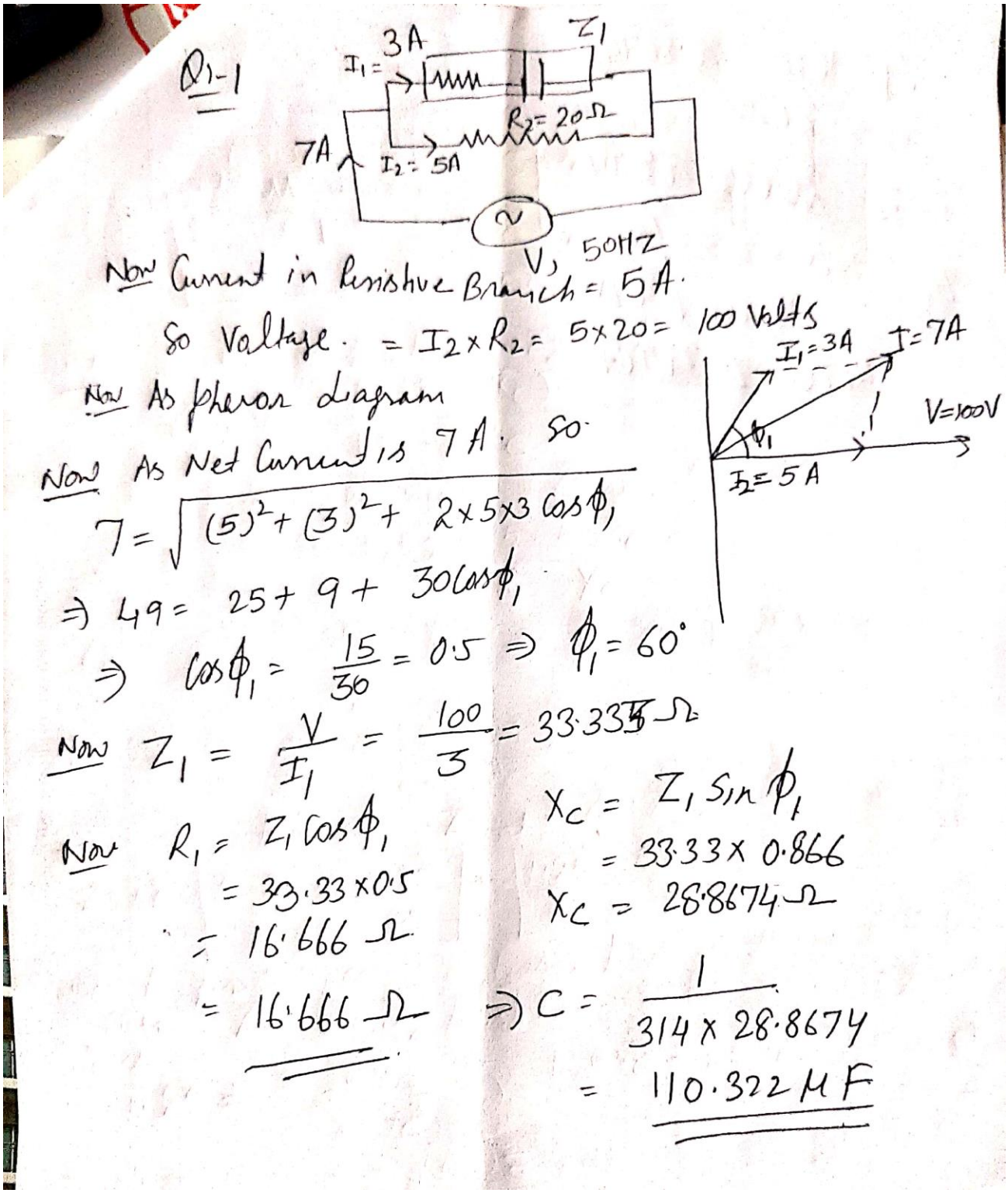
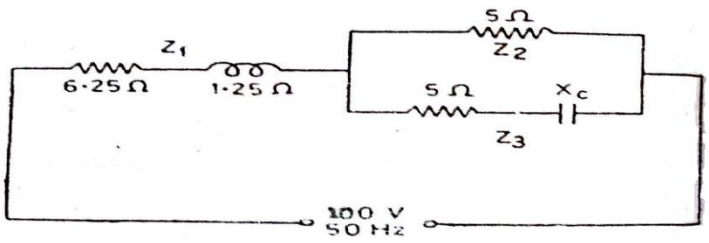
Electrical Engineering (KEE-101)

