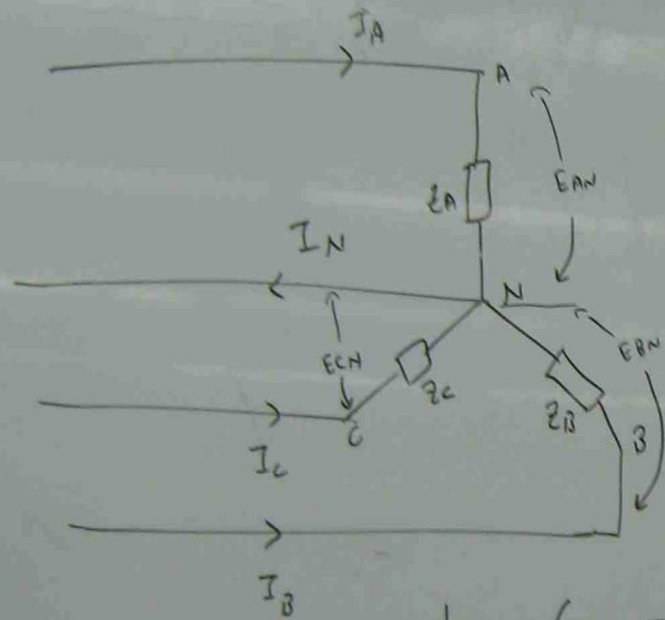
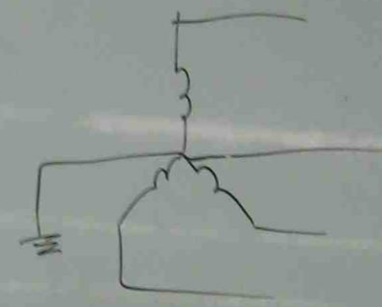
THREE PHASE FOUR WIRE STAR CONNECTED UNBALANCED LOAD





$$I_A = \frac{E_{AN}}{Z_A}$$

$$I_B = \frac{E_{BN}}{Z_B}$$

$$I_C = \frac{E_{CN}}{Z_C}$$

$$I_N = -(I_A + I_B + I_C)$$

Pb. A 3φ 4 WIRE 208 V SUPPLIES A STAR CONNECTED UNBALANCED LOAD WHOSE IMPEDANCES ARE

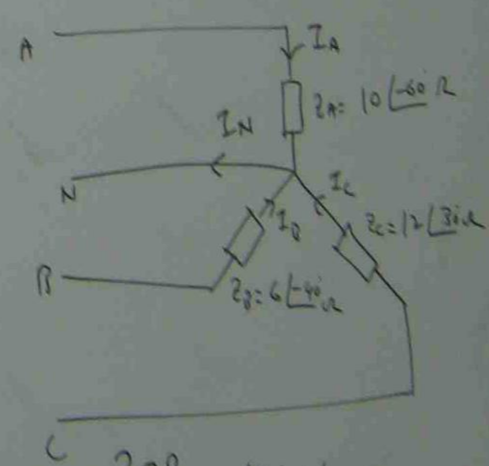
$Z_A = 10 \angle -60\ \Omega$

$Z_B = 6 \angle -90\ \Omega$

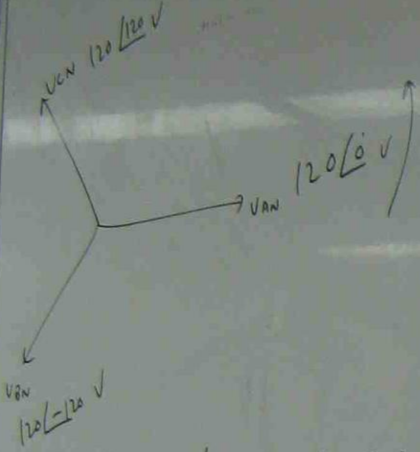
$Z_C = 12 \angle 30\ \Omega$

CALCULATE I_A, Z_B, I_C, I_N

DRAW THE COMPLETE PHASOR DIAGRAM.



