Pb 3φ 415 V STAR CONNECTED LOAD HAS THE FOLLOWING LOADS IN

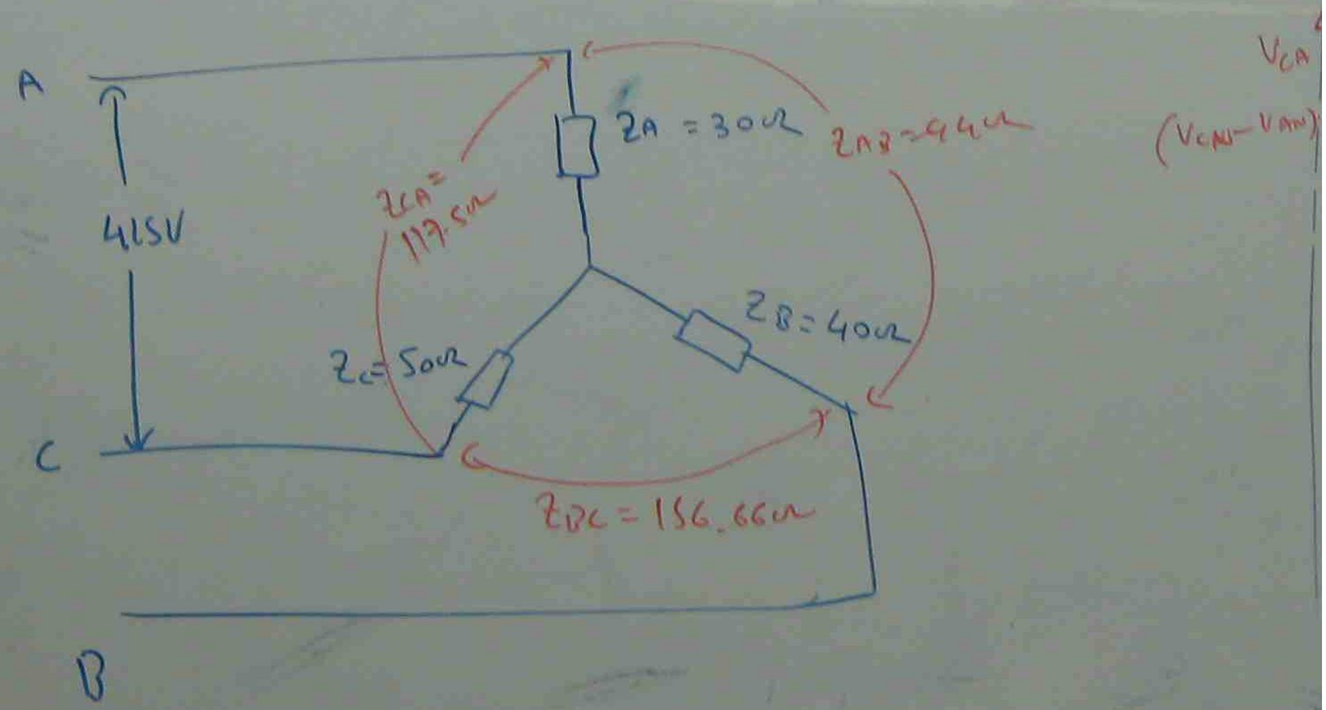
A PHASE = 30Ω RESISTOR

B PHASE = 40 Ω RESISTOR

C PHASE = 50 Ω RESISTOR