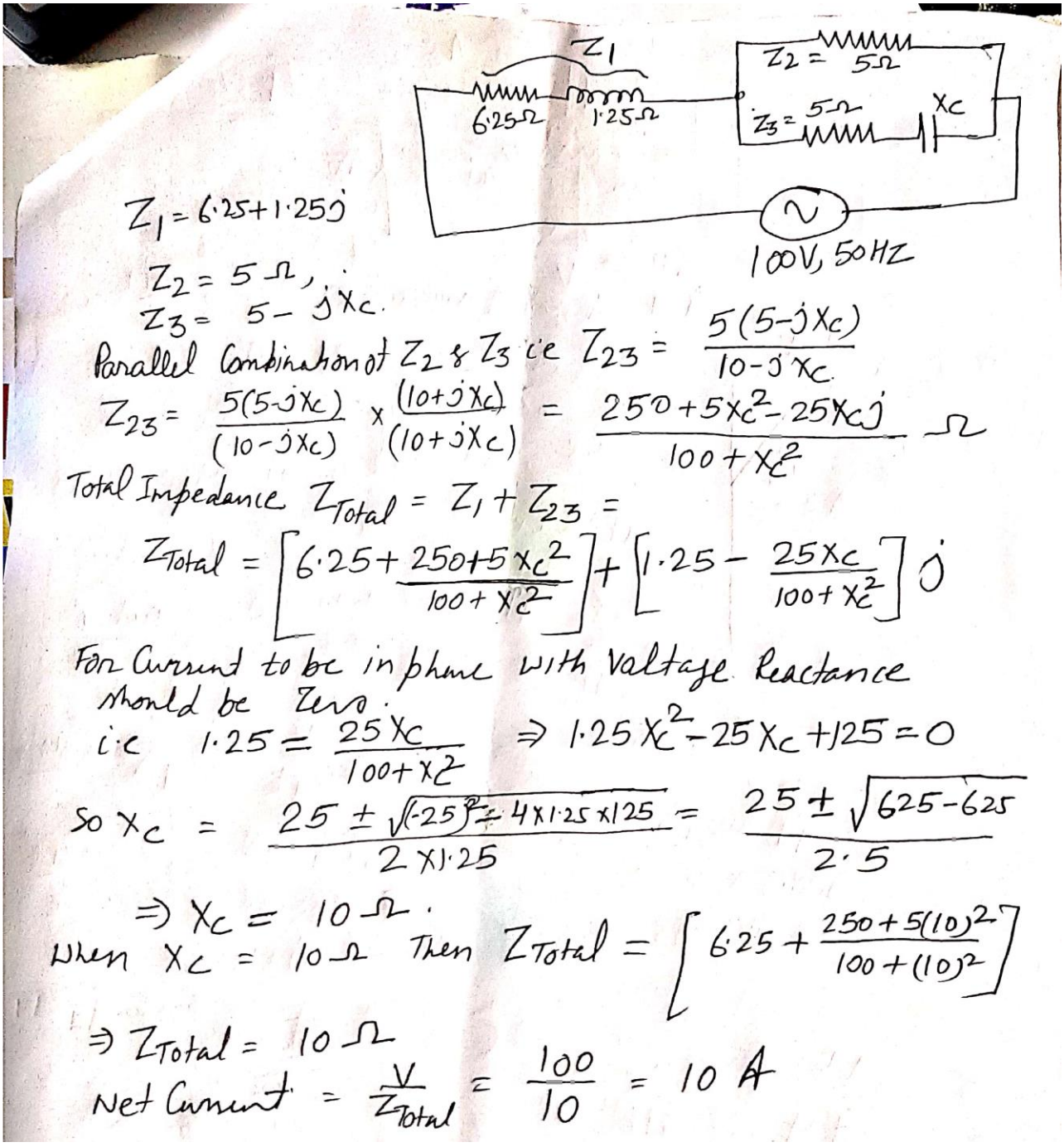
Assignment- Parallel Series parallel &Three phase AC Circuit

Q1. A series combination of R and C is in parallel with 20 Ω resistance across 50 Hz supply. If the total current is 7A, Current through 20 Ω resistor is 5A and current in R-C branch is 3A. Find values of R & C.



