1 The voltage source V_1 is such that when it is connected to a **2 kΩ** resistor, a current of **2 mA** flows as shown in the **Fig. B**. In the **Fig. A**, the voltage V_x is:

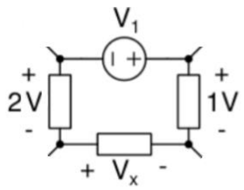


Fig **A**

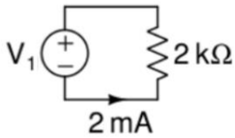
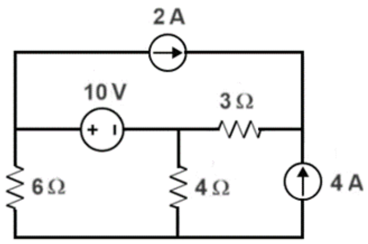


Fig **B**

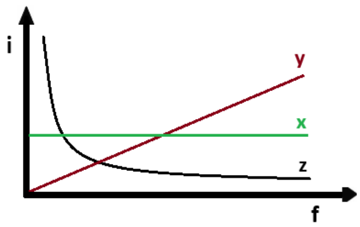
a) 5 V b) – 5 V c) – 3 V **d) 3 V**

2 The current through **6 Ω** resistor in the given circuit is:



a) 2 A (bottom to top) **b) 2.6 A (top to bottom)** c) 2.6 A (bottom to top) d) 4 A (top to bottom)

3 Three identical voltage sources are connected (separately) to a single circuit element: a resistor, a capacitor, and an inductor. The current amplitude is then measured as a function of frequency. Which one of the following curves corresponds to an **inductive** circuit?



a) x

b) y

c) z

d) Can't be ascertained with given information

4 In an AC circuit, the supply voltage and resulting current are expressed by:

$$\bar{\mathbf{V}} = \mathbf{100\ sin(100\pi t + 24°)\ V}$$
$$\bar{\mathbf{I}} = \mathbf{5\,cos(100\pi t + 5°)\ A}$$

The impedance of the load as well as its nature is

a) 18.9 – j 6.5 Ω → Leading load

b) 18.9 + j 6.5 Ω → Lagging load

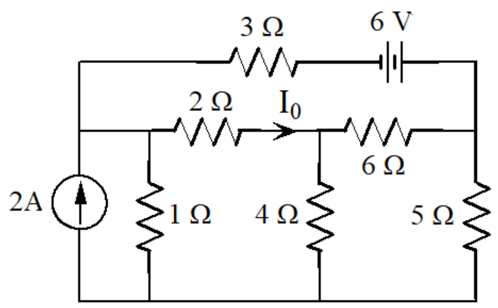
c) 6.5 + j 18.9 Ω → Lagging load

d) 6.5 – j 18.9 Ω → Leading load

5 A sinusoidal AC voltage of $\mathbf{110\ \angle 0°\ V}$ is applied across a series **RLC** circuit with **R = 100 Ω**, $\mathbf{X_L}$ **= 10 Ω** and $\mathbf{X_C}$ **= 40 Ω**. The **reactive** power of the circuit is:

a) 33.3 VAR (Leading) b) 111 VAR (Leading) c) 33.3 VAR (Lagging) d) 116 VAR (Lagging)

6 Using **superposition** principle, determine the current $\mathbf{I_0}$ as shown.



With 6 V source alone

$$\begin{bmatrix} 7 & -4 & -2 \\ -4 & 15 & -6 \\ -2 & -6 & 11 \end{bmatrix} \begin{bmatrix} i_1 \\ i_2 \\ i_3 \end{bmatrix} = \begin{bmatrix} 0 \\ 0 \\ 6 \end{bmatrix} \quad --- \; 1.5\ \mathrm{M}$$

$i_1 = 0.5674\ \mathrm{A},\quad i_2 = 0.5254\ \mathrm{A},\quad i_3 = 0.9352\ \mathrm{A}$

$I_{0\,:\,6\,V} = (i_1 - i_3) = -0.3678\ \mathrm{A} \quad --- \; 0.5\ \mathrm{M}$