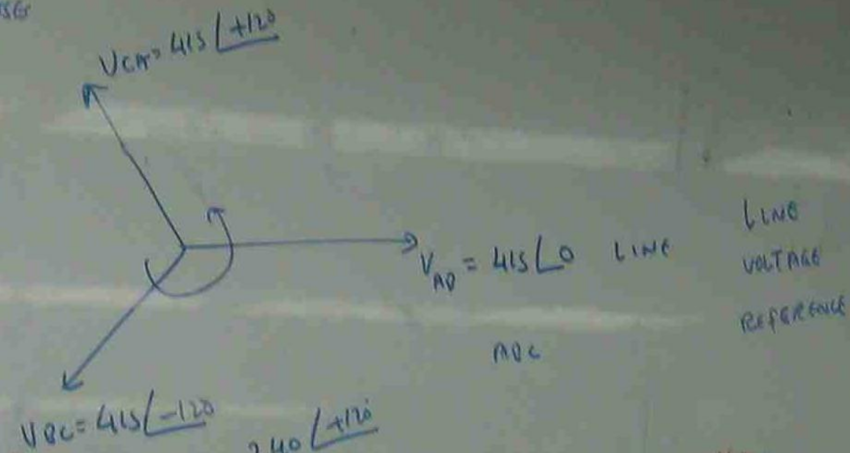
FIND (a) LINE CURRENTS

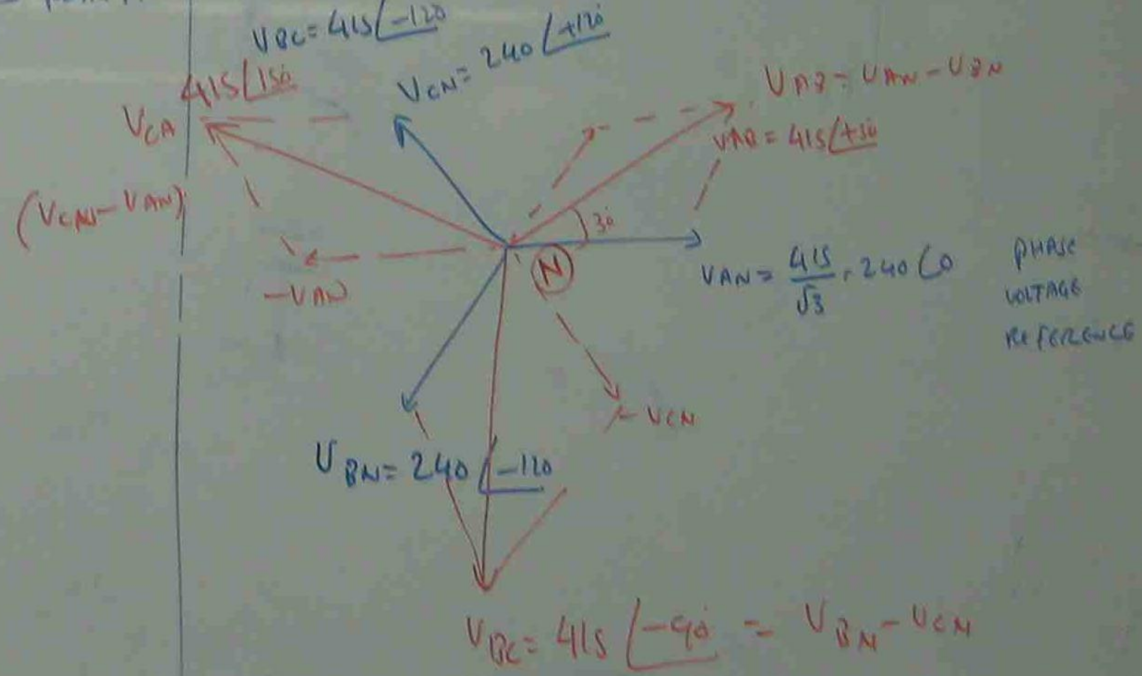
(b) VOLTAGE BETWEEN NEW STAR POINT AND NEUTRAL POINT.

