

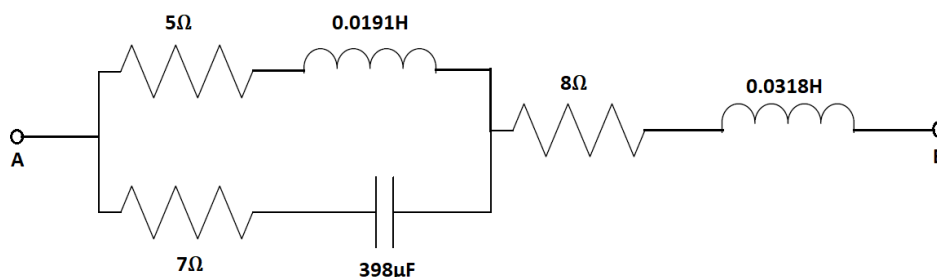
NOTES -Class 32

Series – Parallel AC Circuits

Series - Parallel AC Circuits are those in which few elements are connected in series and few elements are connected in parallel.

It is always advisable to solve such networks using Phasor Method. While applying Phasor method for Series – Parallel AC circuits, consider any known quantity as reference.

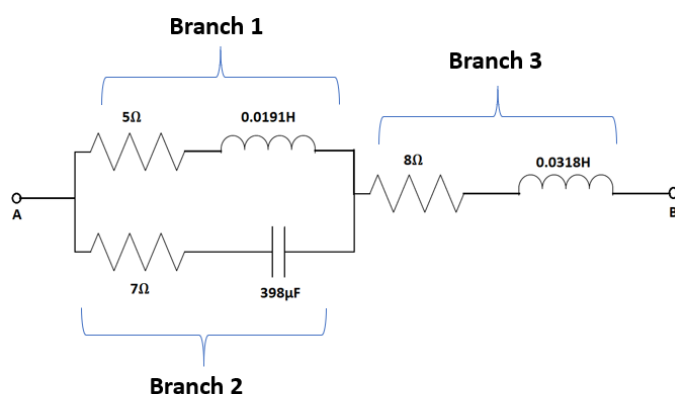
Question 13:



In the circuit shown, what voltage of 50Hz frequency is to be applied across A & B that will cause a current of 10A to flow in the capacitor. Also draw the phasor diagram representing the circuit.

Solution:

Unit II : Single Phase AC Circuits



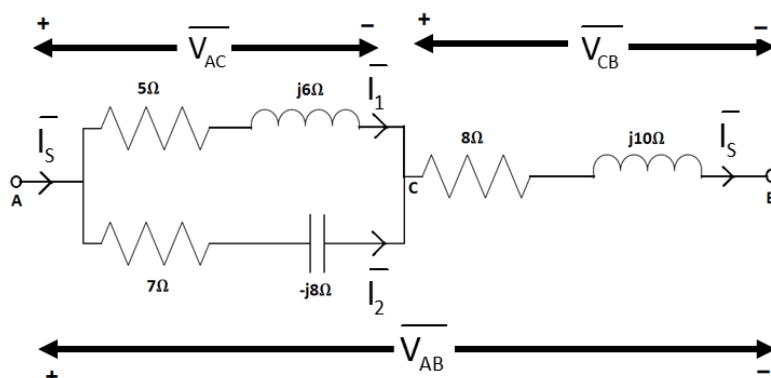
Branches 1 & 3 : Series RL branches

$$\Rightarrow Z_1 = (R_1 + jX_{L1}) = 5 + j(2\pi \cdot 50 \cdot 0.0191) = (5 + j6)\Omega$$

$$\text{Similarly, } Z_3 = (8 + j10)\Omega$$

Branch 2 : Series RC branch

$$\Rightarrow Z_2 = (R_2 - jX_{C2}) = (7 - j8)\Omega$$

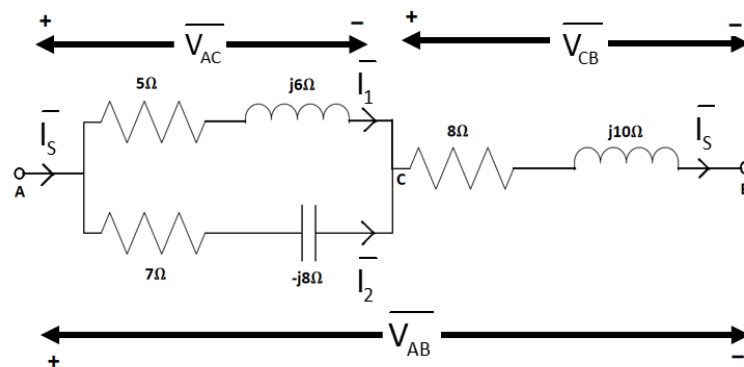


Since current through the capacitor is known, let us take it as reference phasor.

$$\text{Therefore, } \bar{I}_2 = 10 \angle 0^\circ \text{ A}$$

$$\text{Hence, } \bar{V}_{AC} = \bar{I}_2 * Z_2 = 10 \angle 0^\circ * (7 - j8) = 106.3 \angle -48.81^\circ \text{ V}$$

