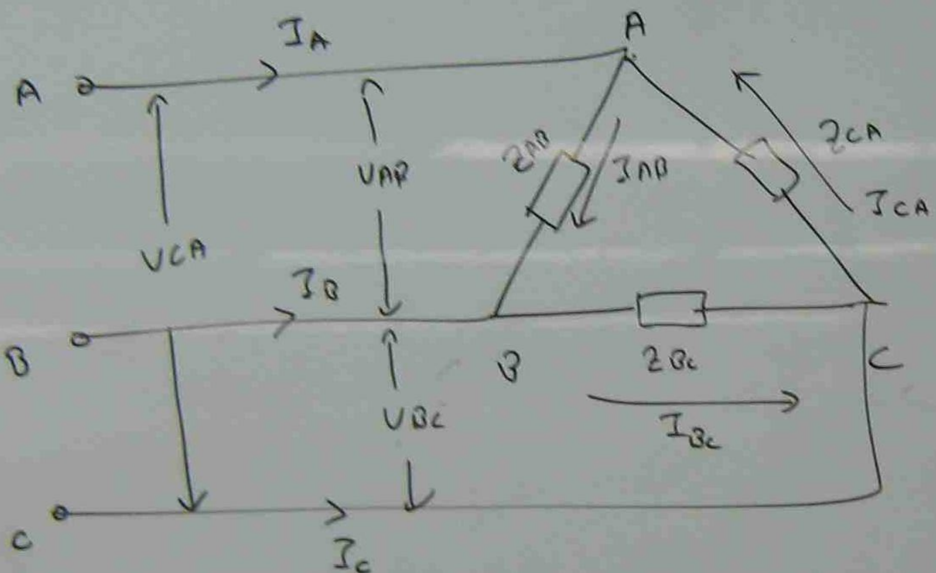
# CALCULATION OF CURRENTS IN DELTA CONNECTED UNBALANCED LOAD




SEQUENCE ABC

$A \longrightarrow B \longrightarrow C$

$$I_{AB} = \frac{V_{AB}}{Z_{AB}}, \quad I_{BC} = \frac{V_{BC}}{Z_{BC}}, \quad I_{CA} = \frac{V_{CA}}{Z_{CA}}$$

FLOW IN = FLOW OUT

A POINT

$$I_A + I_{CA} = I_{AB} \Rightarrow I_A = I_{AB} - I_{CA}$$

B POINT

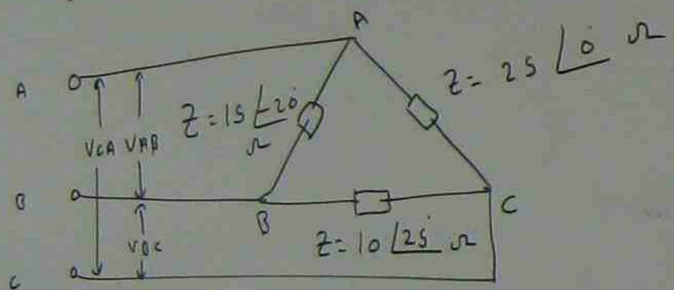
$$I_B + I_{AB} = I_{BC} \Rightarrow I_B = I_{BC} - I_{AB}$$

C POINT

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

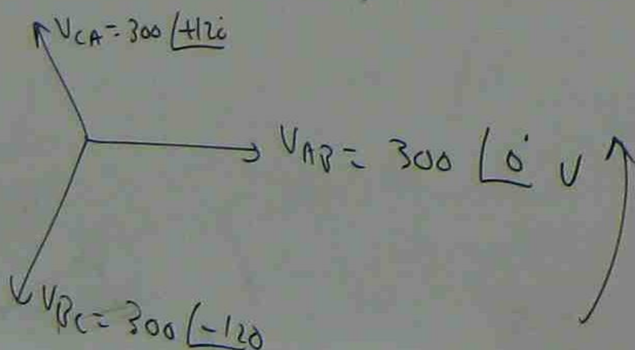
$I_C = I_{CA} - I_{BC}$

pb CALCULATE THE LINE CURRENTS FOR THE LOAD SHOWN IN FIGURE.




