ELEMENTS OF ELECTRICAL ENGINEERING (UE24EE141B)

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Unit 2 - Lectures 34 & 35 - Analysis of Series-Parallel AC Circuits ; Numerical Examples

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Series – Parallel AC Circuits

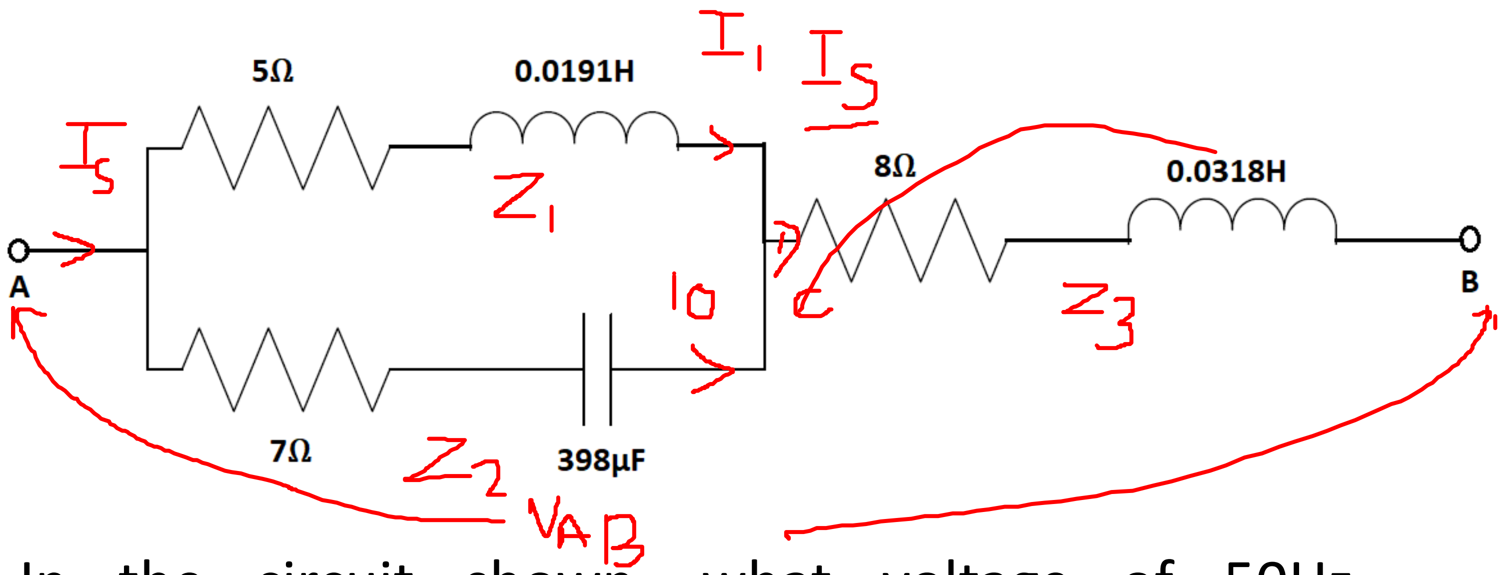
Series - Parallel AC Circuits are those in which few elements are connected in series and few elements are connected in parallel.

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.

Numerical Example 1

Question:

