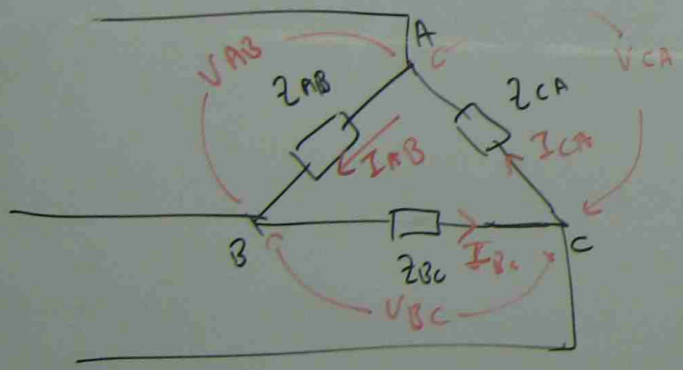
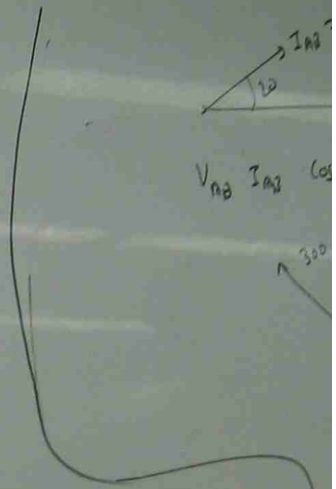
CALCULATION OF 3φ POWER





3φ POWER FOR UNBALANCED $= V_{AB} I_{AB} \cos\theta_{I_{AB}}^{V_{AB}} + V_{BC} I_{BC} \cos\theta_{I_{BC}}^{V_{BC}} + V_{CA} I_{CA} \cos\theta_{I_{CA}}^{V_{CA}}$

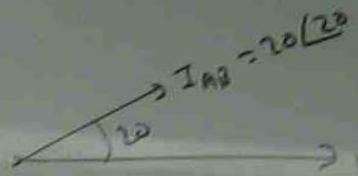
Δ LOAD

$V_{AB} = 300 \angle 0^\circ$ $\quad I_{AB} = 20 \angle 20^\circ$

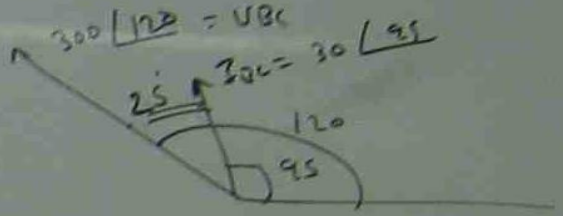
$V_{BC} = 300 \angle 120^\circ$ $\quad I_{BC} = 30 \angle 95^\circ$

$V_{CA} = 300 \angle -120^\circ$ $\quad I_{CA} = 12 \angle -120^\circ$

TOTAL POWER



$V_{AB}\ I_{AB}\ \cos\theta^{V_{AB}}_{I_{AB}} = 300 \times 20 \cos 20 = 5638\ W$



$V_{BC}\ I_{BC}\ \cos\theta^{V_{BC}}_{I_{BC}} = 300 \times 30 \cos 26$

$= 9000 \times 0.906$

$= 8156\ W$

$V_{CA}\ I_{CA}\ \cos\theta^{V_{CA}}_{I_{CA}}$

$I_{CA} = 12\angle -120$

$V_{CA} = 300\angle -120$

$V_{CA}\ I_{CA}\ \cos\theta^{V_{CA}}_{I_{CA}} = 300 \times 12 \cos 0 = 3600\ W$

TOTAL POWER $= 5638 + 8156 + 3600 = 17394\ W$

WHEN PHASE SEQUENCE IS REVERSED, LINE CURRENT WILL CHANGE BUT TOTAL POWER IS UNCHANGED.