$$V_{AN} = \frac{208}{\sqrt{3}} = 120\ V$$

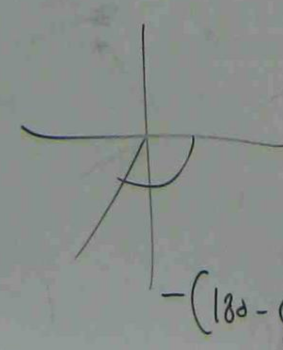


$$\bar{I}_A = \frac{\bar{V}_{AN}}{Z_A} = \frac{120\angle 0}{10\angle -60} = 12\angle 0-(-60) = 12\angle 60 \text{ A}$$

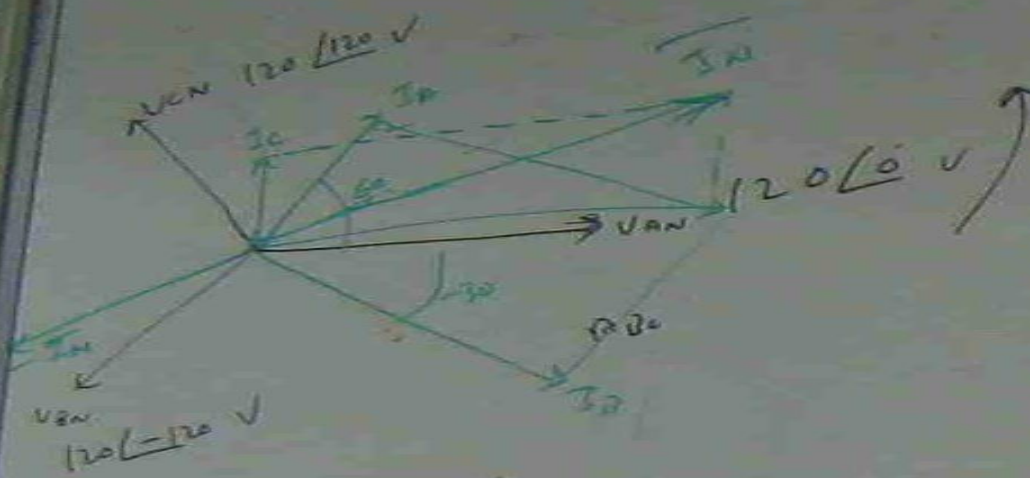
$$\bar{I}_B = \frac{\bar{V}_{BN}}{Z_B} = \frac{120\angle -120}{6\angle -90} = 20\angle -120-(-90) = 20\angle -120+90$$
$$= 20\angle -30 \text{ A}$$

$$\bar{I}_C = \frac{\bar{V}_{CN}}{Z_C} = \frac{120\angle 120}{12\angle 30} = 10\angle 120-30 = 10\angle 90 \text{ A}$$

$$\bar{I}_N = -(\bar{I}_A + \bar{I}_B + \bar{I}_C)$$
$$= -(12\angle 60 + 20\angle -30 + 10\angle 90)$$
$$= -(12(\cos 60 + j\sin 60) + 20(\cos 30 - j\sin 30) + 10(\cos 90 + j\sin 90))$$
$$= -(6 + j10.39 + 17.32 - j10 + j10)$$
$$= -(23.32 + j10.39)$$
$$= -23.32 - j10.39$$
$$= \sqrt{23.32^2 + 10.39^2}\ \angle -\left(180 - \tan^{-1}\frac{10.39}{23.32}\right)$$