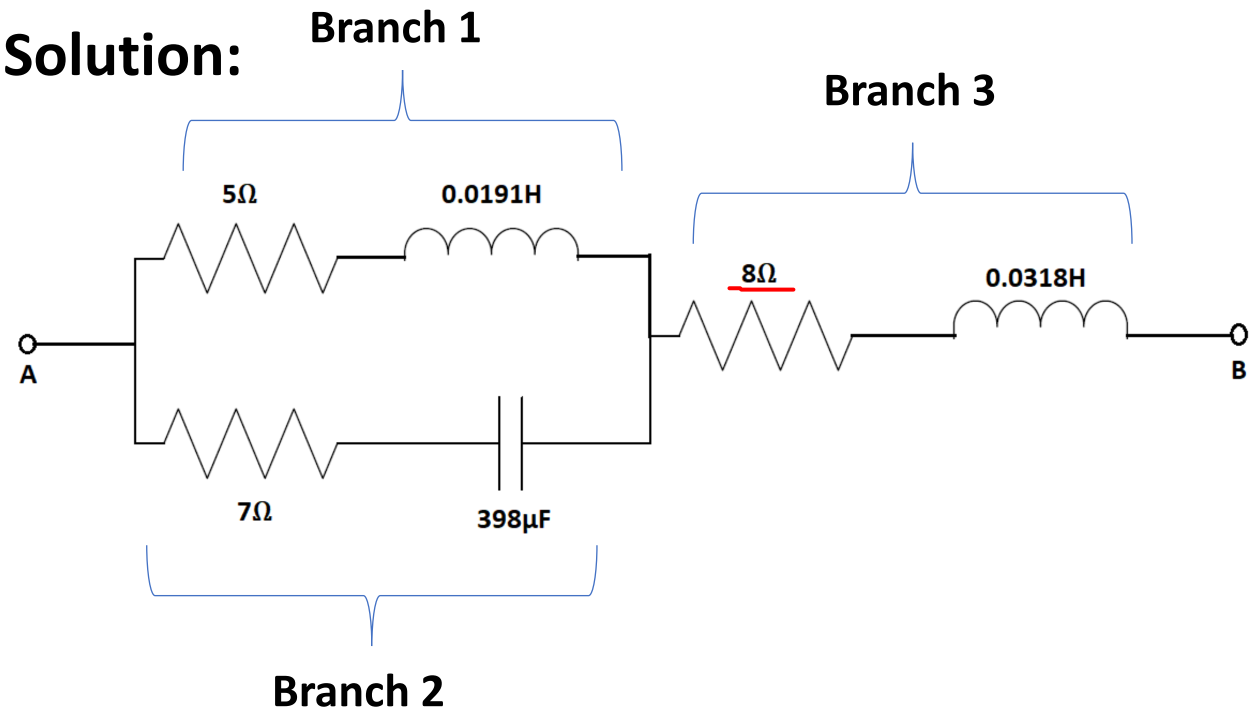


$10\angle 10$

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.

Numerical Example 1

Solution:



