f_1$, then $X_{C_2} = X_{C_1}/5 = 84.66 \ \Omega$
Hence, $I_2 = 5 \times I_1 = 295.3$ mA **Ans**

Q **At what frequency will the reactance of a 22 pF capacitor be 500 Ω?**

A

$C = 22 \times 10^{-12}$ F; $X_C = 500\,\Omega$

$$X_C = \frac{1}{2\pi fC} \text{ ohm; so } f = \frac{1}{2\pi CX_C} \text{ Hz}$$

$$\text{therefore, } f = \frac{1}{2 \times \pi \times 500 \times 22 \times 10^{-12}}$$

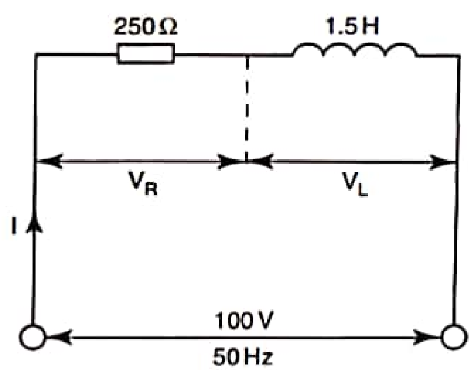
hence, $f = 14.47$ MHz **Ans**

Q A resistor of 250 Ω, is connected in series with a 1.5 H inductor, across a 100 V, 50 Hz supply. Calculate (a) the current flowing, (b) the circuit phase angle, (c) the p.d. developed across each component and (d) the power dissipated.

A

$R = 250\,\Omega; L = 1.5\,\text{H}; V = 100\,\text{V}; f = 50\,\text{Hz}$

The relevant circuit and phasor diagrams are shown in Figs. 1.24 and 1.25.



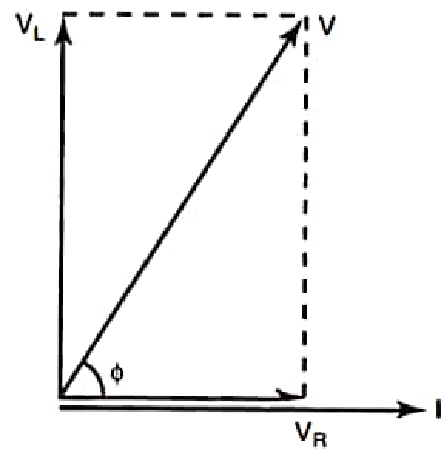


Fig. 1.25

Note: A sketch of these diagrams should normally accompany the written answer.

(a) In order to calculate the current, the impedance must be found. In order to calculate the impedance, the inductive reactance must be known. This then is the starting point in the solution.

$$X_L = 2\pi fL \text{ ohm} = 2 \times \pi \times 50 \times 1.5$$

$$\text{so, } X_L = 471.2\Omega$$

$$Z = \sqrt{R^2 + X_L^2} \text{ ohm} = \sqrt{250^2 + 471.2}$$

$$\text{so, } Z = 533.45\Omega$$

$$I = \frac{V}{Z} \text{amp} = \frac{100}{533.45}$$

therefore, $I = 187.5$ mA **Ans**

(b)

$$\phi = \cos^{-1}\frac{R}{Z} = \frac{250}{533.45}$$

therefore, $\phi = +62.05°$ or $+1.083$ rad **Ans**

(c)

$$V_R = IR \text{ volt} = 0.1875 \times 250$$

therefore, $V_R = 46.88$ V **Ans**

$$V_L = IX_L \text{ volt} = 0.1875 \times 471.2$$

therefore, $V_L = 88.35$ V **Ans**

(d)

$$P = I^2R \text{ watt} = 0.1875^2 \times 250$$

therefore $P = 8.789$ W **Ans**

Q A coil, of resistance 35 Ω and inductance 0.02 H, carries a current of 326.5 mA, when connected to a 400 Hz a.c. supply. Determine the supply voltage.

A

$R = 35\,\Omega$; $L = 0.02\,H$; $I = 0.3265\,A$; $f = 400\,Hz$

$$X_L = 2\pi f L \text{ ohm} = 2 \times \pi \times 400 \times 0.02$$

therefore, $X_L = 50.27\,\Omega$

$$Z = \sqrt{R^2 + X_L^2} \text{ ohm} = \sqrt{35^2 + 50.27^2}$$

therefore, $Z = 61.25\,\Omega$

$$V = IZ \text{ volt} = 0.3265 \times 61.25$$

hence, $V = 20\,V$ **Ans**

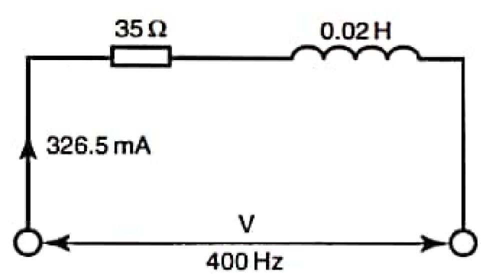
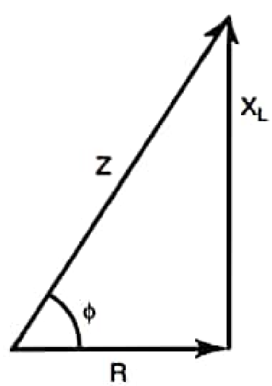


Fig. 1.26



Q A 22 nF capacitor, and a 3.9 kΩ resistor, are connected in series across a 40V, 1 kHz supply. Determine, (a) the circuit current, (b) the circuit phase angle and (c) the power dissipated.