EXERCISE

A 3ϕ 3 WIRE 240 V ACB SEQUENCE IS CONNECTED TO A DELTA LOAD THE IMPEDANCES OF THE LOAD ARE

$Z_{AB} = 10 \angle 30^\circ\ \Omega$

$Z_{BC} = 20 \angle 90^\circ\ \Omega$

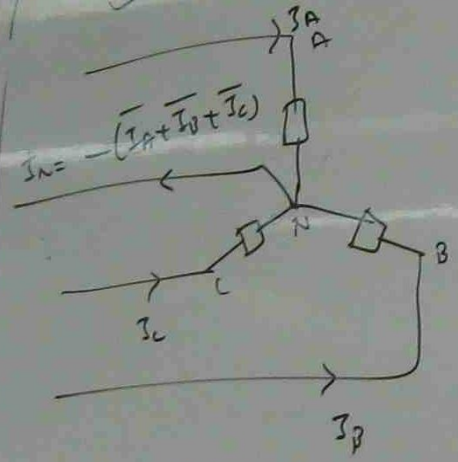
$Z_{CA} = 15 \angle -45^\circ\ \Omega$

FIND (a) PHASE CURRENT

(b) LINE CURRENT

METHOD(?) USE KIRCHOFF'S LAW

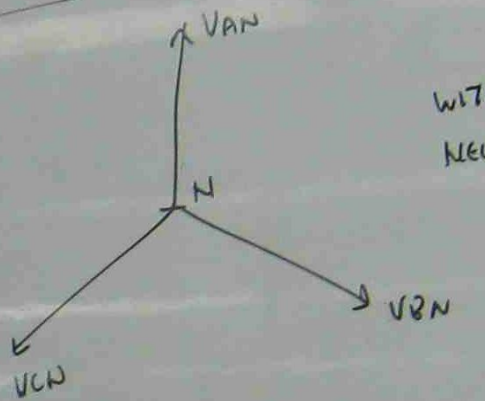
3φ 3WIRE Y CONNECTED UNBALANCED LOAD



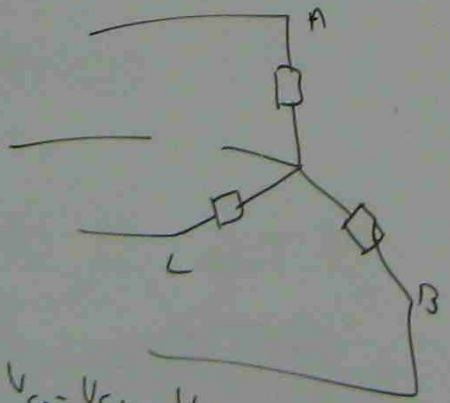
$V_{AN} = E$

$V_{BN} = E$

$V_{CN} = E$

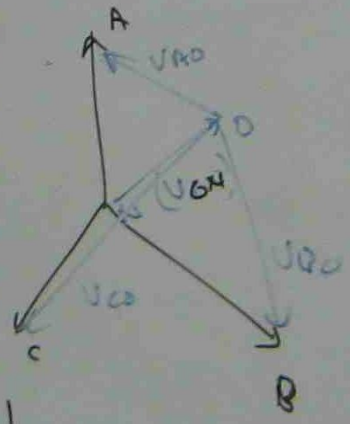


WITH NEUTRAL



$V_{CO} = V_{CN} - V_{NO}$

$I_C = V_{CO} \times Y_C$



METHOD (1)

$\lambda \rightarrow \Delta$

CALCULATE PHASE & LINE CURRENT

METHOD (2)