Q2.Find The value of X_C **(Fig. 1)** so that total circuit current is in phase with the applied voltage. Also Find the value of circuit current and power consumption





$Z_1 = 6.25 + 1.25j$

$Z_2 = 5\ \Omega$,

$Z_3 = 5 - jX_C$.

Parallel Combination of Z_2 & Z_3 i.e $Z_{23} = \dfrac{5(5-jX_C)}{10-jX_C}$

$$Z_{23} = \frac{5(5-jX_C)}{(10-jX_C)} \times \frac{(10+jX_C)}{(10+jX_C)} = \frac{250+5X_C^2-25X_Cj}{100+X_C^2}\ \Omega$$

Total Impedance $Z_{Total} = Z_1 + Z_{23} =$

$$Z_{Total} = \left[6.25 + \frac{250+5X_C^2}{100+X_C^2}\right] + \left[1.25 - \frac{25X_C}{100+X_C^2}\right]j$$

For Current to be in phase with Voltage Reactance should be Zero.

i.e $1.25 = \dfrac{25X_C}{100+X_C^2} \Rightarrow 1.25X_C^2 - 25X_C + 125 = 0$

$$\text{So } X_C = \frac{25 \pm \sqrt{(-25)^2 - 4\times1.25\times125}}{2\times1.25} = \frac{25 \pm \sqrt{625-625}}{2.5}$$

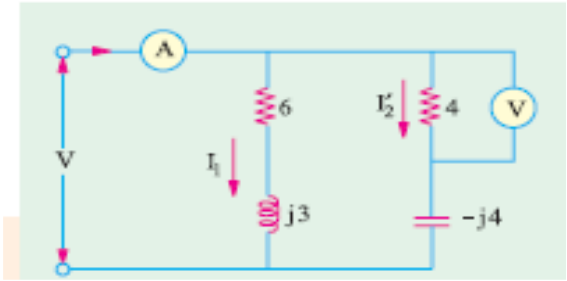
$\Rightarrow X_C = 10\ \Omega$.

When $X_C = 10\ \Omega$ Then $Z_{Total} = \left[6.25 + \dfrac{250+5(10)^2}{100+(10)^2}\right]$

$\Rightarrow Z_{Total} = 10\ \Omega$

Net Current $= \dfrac{V}{Z_{Total}} = \dfrac{100}{10} = 10\ A$

Q3.If in fig.2 given values are in ohms and the voltmeter reads 60 V find the reading of ammeter. (Ans- 22.47 A)



Solution. $I_2 = 60/4 = 15$ A. Taking it as reference quantity
Obviously, the applied voltage is

$$\mathbf{V} = 15\angle 0^\circ \times (4 - j4) = 84.8\angle 45^\circ$$

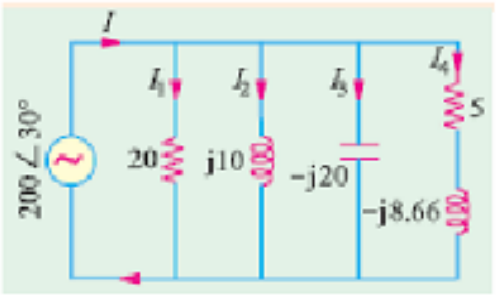
$$\mathbf{I}_1 = 84.8\angle 45^\circ/(6 + j\,3) = 84.8\angle 45^\circ / 6.7\angle 26.6$$

$$= 12.6\angle 71.6^\circ = (4 - j\,12)$$

$$\mathbf{I} = \mathbf{I}_1 + \mathbf{I}_2 = (15 + j\,0) + (4 - j\,12)$$

$$= 19 - j\,12 = 22.47\angle 32.3^\circ$$

Q4. Calculate total current and impedance of given four branched circuit.