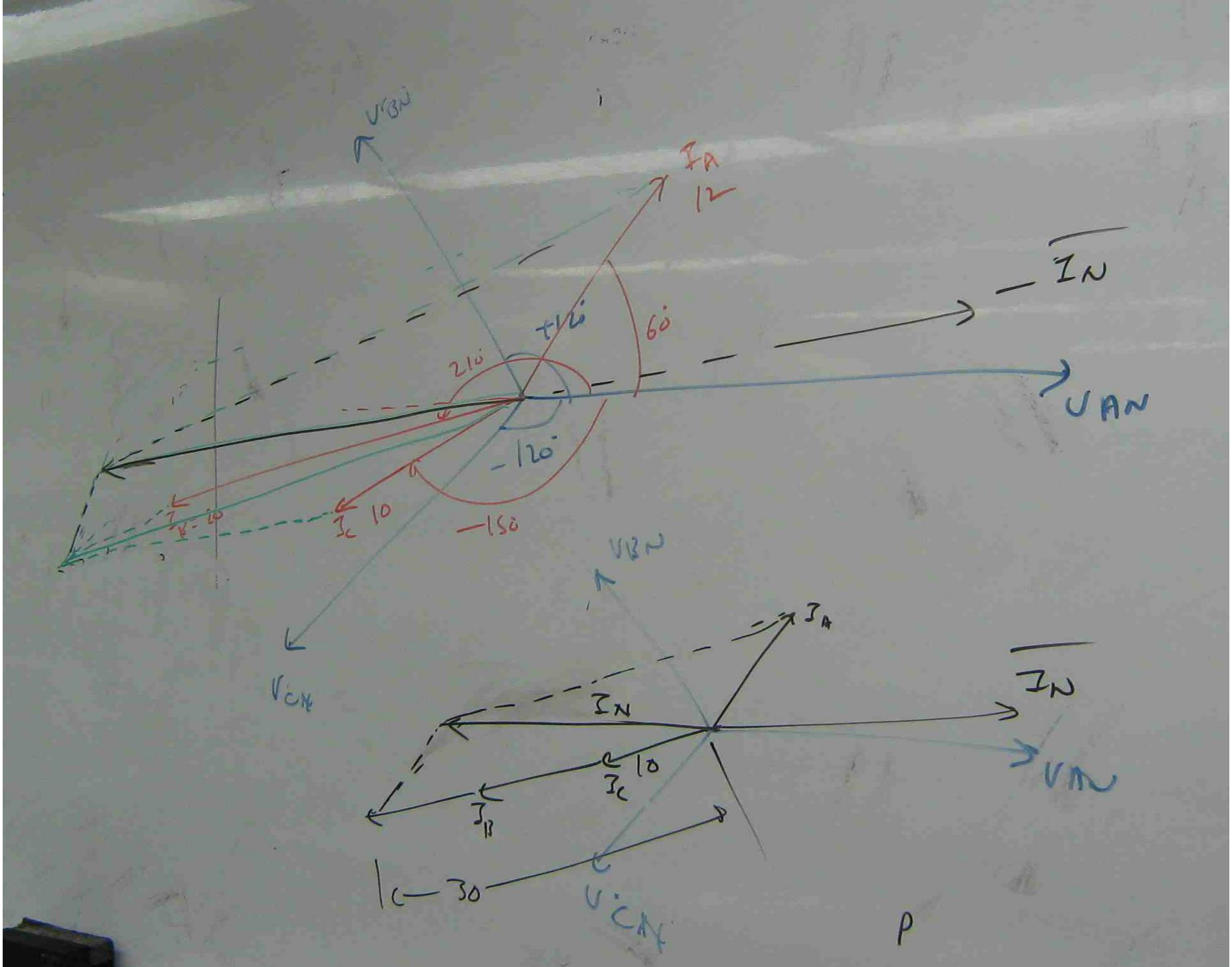
$$= 25.53\angle -156^\circ \text{ Amp}$$



$$\bar{I}_A = \frac{\bar{V}_{AN}}{Z_A} = \frac{120\angle 0}{10\angle -60} = 12\angle 0-(-6$$