SUPPLY VOLTAGE = 300V

PHASE SEQUENCE = A, B, C




$$I_{AB} = \frac{V_{AB}}{Z_{AB}} = \frac{300 \angle 0}{15 \angle -20} = 20° \angle 20 \ A$$

$$I_{BC} = \frac{V_{BC}}{Z_{BC}} = \frac{300 \angle -120}{10 \angle 25} = 30 \angle -145 \ A$$

$$I_{CA} = \frac{V_{CA}}{Z_{CA}} = \frac{300 \angle +120}{25 \angle 0} = 12 \angle 120° \ A$$

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

$$= 20 \angle 20 - 12 \angle 120$$

$$= 20 (\cos 20 + j \sin 20) - 12 (\cos 120 + j \sin 120)$$

$$= 18.79 + j 6.84 + 6 - j 10.39$$

$$= 24.79 - j 3.55$$

$$= \sqrt{24.79^2 + 3.55^2} \angle -\tan^{-1} \frac{3.55}{24.79}$$

$$= 25 \angle -8° \ A$$

$$I_B = I_{BC} - I_{AB} = 30\angle{-145} - 20\angle{20}$$

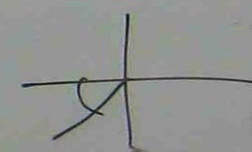
$$= 30(\cos(-145) + j\sin(-145)) - 20(\cos 20 + j\sin 20)$$

$$= -24.57 - j17.2 - 18.79 - j6.84$$

$$= -43.36 - j24.04$$

$$= \sqrt{43.36^2 + 24.04^2}\ \angle{-\left(180 - \tan^{-1}\frac{24.04}{43.36}\right)}$$

$$= 49.6\ \angle{-151}\ \text{A}$$



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

$$= 12\angle{120} - 30\angle{-145}$$

$$= 12(\cos 120 + j\sin 120) - 30(\cos(-145) + j\sin(-145))$$

$$= -6 + j10.39 - 30(\cos 145 - j\sin 145)$$

$$= -6 + j10.39 + 24.57 + j17.2$$

$$= 18.57 - j27.6$$

$$= \sqrt{18.57^2 + 27.6^2}\ \angle{-\tan^{-1}\frac{27.6}{18.57}}$$

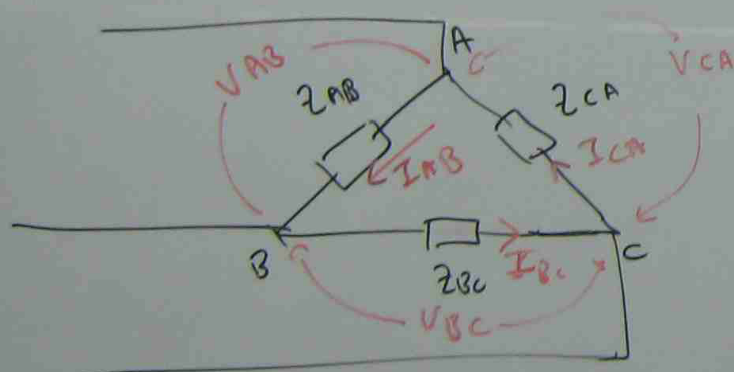
$$= 33.3\ \angle{-56}\ \text{A}$$

## CALCULATION OF POWER IN DELTA CONNECTED UNBALANCED LOAD

CALCULATE 3$\phi$ POWER FOR ABOVE PROBLEM.

FOR BALANCED LOAD, 3$\phi$ POWER = $\sqrt{3}\, E_L I_L \cos\theta$

FOR UNBALANCED LOAD, THIS FORMULA CAN NOT BE USED.