Unit II : Single Phase AC Circuits



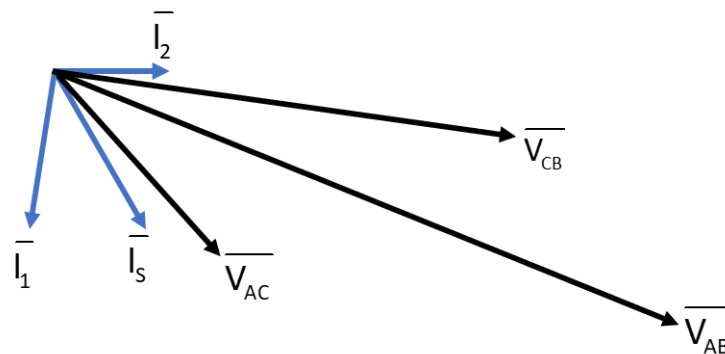
$$\text{Therefore, } \bar{I}_1 = \frac{\bar{V}_{AC}}{Z_1} = 13.61 \angle -99^\circ \text{ A}$$

$$\Rightarrow \bar{I}_S = \bar{I}_1 + \bar{I}_2 = 15.58 \angle -59.65^\circ \text{ A}$$

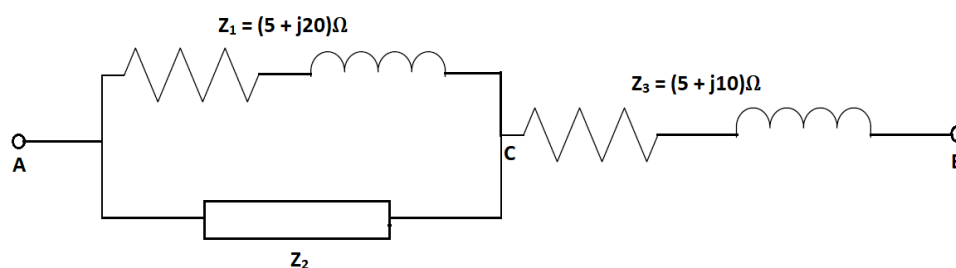
$$\text{Now, } \bar{V}_{CB} = \bar{I}_S * Z_3 = 199.48 \angle -8.31^\circ \text{ V}$$

$$\text{Therefore, } \bar{V}_{AB} = \bar{V}_{AC} + \bar{V}_{CB} = 288.69 \angle -22.15^\circ \text{ V}$$

Phasor Diagram :



Question 14:

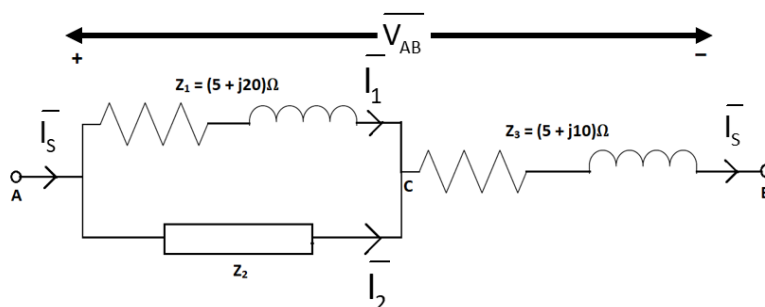


When a 220V AC supply is applied across terminals A & B of the circuit shown, the total power input is 3.25kW and the total current is 20A, lag. Find

Unit II : Single Phase AC Circuits

the complex expressions for currents through Z_1 and Z_2 , taking V_{AC} as reference phasor.

Solution:



Considering supply voltage as reference, $\overline{V_{AB}} = 220\angle 0^\circ \text{ V}$

Given, total power input = 3.25KW

$$\text{i.e., } \overline{V_{AB}} * \overline{I_s} * \cos\phi = 3.25\text{KW} = 220 * 20 * \cos\phi$$

$$\Rightarrow \phi = 42.38^\circ$$

Since supply current is given as lag, $\overline{I_s} = 20\angle -42.38^\circ \text{ A}$

$$\overline{V_{CB}} = \overline{I_s} * \overline{Z_3} = 223.61\angle 21.05^\circ \text{ V}$$

$$\overline{V_{AC}} = \overline{V_{AB}} - \overline{V_{CB}} = 81.11\angle -81.98^\circ \text{ V}$$

$$\overline{I_1} = \frac{\overline{V_{AC}}}{\overline{Z_1}} = 3.93\angle -157.95^\circ \text{ A}$$

$$\overline{I_2} = \overline{I_s} - \overline{I_1} = 21.98\angle -33.1^\circ \text{ A}$$

We found that $\overline{V_{AC}} = 81.11\angle -81.98^\circ \text{ V}$

To make $\overline{V_{AC}}$ as reference, add 81.98° to its phase angle.

Also, Add the same angle to all other phasors.