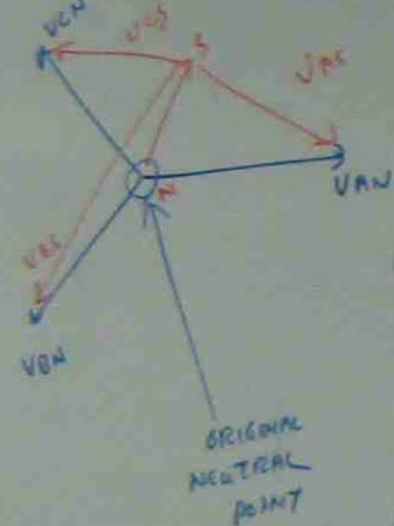


ING LOADS IN PHASE

RAL POINT.







V_{NS}: VOLTAGE BETWEEN NEW STAR POINT & ORIGINAL NEUTRAL POINT

(AT 3ϕ 3WIRE λ)

$$V_{NS} = V_{AN} - V_{AS}$$

$$V_{AS} = I_A \times Z_A$$

$$V_{BS} = I_B \times Z_B$$

$$V_{CS} = I_C \times Z_C$$

CONVERT Y TO Δ AND FIND THE LINE CURRENTS

$\lambda \rightarrow \Delta$

$$Z_{AB} = \frac{Z_A Z_B + Z_B Z_C + Z_C Z_A}{Z_C}$$

$$= \frac{30 \times 40 + 40 \times 50 + 50 \times 30}{50}$$

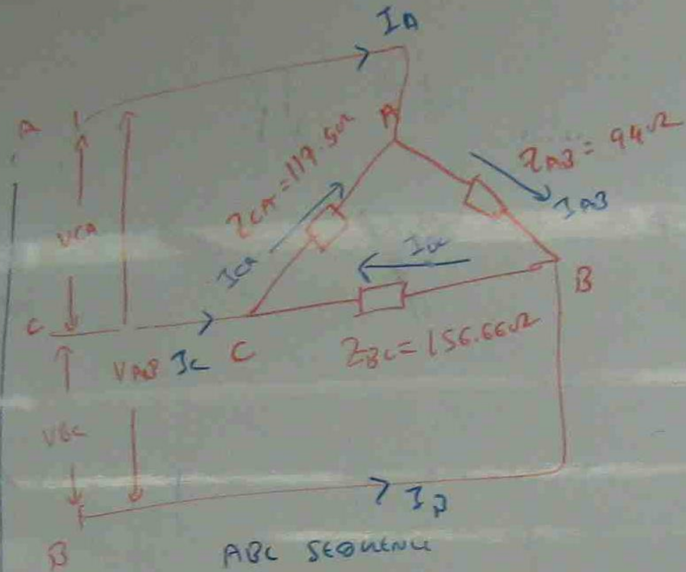
$$= \frac{4700}{50} = 94\Omega$$

$$Z_{BC} = \frac{Z_A Z_B + Z_B Z_C + Z_C Z_A}{Z_A}$$

$$= \frac{4700}{30} = 156.66\Omega$$

$$Z_{CA} = \frac{Z_A Z_B + Z_B Z_C + Z_C Z_A}{Z_B}$$

$$= \frac{4700}{40} = 117.5\Omega$$



ABC SEQUENCE

$$I_{AB} = \frac{V_{AB}}{Z_{AB}} = \frac{415\angle 30}{94} = 4.414\angle 30^\circ \text{ A}$$

$$I_{BC} = \frac{V_{BC}}{Z_{BC}} = \frac{415\angle -90}{156.66} = 2.65\angle -90^\circ \text{ A}$$

$$I_{CA} = \frac{V_{CA}}{Z_{CA}} = \frac{415\angle 150}{117.5} = 3.53\angle 150^\circ \text{ A}$$

