ph

Circuit diagram: Three-phase delta load with wattmeters W_1, current coils (CC) and potential coils (PC).

A — 200V, B — 200V, C

I_A, I_B, I_C line currents

$Z_{AB} = 3 + j4\,\Omega$
$Z_{CA} = 5 + j6\,\Omega$
$Z_{BC} = 3 - j4\,\Omega$

I_{AB}, I_{CA}, I_{BC}

Phasor diagram:
$E_{CA} = 200\,\underline{/+120}\ V$
$E_{AB} = 200\,\underline{/0}\ V$
$E_{BC} = 200\,\underline{/-120}\ V$
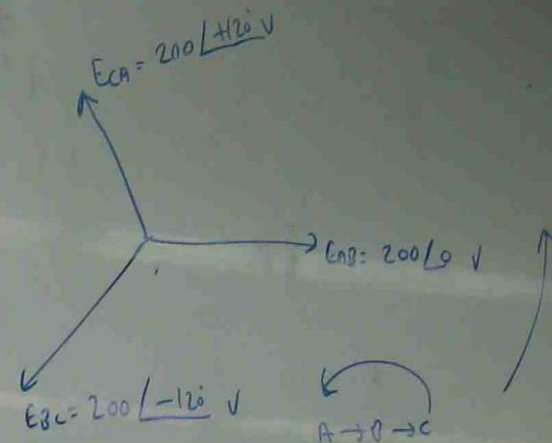$A \to B \to C$

CALCULATE (a) ALL LINE CURRENTS IN POLAR FORM

(b) READING OF WATT METER W_1 & W_2

(c) TOTAL REAL POWER

(d) TOTAL REACTIVE POWER

SEQUENCE A-B-C

$Z_{AB} = 3 + j4 = \sqrt{3^2 + 4^2}\ \underline{/\tan^{-1} 4/3} = 5\ \underline{/53.2}\ \Omega$

$Z_{BC} = 3 - j4 = \sqrt{3^2 + 4^2}\ \underline{/-\tan^{-1} 4/3} = 5\ \underline{/-53.2}\ \Omega$

$Z_{CA} = 5 + j6 = \sqrt{5^2 + 6^2}\ \underline{/\tan^{-1} 6/5} = 7.81\ \underline{/50.2}\ \Omega$

$I_{AB} = \dfrac{E_{AB}}{Z_{AB}} = \dfrac{200\ \underline{/0}}{5\ \underline{/53.2}} = 40\ \underline{/-53.2}\ Amp$

$I_{BC} = \dfrac{E_{BC}}{Z_{BC}} = \dfrac{200\ \underline{/-120}}{5\ \underline{/-53.2}} = 40\ \underline{/-120+53.2}\ Amp.$
$= 40\ \underline{/-66.8}\ Amp.$

$I_{CA} = \dfrac{E_{CA}}{Z_{CA}} = \dfrac{200\ \underline{/120}}{7.81\ \underline{/50.2}} = 25.6\ \underline{/69.8}\ Amp.$

A point

flow in = flow out

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

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

$= 40 \underline{/-53.2} - 25.6 \underline{/69.8}$

$= 40(\cos 53.2 - j\sin 53.2) - 25.6(\cos 69.8 + j\sin 69.8)$

$= 24 - j32 - 25.6(0.345 + j0.938)$

$= 24 - j32 - (8.83 + j24)$

$= 24 - j32 - 8.83 - j24$

$I_A = 15.17 - j56 = \sqrt{15.17^2 + 56^2} \underline{/-\tan^{-1}\frac{56}{15.17}}$

$= 58 \underline{/-74.8°}$ Amp.

B point

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

$I_B = I_{BC} - I_{AB} = 40 \underline{/-66.8} - 40 \underline{/-53.2}$

$= 40(\cos 66.8 - j\sin 66.8) - (24 - j32)$

$= 15.75 - j36.76 - 24 + j32$

$I_B = -8.25 - j4.76 = \sqrt{8.25^2 + 4.76^2} \angle -(180 - \tan^{-1}\frac{-14.76}{8.25})$

$$= 9.52 \angle -(180 - 30$$

$$= 9.52 \angle -150 \quad Amp^\circ$$

C POINT

$I_C + I_{BC} = I_{CA}$
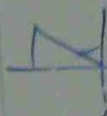
$I_C = I_{CA} - I_{BC} = (8.83 + j24) - (15.76 - j36.76)$

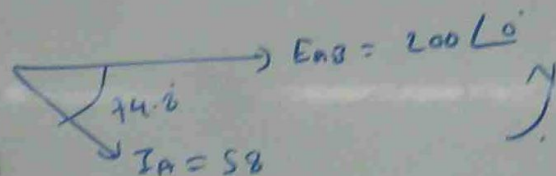$$= 8.83 + j24 - 15.76 + j36.76$$

$$= -6.87 + j60.76$$

$$= \sqrt{6.87^2 + 60.76^2} \angle (180 - \tan^{-1}\frac{60.76}{6.87}$$

$$= 61.147 \angle 180 - 83.54$$

$I_C = 61.147 \angle 96.46 \quad A$

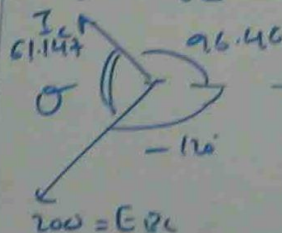$W_1 = E_{AB} \, I_A \, \cos\theta^{E_{AB}}_{I_A}$

$E_{AB} = 200 \angle 0^\circ$

74.8

$I_A = 58$

$$= 200 \times 58 \times \cos 74.8$$

$$= 11600 \times 0.262 = 3039.2 \, W$$

$W_2 = E_{BC} \, I_C \, \cos\theta^{E_{BC}}_{I_C}$

I_C 61.147 96.46

σ

-120°

$200 = E_{BC}$

$\theta^{E_{BC}}_{I_C} = 360 - (96.46 + 120)$

$$= 143.54$$

$W_2 = 200 \times 61.147 \cos 143.54$

$$= 12229.4 \times (-0.804)$$

$$= -9835 \, W$$

$W_T = |W_1| + |W_2| = |3039.2| + |-9835| = 3039.2$
$+ 9835$
$= 12874 \, W$