Thus, $\overline{I_1} = 3.93\angle -75.97^\circ \text{ A}$; $\overline{I_2} = 21.98\angle 48.88^\circ \text{ A}$

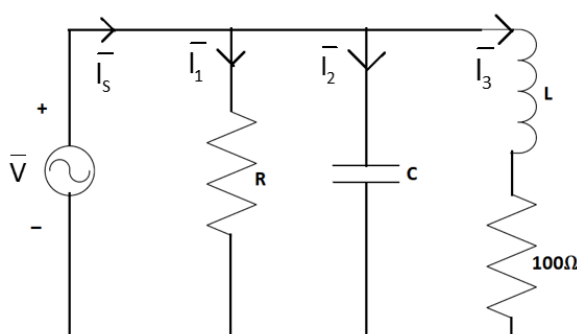
Question 15:

A voltage of 200 V is applied to a pure resistor (R), a pure capacitor, C and a lossy inductor coil with resistance of 100 Ω, all of them connected in parallel. The total current is 2.45 A, while the component currents are 1.5, 2.0 and 1.2 A

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respectively. Find the total power factor and also the power factor of the coil. Also find the total active and reactive power.

Solution:



Let us consider supply voltage as reference

$$\Rightarrow \bar{V} = 200 \angle 0^\circ \text{ V}$$

$$\text{Therefore, } \bar{I}_1 = 1.5 \angle 0^\circ \text{ A ; } \bar{I}_2 = 2 \angle 90^\circ \text{ A}$$

$$\text{In branch 3, } |Z_3| = \frac{200}{1.2} = 166.66 \Omega$$

$$\text{Therefore, } \phi_3 = \cos^{-1}\left(\frac{r_3}{|Z_3|}\right) = 53.13^\circ \Rightarrow \bar{I}_3 = 1.2 \angle -53.13^\circ \text{ A}$$

$$\text{Hence, } \bar{I}_s = \bar{I}_1 + \bar{I}_2 + \bar{I}_3 = 2.45 \angle 25.1^\circ \text{ A}$$

$$\text{Phase Angle of the network} = \phi = \angle \bar{V} - \angle \bar{I}_s = -25.1^\circ$$

$$\text{Overall Power factor} = \cos \phi = 0.905 \text{ Lead}$$

$$\text{Power factor of the coil} = \cos \phi_3 = 0.6 \text{ Lag}$$

$$\text{Total Active Power, } P_T = V \cdot I_s \cdot \cos \phi = 443.45 \text{ W}$$

$$\text{Total Reactive Power, } Q_T = V \cdot I_s \cdot \sin \phi = -207.85 \text{ VAR}$$

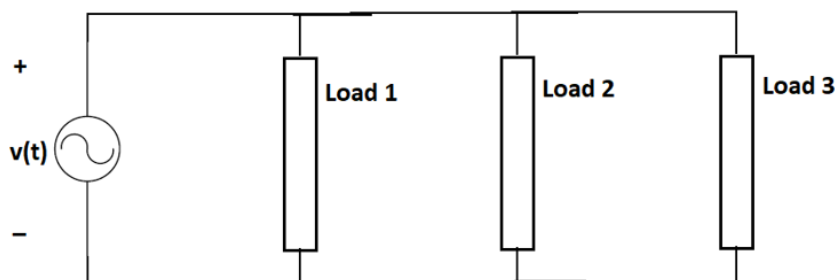
Question 16:

The load connected across an AC supply consists of a heating load of 15KW, a motor load of 40KVA at 0.6 lag and a load of 20KW at 0.8 lag. Calculate the total power drawn from the supply in (KW and KVA) and its power factor.

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What would be the KVAR rating of a capacitor to bring the power factor to unity and how must the capacitor be connected?

Solution:



Load 1 : Heating Load \Rightarrow Resistive $\Rightarrow \cos\phi_1 = 1$

$P_1 = 15\text{KW}$ (given)

$Q_1 = 0$

$S_1 = \sqrt{P_1^2 + Q_1^2} = 15\text{KVA}$

Load 2 : Motor Load \Rightarrow Inductive

$S_2 = 40\text{KVA}$ & $\cos\phi_2 = 0.6$ Lag (given)

$P_2 = S_2 \cos\phi_2 = 24\text{KW}$

$Q_2 = \sqrt{S_2^2 - P_2^2} = 32\text{KVAR}$

Load 3 : Inductive Load

$P_3 = 20\text{KW}$ & $\cos\phi_3 = 0.8$ Lag (given)

$S_3 = \frac{P_3}{\cos\phi_3} = 25\text{KVA}$

$Q_3 = \sqrt{S_3^2 - P_3^2} = 15\text{KVAR}$

Net Active Power, $P_T = P_1 + P_2 + P_3 = 59\text{KW}$

Net Reactive Power, $Q_T = Q_1 + Q_2 + Q_3 = 47\text{KVAR}$

Net Apparent Power, $S_T = \sqrt{P_T^2 + Q_T^2} = 75.43\text{KVA}$

To make overall power factor unity, net reactive power must be zero. Hence, connect a capacitor of rating 47KVAR in parallel to achieve this.