(A) POINT   FLOW IN = FLOW OUT

$$I_A + I_{CA} = I_{AB}$$

$$I_A = I_{AB} - I_{CA} = 4.414\angle 30 - 3.53\angle 150$$

$$= 4.414(\cos 30 + j\sin 30) - 3.53(\cos 150 + j\sin 150)$$

$$= 3.82 + j2.207 - 3.53(-0.866 + j0.5)$$

$$I_A = 3.82 + j2.207 + 3.05 - j1.765$$

$$= 6.87 + j0.442$$

$$= \sqrt{6.87^2 + 0.442^2}\ \angle \tan^{-1}\frac{0.442}{6.87}$$

$$= 6.88\ \angle 3.66^\circ \text{ Amp}$$

$$V_{NS} = V_{AN} - V_{AS}$$

$$= 240\angle 0 - I_A Z_A$$

$$= 240\angle 0 - 6.88\angle 3.66 \times 30$$

$$= 240\angle 0 - 206.4\angle 3.66$$

$$= 240 - 206.4(\cos 3.66 + j\sin 3.66)$$

$$= 240 - 206.4(0.997 + j0.063)$$

$$= 240 - (205.7 + j13)$$

$$= 240 - 205.7 - j13$$

$$= 34.3 - j13$$

$$V_{NS} = \sqrt{34.3^2 + 13^2}\ \angle -\tan^{-1}\frac{13}{34.3}$$

$$= 36.68\ \angle -20.75^\circ \text{ V}$$

AT (B) Flow IN = Flow out

$$I_B + I_{AB} = I_{BC}$$

$$I_B = I_{BC} - I_{AB}$$

$$= 2.65\angle{-90} - 4.414\angle{30}$$

$$= 2.65(\cos 90 - j\sin 90) - 4.414(\cos 30 + j\sin 30)$$

$$= 2.65(0 - j1) - (3.82 + j2.207)$$

$$= 0 - j2.65 - 3.82 - j2.207$$

$$I_B = -3.82 - j4.857$$

$$I_B = \sqrt{3.82^2 + 4.857^2}\ \angle{-\left(180 - \tan^{-1}\frac{4.857}{3.82}\right)}$$

$$= 6.179\angle{-(180 - 51.78)}$$

$$= 6.179\angle{-\underline{128.22}}\ A$$

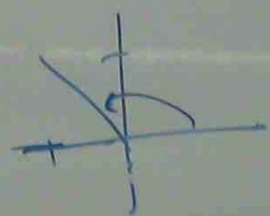
AT (c) Flow IN = Flow OUT

$$I_C + I_{BC} = I_{CA}$$

$$I_C = I_{CA} - I_{BC} = 3.53\angle 150 - 2.65\angle -90$$

$$= 3.53\,(\cos 150 + j\sin 150) - (0 - j2.65)$$

$$= 3.53\,(-0.866 + j0.5) + j\,2.65$$



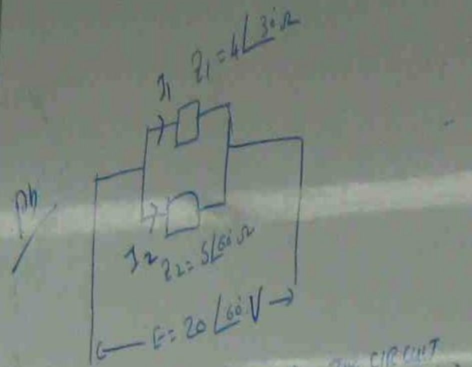
$$= -3.05 + j1.765 + j\,2.65$$

$$= -3.05 + j4.415$$

$$I_C = \sqrt{3.05^2 + 4.415^2}\ \angle -\left(180 - \tan^{-1}\frac{4.415}{3.05}\right)$$

$$= 5.36\ \angle -(180 - 55.22$$

$$= 5.36\ \angle -124.78 \quad A$$

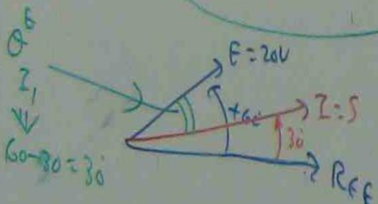


FIND TOTAL POWER TAKEN BY THE CIRCUIT.