With 2 A source alone

$$\begin{bmatrix} 7 & -4 & -2 \\ -4 & 15 & -6 \\ -2 & -6 & 11 \end{bmatrix} \begin{bmatrix} i_1 \\ i_2 \\ i_3 \end{bmatrix} = \begin{bmatrix} 2 \\ 0 \\ 0 \end{bmatrix} \quad --- \; 1.5\ \mathrm{M}$$

$i_1 = 0.45184\ \mathrm{A},\quad i_2 = 0.19615\ \mathrm{A},\quad i_3 = 0.18914\ \mathrm{A}$

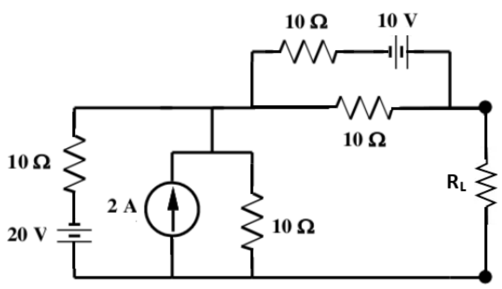
$I_{0\,:\,2\,A} = (i_1 - i_3) = 0.2627\ \mathrm{A} \quad --- \; 0.5\ \mathrm{M}$

$I_0 = I_{0\,:\,6\,V} + I_{0\,:\,2\,A} = -0.1051\ \mathrm{A} \quad --- \; 1\ \mathrm{M}$

7 For the network shown, determine

A) The value of $\mathbf{R_L}$ that absorbs maximum power from the circuit.

B) The corresponding power under the above condition.

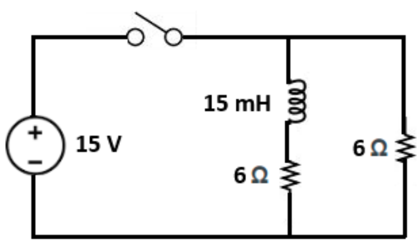


$V_{Th} = -(2 \times 10) + 20 + (10 \times 0.5) = 5\ \mathrm{V} \quad --- \; 2\ \mathrm{M}$

For P_{max}: $\quad R_L = R_{Th} = (10 \parallel 10) + (10 \parallel 10) = 10\ \Omega \quad --- \; 1.5\ \mathrm{M}$

$P_{max} = \dfrac{V_{Th}^2}{4\,R_{Th}} = 0.625\ \mathrm{W} \quad --- \; 0.5\ \mathrm{M}$

8 In the circuit shown, the switch was initially open for a long. It is closed at **t = 0**. Obtain inductor current at **t > 0**. Also determine the value of inductor current after **2** time constant.



$i_L(\text{initial}) = 0\ \mathrm{A}\ (\text{switch open}) \quad --- \; 0.5\ \mathrm{M}$

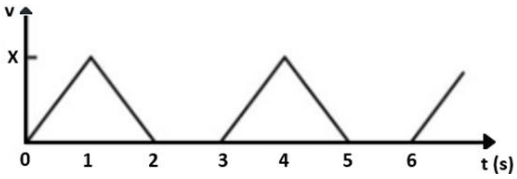
$i_L(\text{steady}) = 2.5\ \mathrm{A}\ (\text{switch closed}) \quad --- \; 0.5\ \mathrm{M}$

$\tau = {0.015}/{6} = 2.5\ \mathrm{ms} \quad --- \; 1\ \mathrm{M}$

$i_L(t) = 2.5(1 - e^{-400\,t})\ \mathrm{A} \quad --- \; 1\ \mathrm{M}$

$i_L(5\ \mathrm{ms}) = 2.162\ \mathrm{A} \quad --- \; 1\ \mathrm{M}$

9 Obtain the **Average** and **RMS** values of the voltage waveform below if the amplitude (**X**) is **10 V**.

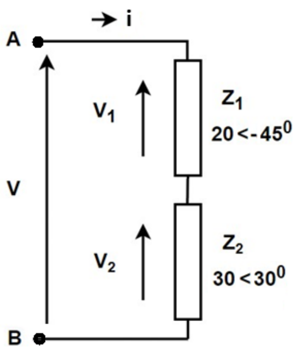


$$\textbf{Equation:}\ \begin{cases} v = 10\,t & 0 < t < 1 \\ v = 20 - 10\,t & 1 < t < 2 \\ v = 0 & 2 < t < 3 \end{cases} \quad --- \ 1\ M$$