A

$C = 22 \times 10^{-9}$ F; $R = 3900\,\Omega$; $V = 40$ V; $f = 10^3$ Hz

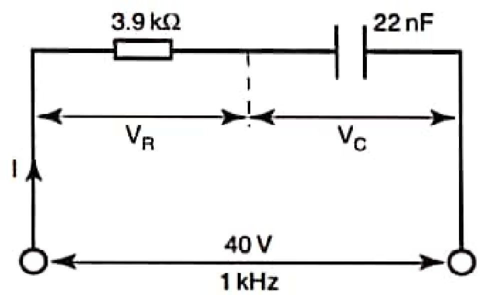


Fig. 1.34

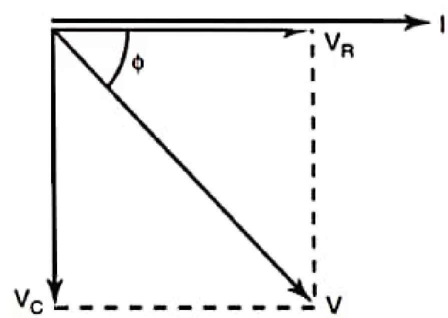


Fig. 1.35

(a) $$X_c = \frac{1}{2\pi fC}\ \text{ohm} = \frac{1}{2 \times \pi \times 10^3 \times 22 \times 10^{-9}}$$

so, $X_C = 7.234\ k\Omega$

$$Z\sqrt{R^2 + X_C^2}\ \text{ohm} = \sqrt{(3.9 \times 10^3)^2 + (7.234 \times 10^3)^2}$$

hence, $Z = 8.218\ k\Omega$

$$I = \frac{V}{Z}\ \text{amp} = \frac{40}{8.218 \times 10^3}$$

therefore, $I = 4.87$ mA **Ans**

(b) $$\phi = \cos^{-1}\frac{R}{Z} = \frac{3.9 \times 10^3}{8.218 \times 10^3}$$

therefore, $\phi = -61.67°$ or -1.076 rad **Ans**

(c) $$P = I^2R\ \text{watt} = (4.87 \times 10^{-3})^2 \times 3.9 \times 10^3$$

therefore, $P = 92.5$ mW **Ans**

Q **A coil of resistance 8 Ω and inductance 150 mH, is connected in series with a 100 μF capacitor, across a 240 V, 50 Hz a.c. supply. Calculate (a) the circuit current, (b) the circuit phase angle, (c) the p.d. across the coil, (d) the p.d. across the capacitor, and (e) the power dissipated.**

A

$R = 8\Omega$; $L = 0.15$ H; $C = 10^{-4}$ F; $V = 240$V; $f = 50$Hz

The circuit diagram is shown in Fig. 1.40. Note that the coil has been considered as the combination of a pure resistor and a pure inductor.

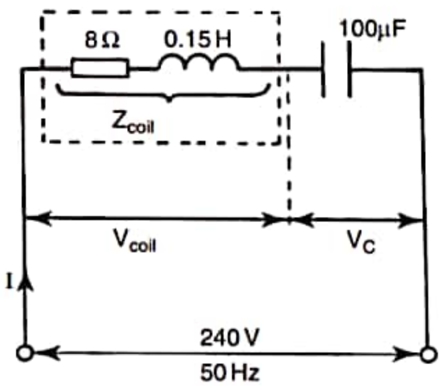


Fig. 1.40

(a)

$$X_L = 2\pi fL \text{ ohm} = 2 \times \pi \times 50 \times 0.15$$

$$\text{so, } X_L = 47.12\ \Omega$$

$$X_C = \frac{1}{2\pi fC} \text{ ohm} = \frac{1}{2 \times \pi \times 50 \times 10^{-4}}$$

$$\text{so } X_C = 31.83\ \Omega$$

$$Z = \sqrt{R^2 + (X_L - X_C)^2} \text{ ohm}$$

$$= \sqrt{18^2 + (47.12 - 31.83)^2}$$

$$\text{therefore } Z = 17.26\ \Omega$$

$$I = \frac{V}{Z} \text{ amp} = \frac{240}{17.26}$$

therefore $I = 13.91$ A **Ans**

(b)

$$\phi = \cos^{-1}\frac{R}{Z} = \cos^{-1}\frac{8}{17.26}$$

therefore, $\phi = +62.38°$ or $+1.089$ rad **Ans**

(c) The coil has both inductance and reactance. The coil itself therefore possesses impedance, Z_{coil} ohm. The p.d. across the coil is therefore due to its impedance, and NOT only R or X_L.

$$Z_{coil} = \sqrt{R^2 + X_L^2} \text{ ohm} = \sqrt{8^2 + 47.12^2}$$

$$\text{hence, } Z_{coil} = 47.8\ \Omega$$

$$V_{coil} = IZ_{coil} \text{ volt} = 13.91 \times 47.8$$

therefore, $V_{coil} = 664.9$ V **Ans**

(d) $V_C = IX_C$ volt $= 13.91 \times 31.83$

hence, $V_C = 442.8$ V **Ans**

(e) $P = I^2R$ watt $= 13.91^2 \times 8$

therefore, $P = 1.547$ kW **Ans**