Solution. $\mathbf{Y}_1 = 1/20 = 0.05$ S, $\mathbf{Y}_2 = 1/j10 = -j0.1$ S;

$$\mathbf{Y}_3 = 1/-j20 = j0.05 \text{ S}\,; \quad \mathbf{Y}_4 = 1/5 - j8.66 = 1/10\angle 60^\circ$$

$$= 0.1\angle 60^\circ = (0.05 - j0.0866) \text{ S}$$

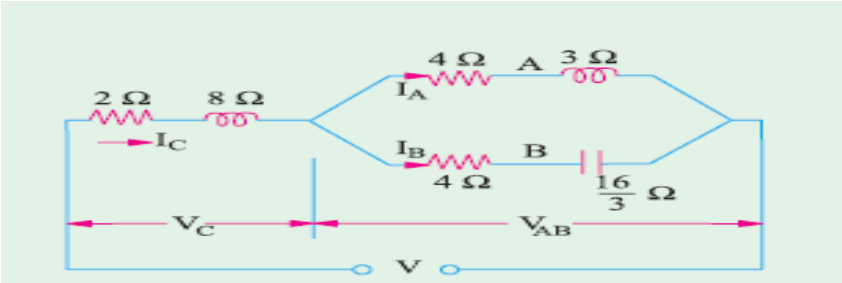
$$\mathbf{Y} = \mathbf{Y}_1 + \mathbf{Y}_2 + \mathbf{Y}_3 + \mathbf{Y}_4 = (0.1 - j\,0.1366) \text{ S}$$

$$= 0.169\angle -53.8^\circ \text{ S}$$

(*i*) $\mathbf{I} = \mathbf{VY} = 200\angle 30^\circ \times 0.169\angle -53.8^\circ = 33.8\angle -23.8^\circ$ A

(*ii*) $\mathbf{Z} = 1/\mathbf{Y} = 1/0.169\angle -53.8^\circ = 5.9\angle 53.8^\circ\ \Omega$

Q5. In given series parallel circuit if current I_C = 25, determine branch currents and power consumption in each branch.



$Z_A = 4+3j = 5\angle 36.86°$, $Z_B = 4 - \frac{16}{3}j = 6.664\angle -53.13\ \Omega$

Parallel Combination: $Z_A \| Z_B$

$$Z_{AB} = \frac{5\angle 36.86 \times 6.664\angle -53.13}{8 - 2.333j} = \frac{5\angle 36.86 \times 6.664\angle -53.13}{8.333\angle -16.26}$$

$Z_{AB} = 3.998\angle 0.01 \cong 4\angle 0°\ \Omega$

Now Voltage. $V_{AB} = I_C \cdot Z_{AB} = 100\angle 0°$

Current $I_A = \frac{V_{AB}}{Z_A} = \frac{100\angle 0°}{5\angle 36.86} = 20\angle -36.86A$ | $I_B = \frac{100\angle 0°}{6.664\angle -53.13} = 15\angle 53.13$

Power in Branch A $= (20)^2 \times 4 = 1600$ watt | Power in Branch B $= (15)^2 \times 4 = 900$ Watt

$\Rightarrow$

Total Impedance of Circuit $= Z_{Total} = (2+8j) + Z_{AB}$

$Z_{Total} = 2+8j+4+0j = 6+8j = 10\angle 53.13\ \Omega$.

Total Voltage $V_{Total} = I_C \cdot Z_{Total} = 25\angle 0 \times 10\angle 53.13$

$= 250\angle 53.13$ Volts.

$Z_C = 2+8j = 8.246\angle 75.96°\ \Omega$

So voltage $V_C = I_C \cdot Z_C = 206.15\angle 75.96°$ Volts

Power in $Z_C = (25)^2 \times 2 = 1250$ Watt

Total Power $P_{Total} = VI\cos\phi = 250 \times 25 \times \cos 53.13°$

$= 3750$ watts.

Also $P_{Total} = P_A + P_B + P_C = 1600 + 900 + 1250 = 3750$ watt