$Y_A = \frac{1}{Z_A}$

$Y_B = \frac{1}{Z_B}$

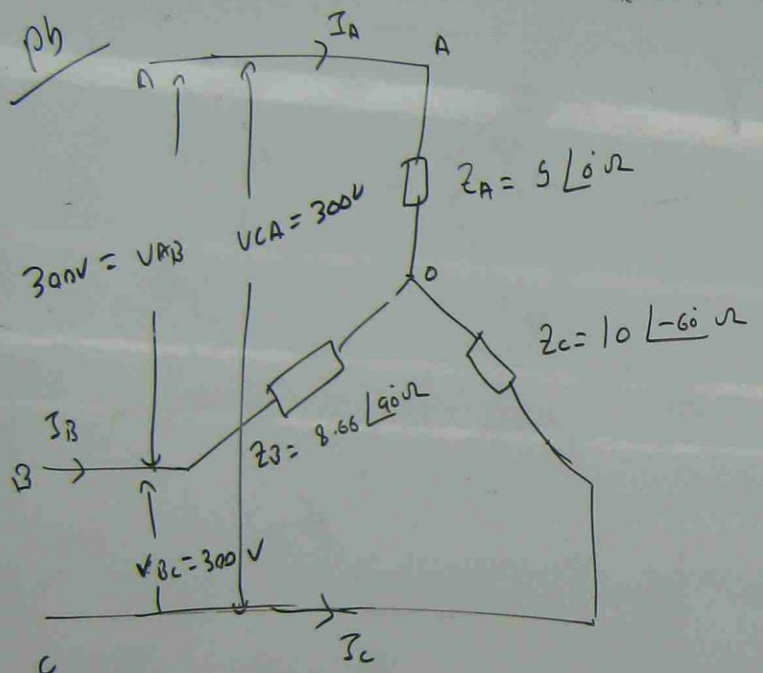
$Y_C = \frac{1}{Z_C}$

$$V_{ON} = \frac{V_{AN} Y_A + V_{BN} Y_B + V_{CN} Y_C}{Y_A + Y_B + Y_C}$$

$V_{AO} = V_{AN} - V_{ON} \rightarrow I_A = V_{AO} \times Y_A$

$V_{BO} = V_{BN} - V_{ON} \rightarrow I_B = V_{BO} Y_B$

ph

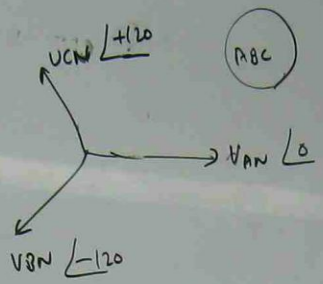


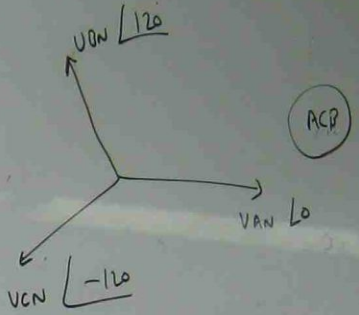
CALCULATE (i) V_{ON}

(ii) UNBALANCED PHASE VOLTAGES

(iii) LINE CURRENTS.

SEQUENCE ACB





$$V_{AN} = \frac{\text{LINE VOLTAGE}}{\sqrt{3}} = \frac{300}{1.7321} = 173.2 \angle 0$$

$V_{BN} = 173.2 \angle +120$, $V_{CN} = 173.2 \angle -120$

$$Y_A = \frac{1}{Z_A} = \frac{1}{5 \angle 0} = 0.2 \angle 0° \text{ } \mho$$

$$Y_B = \frac{1}{Z_B} = \frac{1}{8.66 \angle 90} = 0.115 \angle -90° \text{ } \mho$$

$$Y_C = \frac{1}{Z_C} = \frac{1}{10 \angle -60} = 0.1 \angle 60° \text{ } \mho$$

$$V_{ON} = \frac{V_{AN}Y_A + V_{BN}Y_B + V_{CN}Y_C}{Y_A + Y_B + Y_C}$$

$$= \frac{173.2 \angle 0 \times 0.2 \angle 0 + 173.2 \angle 120 \times 0.115 \angle -90 + 173.2 \angle -120 \times 0.1 \angle 60}{0.2 \angle 0 + 0.115 \angle -90 + 0.1 \angle 60}$$

$$V_{ON} = \frac{34.6 \angle 0 + 19.9 \angle 30 + 17.3 \angle -60}{0.2 + j0 + 0 - j0.115 + 0.05 + j0.087}$$

$$34.6 + 19.9(\cos 30 + j \sin 30) + 17.3(\cos 60 - j \sin 60)$$

$$0.25 - j0.28$$

$$\frac{60.66 \angle -47}{0.25 \angle -64}$$

$V_{ON} = 242.6 \angle 17$

$V_{AO} = V_{AN} - V_{ON} = 173.2\angle 0 - 242.6\angle 1.7$

$= 173.2 - 242.6(\cos 1.7 + j\sin 1.7)$

$= 173.2 - (242.5 + j7.2)$

$= -69.5 - j7.2$

$= \sqrt{69.5^2 + 7.2^2}\ \angle -\left(180 - \tan^{-1}\frac{7.2}{69.5}\right)$

$= 69.9\angle -174$ V

$V_{BO} = V_{BN} - V_{ON} = 173.2\angle 120 - 242.6\angle 1.7$

$= 173.2(\cos 120 + j\sin 120) - (242.5 + j7.2)$

$= -329 + j142.6$

$= 358.6\angle 156$ V

$V_{CO} = V_{CN} - V_{ON} = 173.2\angle -120 - 242.6\angle 1.7$

$= -86.5 - j149.8 - (242.5 + j7.2)$

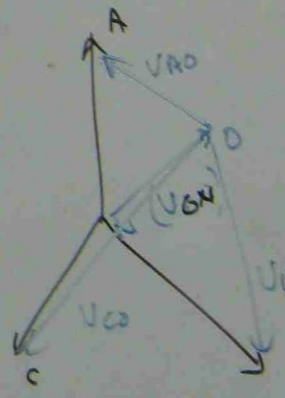
$= -329 - j157$

$V_{CO} = 364.5\angle -154.5$ V

$I_A = V_{AO} Y_A = 69.9\angle -174 \times 0.2\angle 0 = 14\angle -174$ A

$I_B = V_{BO} Y_B = 358.6\angle 156 \times 0.115\angle -90 = 41.2\angle 67$ A

$I_C = V_{CO} Y_C = 364.5\angle -154.5 \times 0.1\angle 60 = 36.5\angle -94$ A



METHOD

$\lambda -$

METHO

$V_{CO} = V_{CN} - V_{ON}$

$I_C = V_{CO} \times Y_C$

$Y_A = \frac{1}{Z_A}$

$Y_B = \frac{1}{Z_B}$

$Y_C = \frac{1}{}$

$V_{ON} = \frac{V_{AN} Y_A + V_{B}}{Y_A + Y}$

$V_{AO} = V_{A}$