$$V_{AVG} = \frac{1}{3}\left[\int_0^1 (10\,t)\,dt + \int_1^2 (20 - 10\,t)\,dt + \int_2^3 (0)\,dt\right] = 3.333\ V \quad --- \ 1.5\ M$$

$$V_{RMS} = \sqrt{\frac{1}{3}\left[\int_0^1 (10\,t)^2\,dt + \int_1^2 (20 - 10\,t)^2\,dt + \int_2^3 (0)^2\,dt\right]} = 4.714\ V \quad --- \ 1.5\ M$$

10 Two impedances of $\mathbf{20 \angle{-45^\circ}\ \Omega}$ and $\mathbf{30 \angle 30^\circ\ \Omega}$ are connected in series across a certain supply and the resulting current (**i**) is found to be **10 A**. If the supply voltage remains unchanged, obtain the supply current when the impedances are connected in parallel.



$$\text{Let}\quad \bar{I} = 10 \angle 0^\circ\ A \quad --- \ 0.5\ M$$

$$\bar{Z}_T = (\bar{Z}_1 + \bar{Z}_2) = 40.132 \angle 1.225^\circ\ \Omega \quad --- \ 1\ M$$

$$\bar{V} = \bar{I} \times \bar{Z}_T = 401.32 \angle 1.225^\circ\ V \quad --- \ 0.5\ M$$

$$\bar{Z}_{T-New} = \frac{\bar{Z}_1\,\bar{Z}_2}{\bar{Z}_1 + \bar{Z}_2} = 14.951 \angle{-16.225^\circ}\ \Omega \quad --- \ 1.5\ M$$

$$\bar{I}_{New} = \frac{\bar{V}}{\bar{Z}_{T-New}} = 26.842 \angle 17.45^\circ\ A \quad --- \ 0.5\ M$$

11 A **240 V**, **50 Hz** source supplies a parallel combination of a **5 KW** heater and a **25 KVA** induction motor whose power factor is **0.82** lagging. Determine:

(a) the system apparent power

(b) the system reactive power, and

(c) the value of the capacitor required to adjust the system power factor to **0.95** lagging.

$$P_1 = 5\ KW$$

$$P_2 = S_2\ \cos\emptyset_2 = 25 \times 0.82 = 20.5\ KW$$

$$P_T = 25.5\ KW \quad --- \ 0.5\ M$$

$$Q_1 = 0\ KVAR$$

$$Q_2 = 25 \times \sin\left(\cos^{-1} 0.82\right) = 14.31\ KVAR$$

$$Q_T = 14.31\ KVAR\ (\text{Lagging}) \quad --- \ 0.5\ M$$

$$S_T = \sqrt{25.5^2 + 14.31^2} = 29.241\ KVA \quad --- \ 1\ M$$

$$\cos\emptyset_{New} = 0.95\ \text{Lagging} \quad \text{or} \quad \emptyset_{New} = 18.195^\circ$$

$$Q_{New} = 25.5 \times \tan 18.195^\circ = 8.3815\ KVAR\ (\text{Lagging}) \quad --- \ 0.5\ M$$

$$Q_C = Q_T - Q_{New} = 5.9285\ KVAR\ (\text{Leading}) \quad --- \ 0.5\ M$$

$$X_C = \frac{240^2}{Q_C} = 9.716\ \Omega \quad --- \ 0.5\ M$$

$$C = \frac{1}{2\pi\,f\,X_C} = 327.614\ \mu F \quad --- \ 0.5\ M$$