Branches 1 & 3 : Series RL branches

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

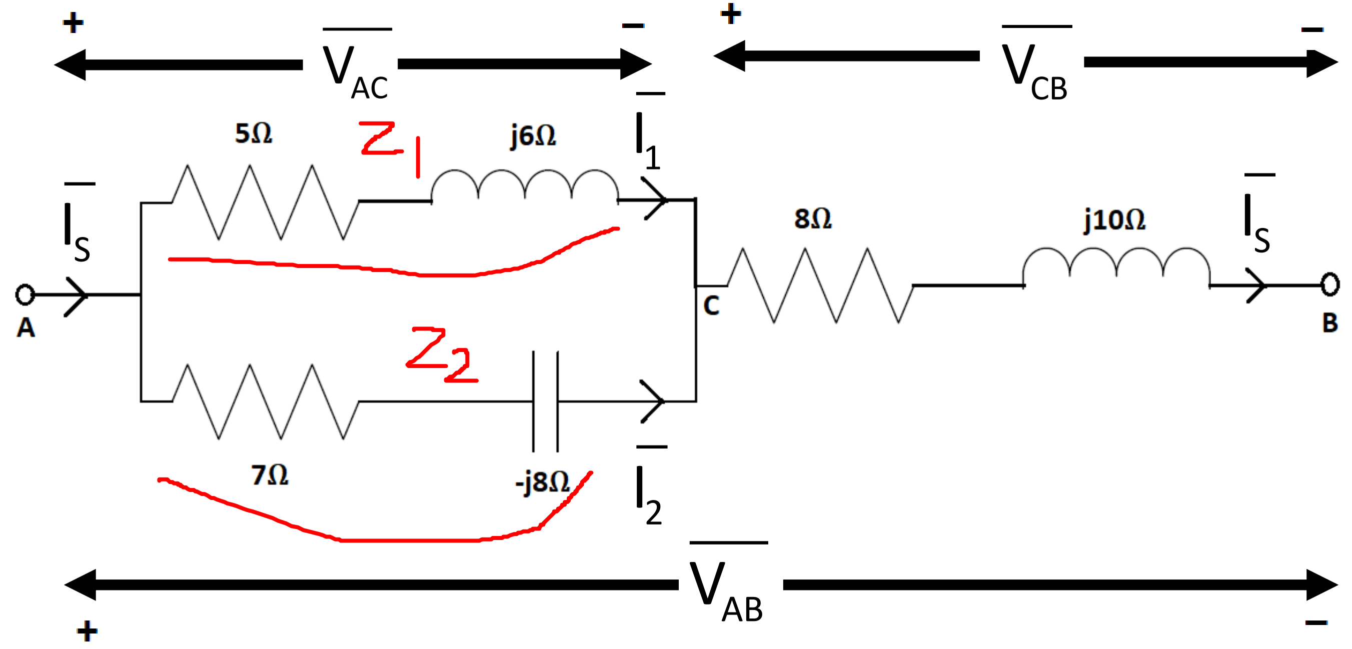
Similarly, $Z_3 = (8 + j10)\Omega$

Branch 2 : Series RC branch

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

Numerical Example 1

Solution (Continued..) :



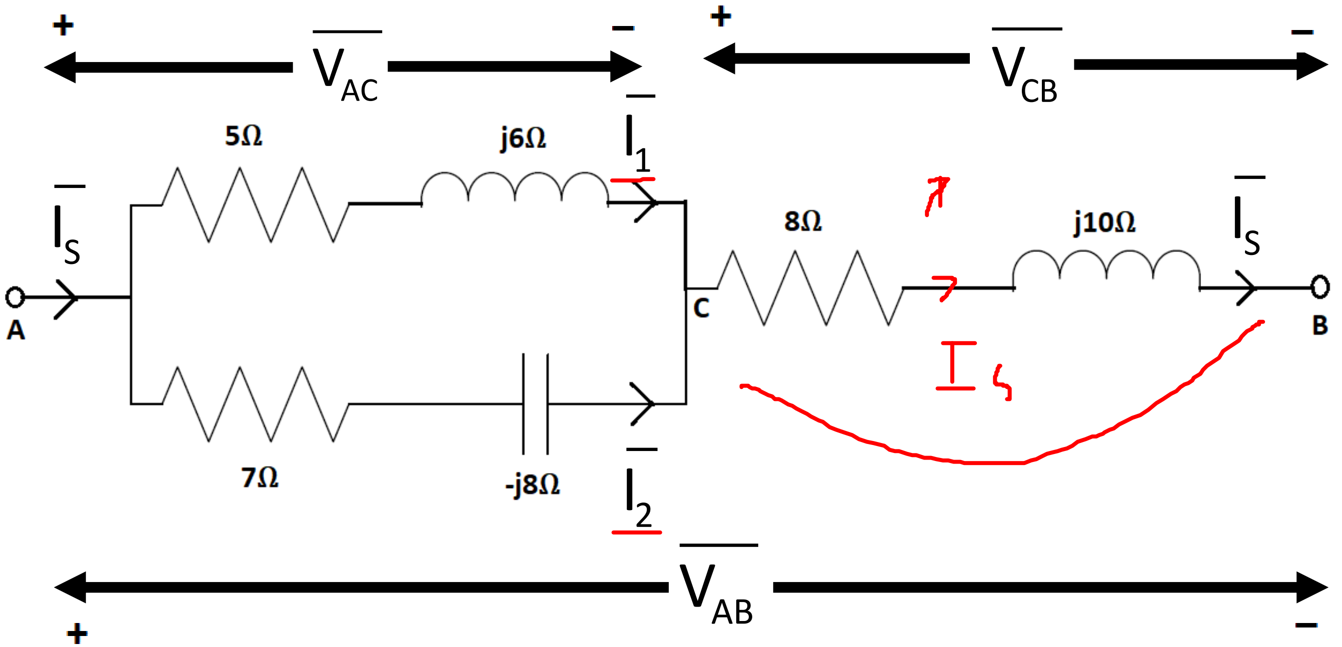
Since current through the capacitor is known, let us take it as reference phasor.