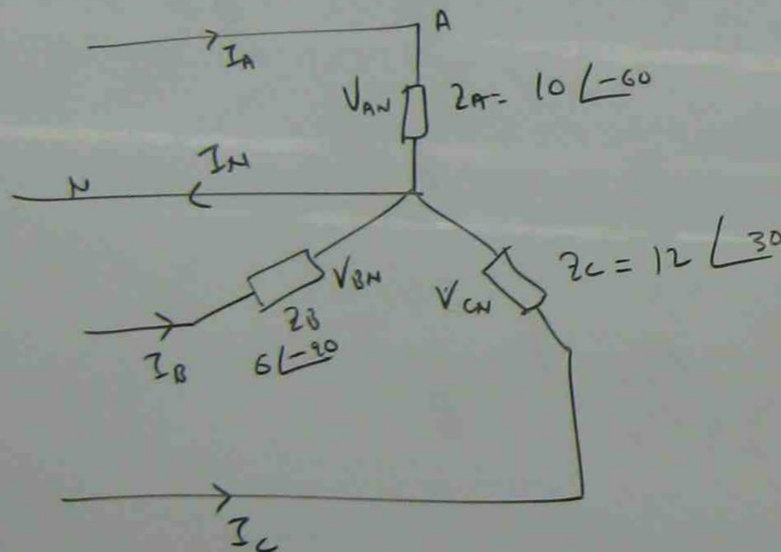
$$\bar{I}_B = \frac{\bar{V}_{BN}}{Z_B} = \frac{120\angle -120}{6\angle -90} =$$

$$\bar{I}_C = \frac{\bar{V}_{CN}}{Z_C} = \frac{120\angle 120}{12\angle 30} =$$

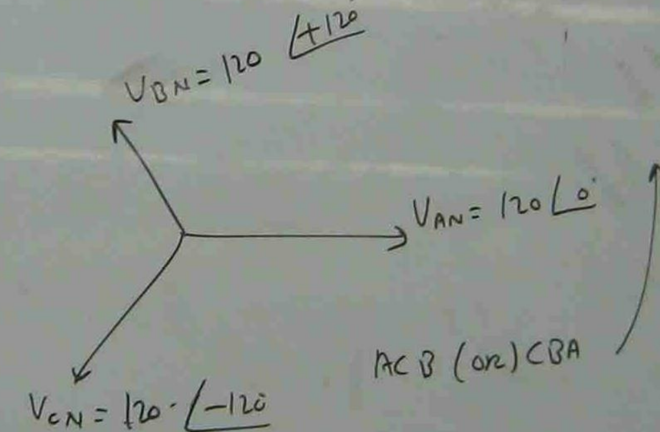

VBN
IA
12
IN
+120
60
210
VAN
-120
IC 10
-150
VCN
VBN
IA
IN
IN
10
IC
IB
VAN
VCN
P

EFFECT OF PHASE REVERSAL ON LOAD CURRENTS

Pb IN ABOVE PROBLEM, IF PHASE SEQUENCE IS ACB (OR) CBA, WHAT WILL HAPPEN TO LINE CURRENTS AND NEUTRAL CURRENT?



$$V_{AN} = \frac{208}{\sqrt{3}} = 120^\circ$$



$$\bar{I}_A = \frac{\bar{V}_{AN}}{\bar{Z}_A} = \frac{120\angle 0}{10\angle -60} = 12\angle 60^\circ \text{ A}$$

$$\bar{I}_B = \frac{V_{BN}}{Z_B} = \frac{120\angle +120}{6\angle -90} = 20\angle (120-(-90)) = 20\angle 210^\circ \text{ A}$$

$$\bar{I}_C = \frac{V_{CN}}{Z_C} = \frac{120\angle -120}{12\angle 30} = 10\angle -150^\circ \text{ A}$$