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

$V_{AB} = 300 \angle 0$

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

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

$I_{AB} = 20 \angle 20$

$I_{BC} = 30 \angle -145$

$I_{CA} = 12 \angle 120$

AB

$V_{AB} I_{AB} \cos\theta$

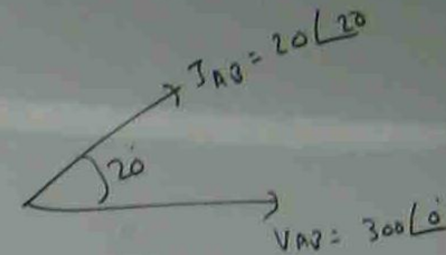
BC

CA

$V_{CA} I_C$

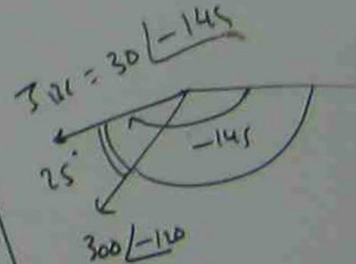
TOTAL P

AB




$$V_{AB} I_{AB} \cos\theta_{I_{AB}}^{V_{AB}} = 300 \times 20 \cos 20 = 5638 \text{ W}$$

BC



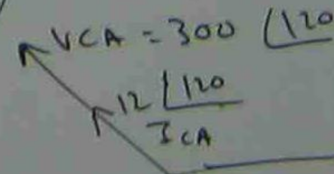

$$V_{BC} I_{BC} \cos\theta_{I_{BC}}^{V_{BC}} = 300 \times 30 \cos 25 = 8156.8 \text{ W}$$

$$\ldots + V_{CA} I_{CA} \cos\theta_{I_{CA}}^{V_{CA}}$$

$\angle 45$

$\angle 20$

CA



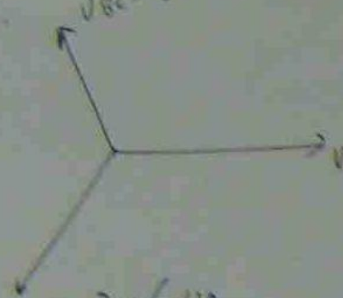

$$V_{CA} I_{CA} \cos\theta_{I_{CA}}^{V_{CA}} = 300 \times 12 \times \cos 0$$

$$= 3600 \text{ W}$$

TOTAL POWER = 5638 + 8156.8 + 3600 = 17395 W

## EFFECT OF PHASE REVERSAL ON LOAD CURRENTS

Q) In above problem if phase sequence is changed to ACB (CBA), what will be line currents and power?




$$I_{AB} = \frac{V_{AB}}{Z_{AB}} = \frac{300\angle 0}{15\angle{-20}} = 20\angle 20^\circ \text{ A}$$

$$I_{BC} = \frac{V_{BC}}{Z_{BC}} = \frac{300\angle 120}{10\angle 25} = 30\angle 95^\circ \text{ A}$$

$$I_{CA} = \frac{V_{CA}}{Z_{CA}} = \frac{300\angle{-120}}{25\angle 0} = 12\angle{-120^\circ} \text{ A}$$

$$I_A = I_{AB} - I_{CA} = 20\angle 20 - 12\angle -120 = 20(\cos 20 + j\sin 20) - 12(\cos(-120) + j\sin(-120))$$

$$= 18.79 + j6.84 + 6 + j10.39 = 24.79 + j17.32$$

$$= \sqrt{24.79^2 + 17.32^2}\ \angle \tan^{-1}\frac{17.32}{24.79}$$

$$= 30.2\ \angle 34.8^\circ \text{ A}$$

$$I_B = I_{BC} - I_{AB} = 30\angle 95 - 20\angle 20 = 30(\cos 95 + j\sin 95) - 20(\cos 20 + j\sin 20)$$

$$= -2.61 + j29.89 - 18.79 - j6.84$$

$$= -21.4 + j23.05$$

$$= \sqrt{21.4^2 + 23.05^2}\ \angle 180 - \tan^{-1}\frac{23.05}{21.4}$$

$$= 31.45\ \angle 132.9^\circ \text{ A}$$

$$I_C = I_{CA} - I_{BC} = 12\angle -120 - 30\angle 95$$

$$= 12(\cos(-120) + j\sin(-120)) - 30(\cos 95 + j\sin 95)$$

$$= -6 - j10.39 + 2.61 - j29.89$$

$$= -3.4 - j40.28 = \sqrt{3.4^2 + 40.28^2}\ \angle -\left(180 - \tan^{-1}\frac{40.28}{3.4}\right)$$

$$= 40.4\ \angle -94.8^\circ \text{ A}$$