Therefore, $\overline{I}_2 = 10\angle 0° A$

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

Numerical Example 1

Solution (Continued..) :



Therefore, $\overline{I}_1 = \dfrac{\overline{V}_{AC}}{Z_1} = 13.61\angle -99°A$

$\Rightarrow \overline{I}_S = \overline{I}_1 + \overline{I}_2 = 15.58\angle -59.65°A$

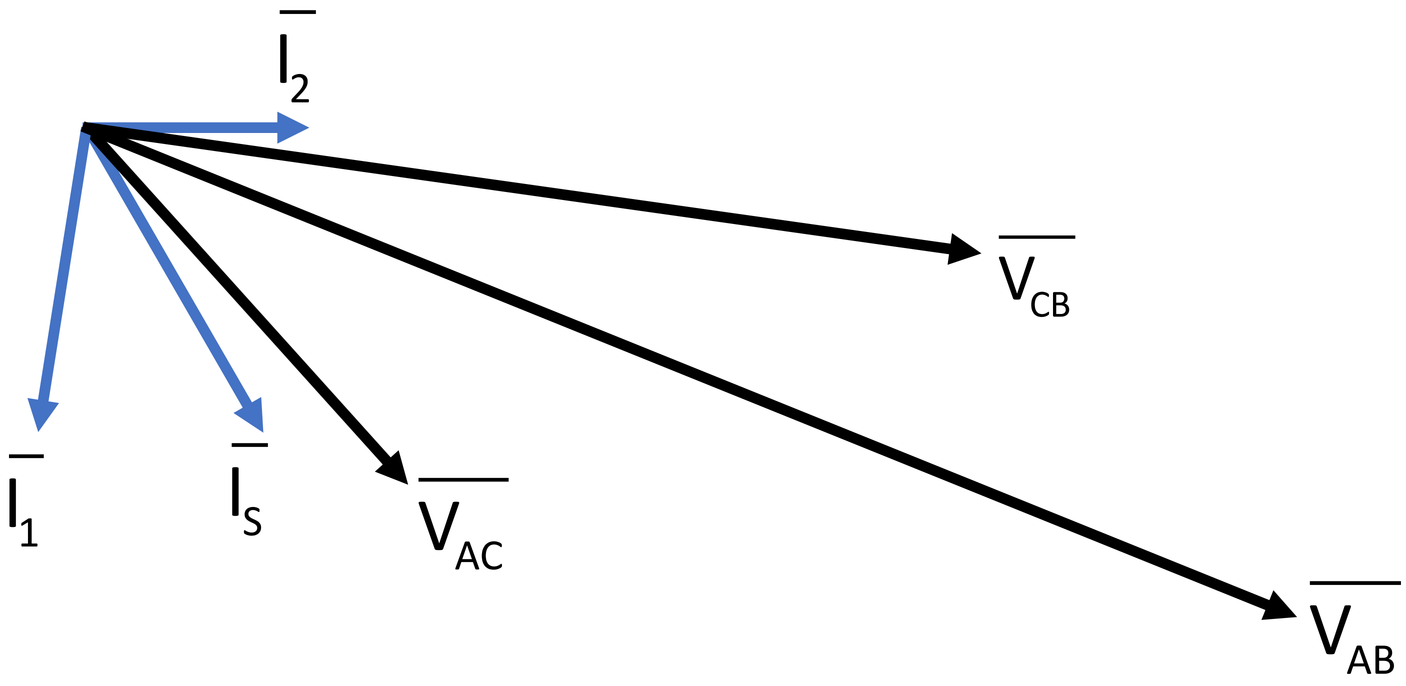
Now, $\overline{V}_{CB} = \overline{I}_S * Z_3 = 199.48\angle -8.31°V$

Numerical Example 1

Solution (Continued..) :