$$\bar{I}_N = -(\bar{I}_a + \bar{I}_b + \bar{I}_c)$$

$$= -(12\angle 60 + 20\angle 210 + 10\angle -150)$$

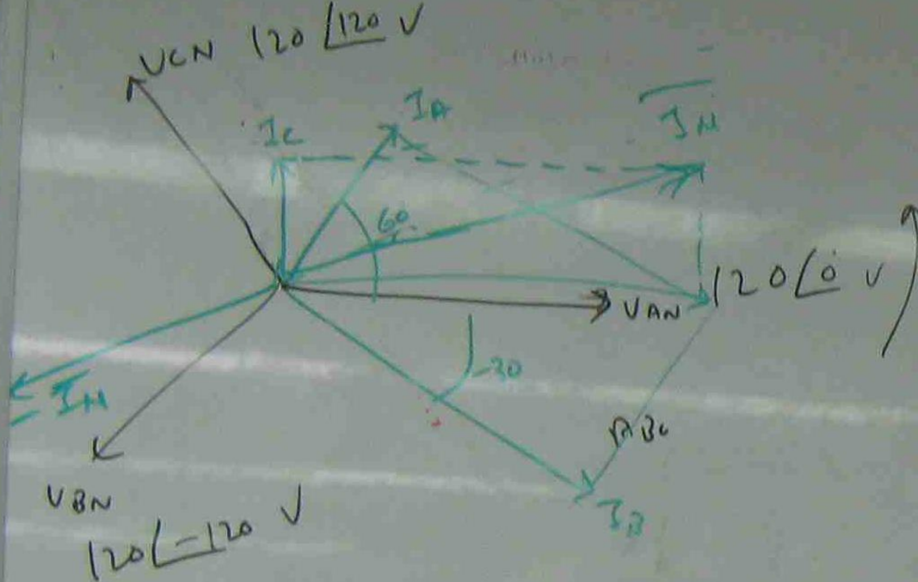
$$= -\big(12(\cos 60 + j\sin 60) + 20(\cos 210 + j\sin 210)$$
$$+ 10(\cos 150 - j\sin 150)\big)$$

$$= -(-20 - j4.6)$$

$$= 20 + j4.6$$

$$= \sqrt{20^2 + 4.6^2}\ \angle \tan^{-1}\frac{4.6}{20}$$

$$= 20.5\angle 13^\circ \text{ A}$$



$$\bar{I}_A = \frac{\bar{V}_{AN}}{Z_A} = \frac{120\angle 0}{10\angle -60} = 12\angle 0-(-60) = 12\angle 60^\circ \text{ A}$$

$$\bar{I}_B = \frac{\bar{V}_{BN}}{Z_B} = \frac{120\angle -120}{6\angle -90} = 20\angle -120-(-90) = 20\angle -120+90$$
$$= 20\angle -30 \text{ A}$$

$$\bar{I}_C = \frac{\bar{V}_{CN}}{Z_C} = \frac{120\angle 120}{12\angle 30} = 10\angle 120-30 = 10\angle 90^\circ \text{ A}$$

$$\bar{I}_N = -(\bar{I}_A + \bar{I}_B + \bar{I}_C)$$

$$= -(12\angle 60 + 20\angle -30 + 10\angle 90)$$

$$= -(12(\cos 60 + j\sin 60) + 20(\cos 30 - j\sin 30) + 10(\cos 90 + j\sin 90))$$

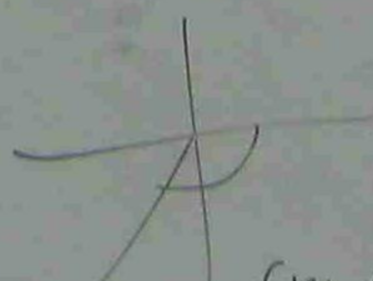
$$= -(6 + j10.39 + 17.32 - j10 + j10)$$

$$= -(23.32 + j10.39)$$

$$= -23.32 - j10.39$$

$$= \sqrt{23.32^2 + 10.39^2}\ \angle -\left(180 - \tan^{-1}\frac{10.39}{23.32}\right)$$

$$= 25.53\ \angle -156^{\circ} \text{ Amp}$$



$-(180 - \phi)$