$$I_1 = \frac{E}{Z_1} = \frac{20\angle 60}{4\angle 30} = 5\angle 60-30 = 5\angle 30° \text{ A}$$

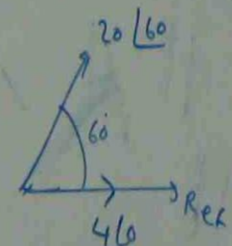
$$I_2 = \frac{E}{Z_2} = \frac{20\angle 60}{5\angle 60} = 4\angle 0° \text{ A}$$

POWER IN Z_1 = $E \times I_1 \cos\theta^{E}_{I_1}$



$$P_{Z_1} = 20 \times 5 \times \cos 30° = 100 \times 0.866 = 86.6 \text{ W}$$

POWER IN $Z_2 = E\, I_2 \cos\theta^{E}_{I_2}$



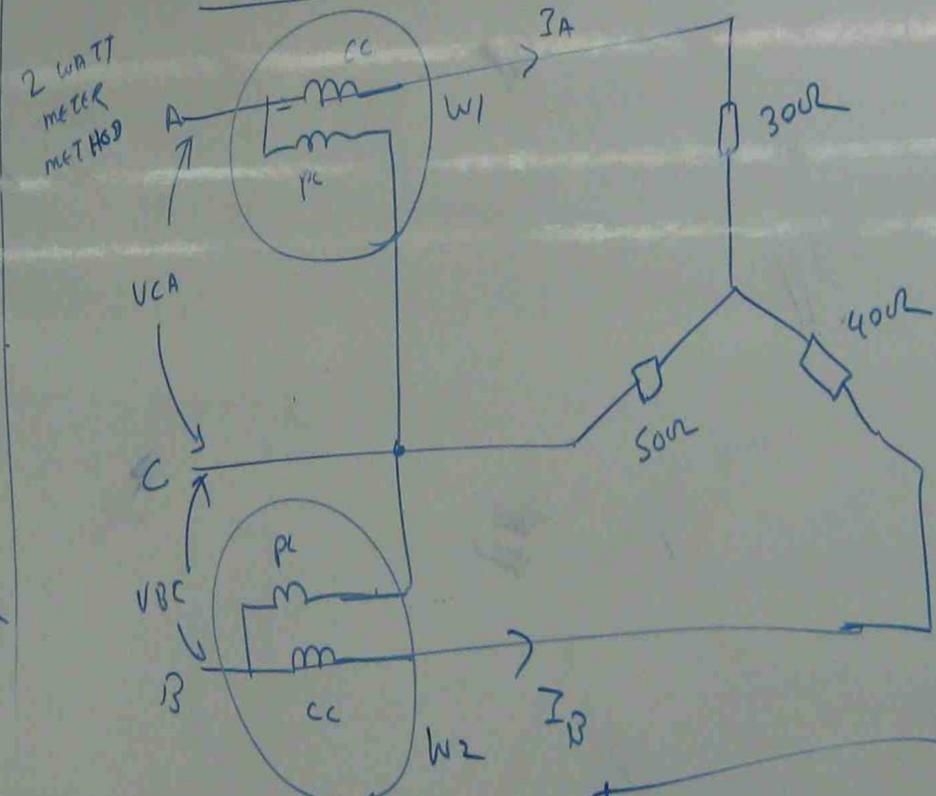
$$P_{Z_2} = 20 \times 4 \times \cos 60 = 80 \times 0.5 = 40 \text{ W}$$

A !

TOTAL POWER = $P_{Z_1} + P_{Z_2} = 86.6 + 40 = 126.6$ W

3ϕ POWER IN UNBALANCED LOAD

2 WATT METER METHOD



$$W_1 = I_A \times V_{CA} \cos\theta^{V_{CA}}_{I_A}$$

$$W_2 = I_B \times V_{BC} \cos\theta^{V_{BC}}_{I_B}$$

$$\boxed{W_T = W_1 + W_2}$$