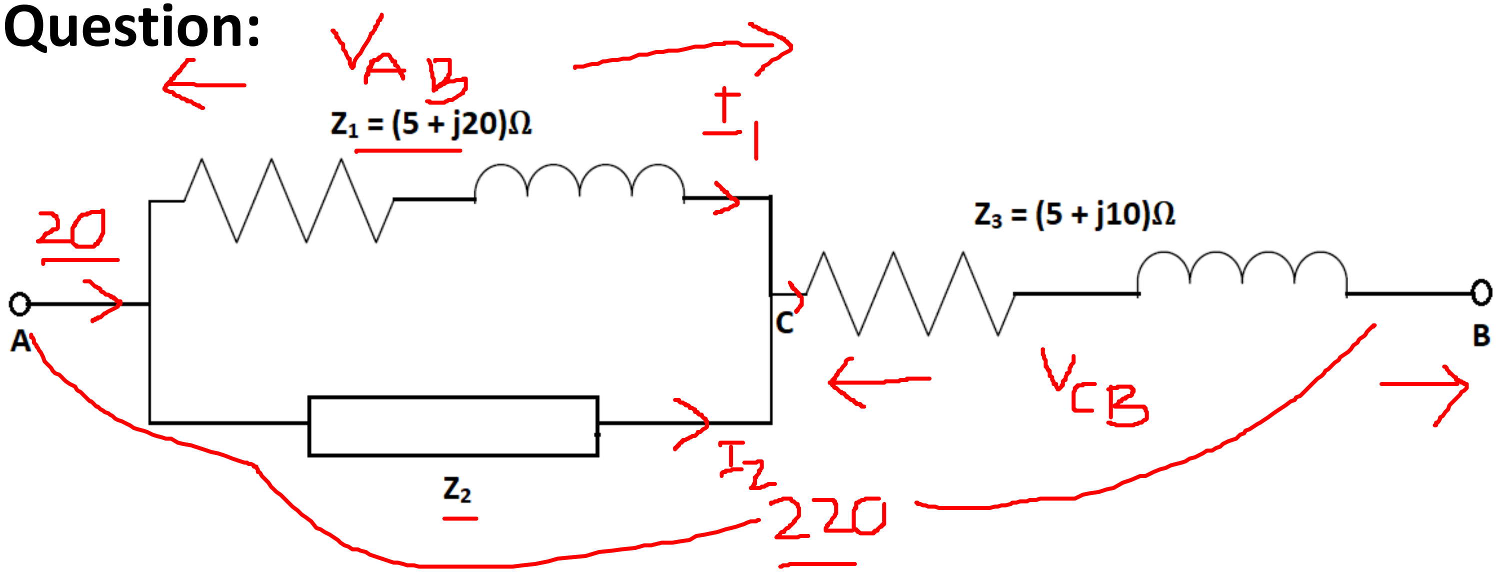
Therefore, $\overline{V_{AB}} = \overline{V_{AC}} + \overline{V_{CB}} = 288.69\angle -22.15°V$

Phasor Diagram :



Numerical Example 2

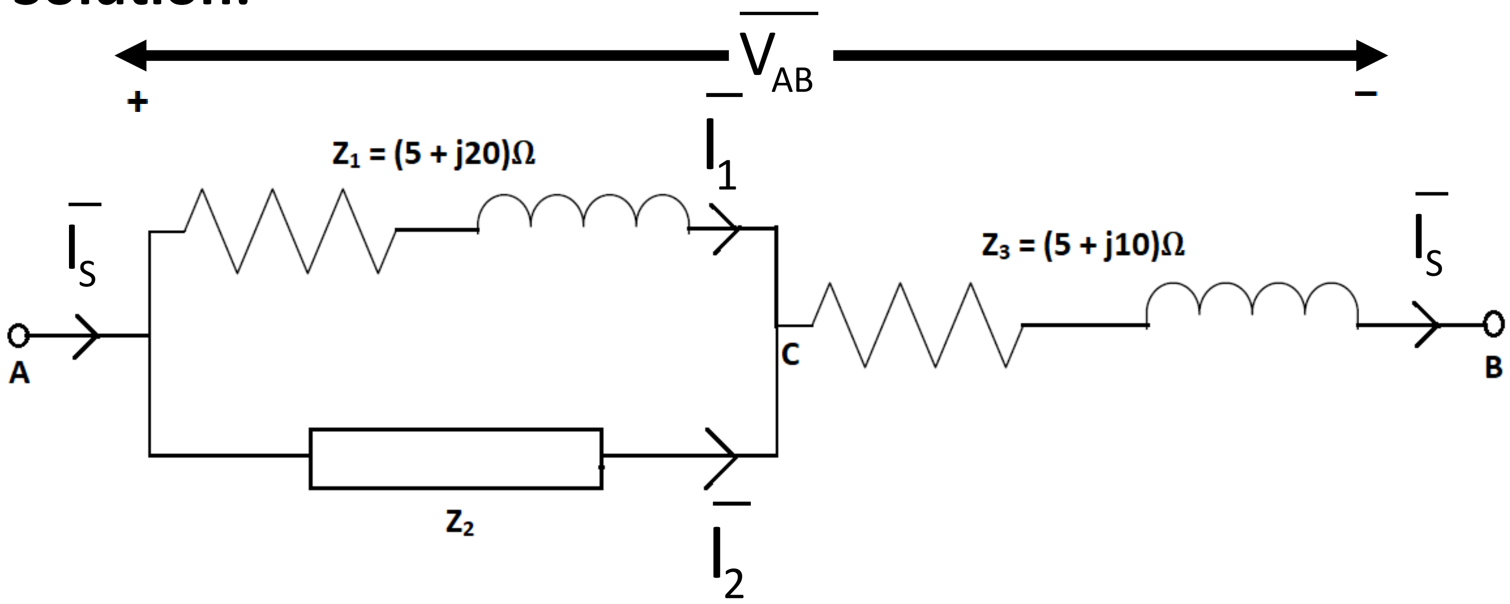
Question:



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

Numerical Example 2

Solution:



Considering supply voltage as reference, $\overline{V}_{AB} = 220\angle 0°$ V

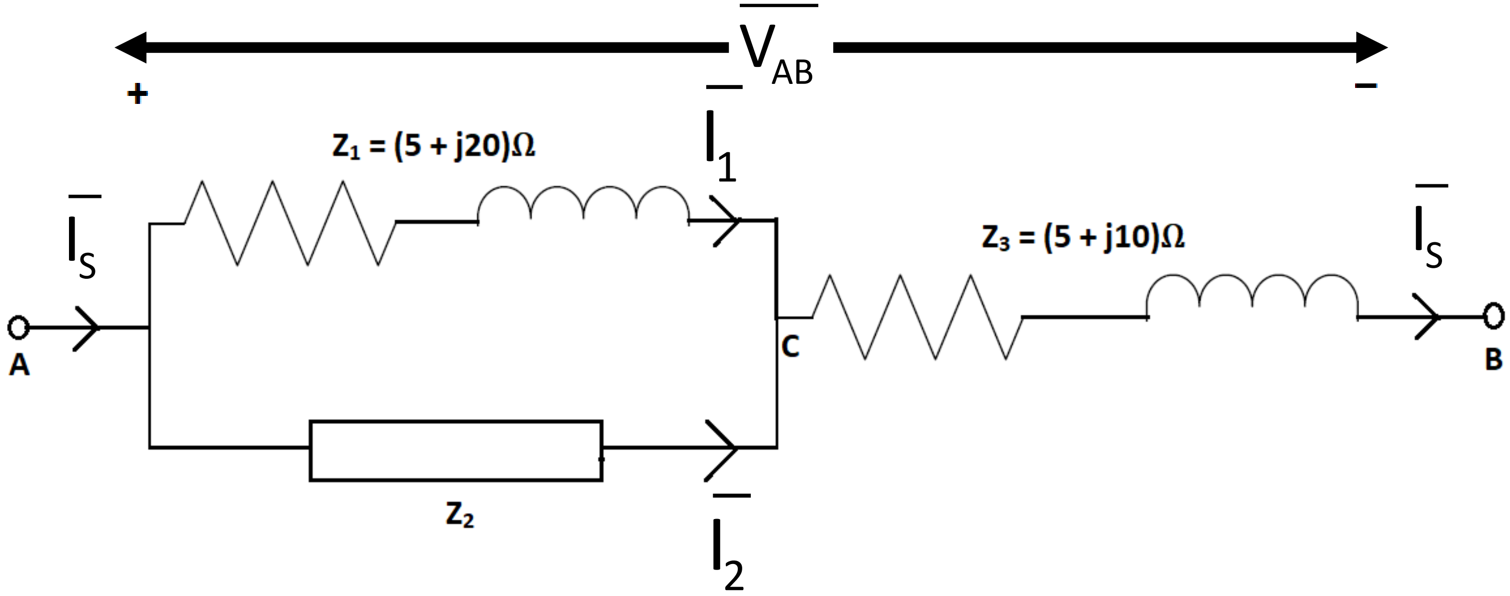
Given, total power input = 3.25KW

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

$\Rightarrow \phi = 42.38°$

Numerical Example 2

Solution:



Since supply current is given as lag, $\overline{I}_S = 20\angle-42.38°$ A

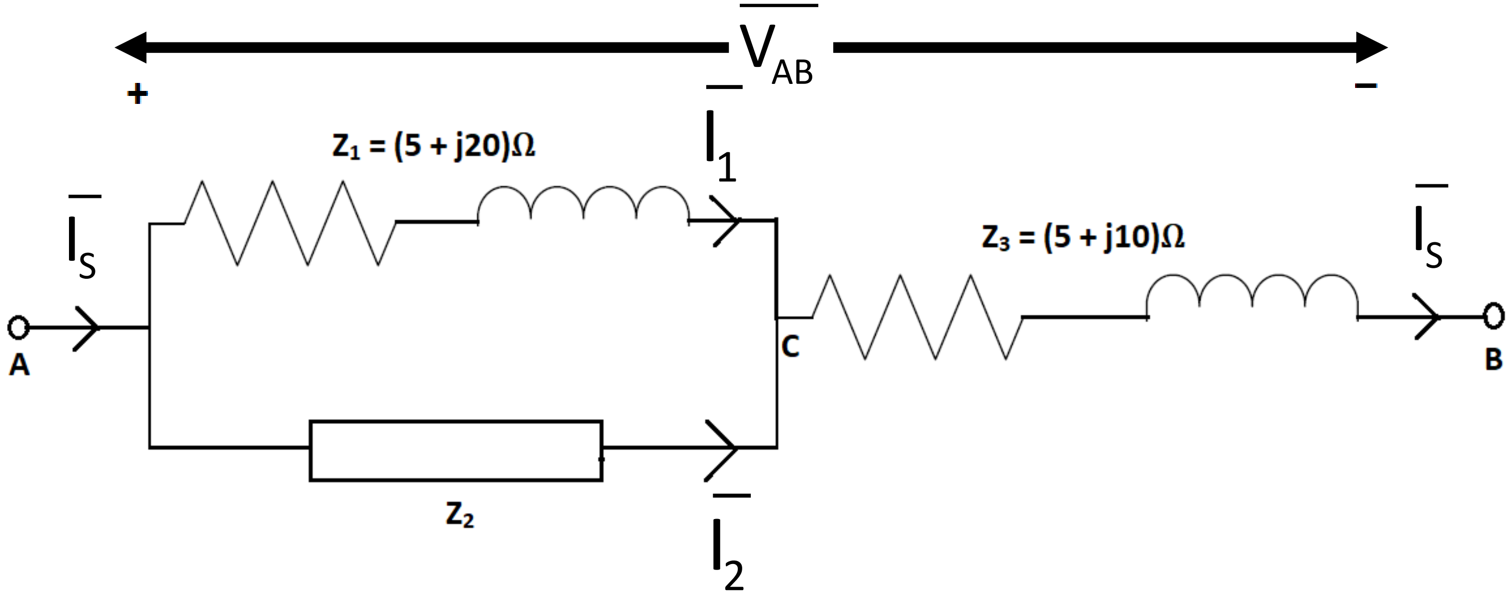
$$\overline{V}_{CB} = \overline{I}_S * Z_3 = 223.61\angle 21.05° V$$

$$\overline{V}_{AC} = \overline{V}_{AB} - \overline{V}_{CB} = 81.11\angle-81.98° V$$

$$\overline{I}_1 = \frac{\overline{V}_{AC}}{Z_1} = 3.93\angle\text{-}157.95° A$$

Numerical Example 2

Solution:



$\overline{I}_2 = \overline{I}_s - \overline{I}_1 = 21.98\angle -33.1°A$

We found that $\overline{V}_{AC} = 81.11\angle\text{-}81.98°$ 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, $\overline{I}_1 = 3.93\angle -75.97°A$; $\overline{I}_2 = 21.98\angle 48.88°A$

Text Book & References

Text Book:

"Electrical and Electronic Technology" E. Hughes (Revised by J. Hiley, K. Brown & I.M Smith), 11th Edition, Pearson Education, 2012.

Reference Books:

1. "Basic Electrical Engineering - Revised Edition", D. C. Kulshreshta, Tata- McGraw-Hill, 2012.
2. "Basic Electrical Engineering", K Uma Rao, Pearson Education, 2011.
3. "Engineering Circuit Analysis", William Hayt Jr., Jack E. Kemmerly & Steven M. Durbin, 8th Edition, McGraw-Hill, 2012.

THANK YOU

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