4 Questions, 100 marks

Pr 11.2

$\frac{}{25}$

a) $V_a = 180 \angle 0^\circ$ V

$V_b = 180 \angle -120^\circ$ V

$V_c = 180 \angle -240^\circ$ V

So Balanced, positive phase sequence.

b) $V_a = 180 \angle 0^\circ$ V

$V_b = 180 \angle 120^\circ$ V $V_b = 180 \angle -240^\circ$

$V_c = 180 \angle -120$

So, Balanced negative phase seq

c) $400 \angle -270^\circ = 400 \angle 90^\circ$ V V_a

$400 \angle 120^\circ$ V V_b

$400 \angle -30^\circ$ V V_c.

Unbalanced, phase angle in b-phase.

d) $V_a = 200 \angle 30^\circ$ V

$V_b = 201 \angle 150^\circ$ V

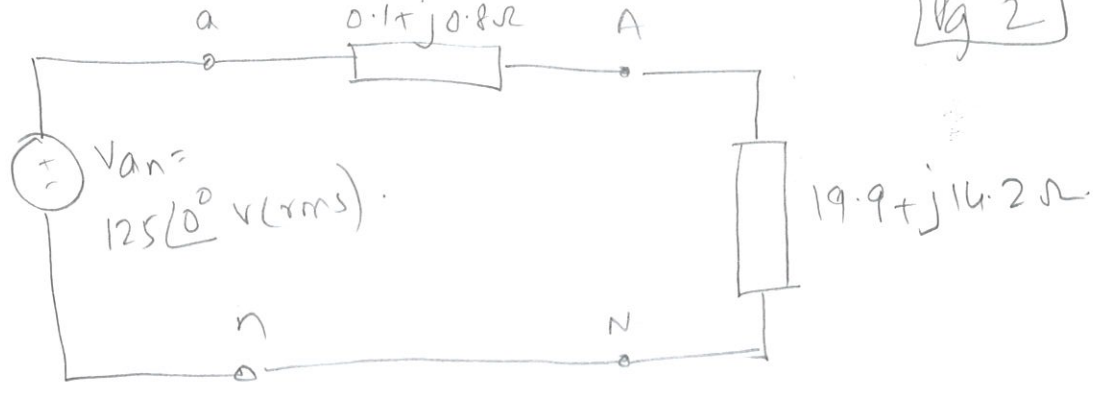
$V_c = 200 \angle 270^\circ$ V $= 200 \angle -90^\circ$ V.

Unbalanced, unequal amplitude in the b-phase.

P11.12

25

acb sequence



a). $I_a = \dfrac{125\angle 0^\circ}{(0.1+j0.8)+(19.9+j14.2)} = \dfrac{125\angle 0}{20+j15} = 4-j3 = 5\angle -36.87^\circ$ A (rms)

$I_b = 5\angle -36.87^\circ + 120 = 5\angle 83.13^\circ$ A (rms).

$I_c = 5\angle -36.87^\circ - 120 = 5\angle -156.87^\circ$ A (rms).

b). Given $V_{an} = 125\angle 0^\circ$ V.

$V_{ab} = (\sqrt{3}\angle -30^\circ)V_{an}$

$= 216.51\angle -30^\circ$ V (rms)

so $V_{bc} = 216.51\angle -30+120^\circ = 216.51\angle 90^\circ$ V

$V_{ca} = 216.51\angle -30-120^\circ = 216.51\angle -150^\circ$ V.

c). At the load, $V_{AN} = I_a Z_{Load}$

$= (4-j3)(19.9+j14.2) = 122.2 - j2.9$

$= 122.23\angle -1.36^\circ$ V (rms)

$V_{BN} = 122.23\angle -1.36^\circ + 120^\circ = 122.23\angle 118.64^\circ$ V

$V_{CN} = 122.23\angle -121.36^\circ$ V.

d) $V_{AB} = V_{AN}(\sqrt{3}\angle -30^\circ) = 211.72\angle -31.36^\circ$ V

so $V_{BC} = 211.72\angle 88.64^\circ$ V and $V_{CA} = 211.72\angle -151.36^\circ$ V

P11.13 Δ load, abc sequence

Draw the single-phase eq. for calculating V_{an}, V_{ab}, V_{bc} & V_{ca}.

a) $I_{AB} = \dfrac{V_{AB}}{Z_\Delta} = 6.4\angle{-36.87^\circ}$ A (rms)   Using direct method!

$I_{BC} = 6.4\angle{-36.87^\circ - 120} = 6.4\angle{-156.87^\circ}$ A

$I_{CA} = 6.4\angle{83.13^\circ}$ A

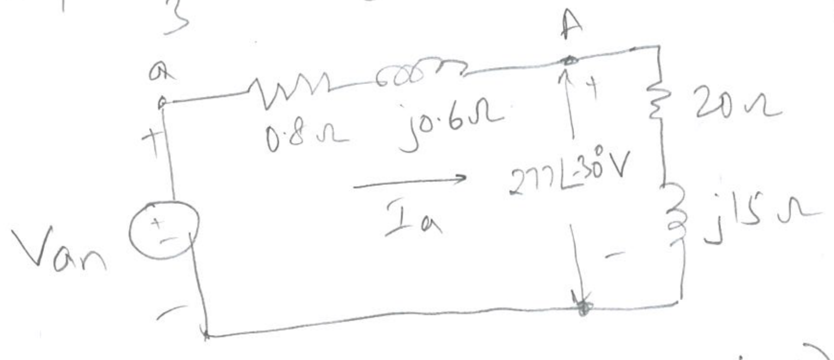
b). $I_A = \sqrt{3}\angle{-30^\circ}\, I_{AB} = 11.09\angle{-66.87^\circ}$ A.   line current

$I_B = 11.09\angle{173.13^\circ}$ A

$I_C = 11.09\angle{53.13^\circ}$ A.

c). $Z_Y = \dfrac{Z_\Delta}{3} = 20 + j15\,\Omega$.   Also, at the load $V_{AB} = 480\text{V}\angle{0^\circ}$

$V_{AN} = \dfrac{480}{\sqrt{3}\angle{30}} = 277\angle{-30^\circ}$ V



$\bar{V}_{an} = \bar{V}_{AN} + \bar{V}_{Line} = 277.25\angle{-30^\circ} + (0.8 + j0.6)(11.09\angle{-66.87^\circ})$

$= 288.34\angle{-30^\circ}$ V.

$V_{ab} = \sqrt{3}\angle{30^\circ}\, V_{an} = 499.42\angle{0^\circ}$ V

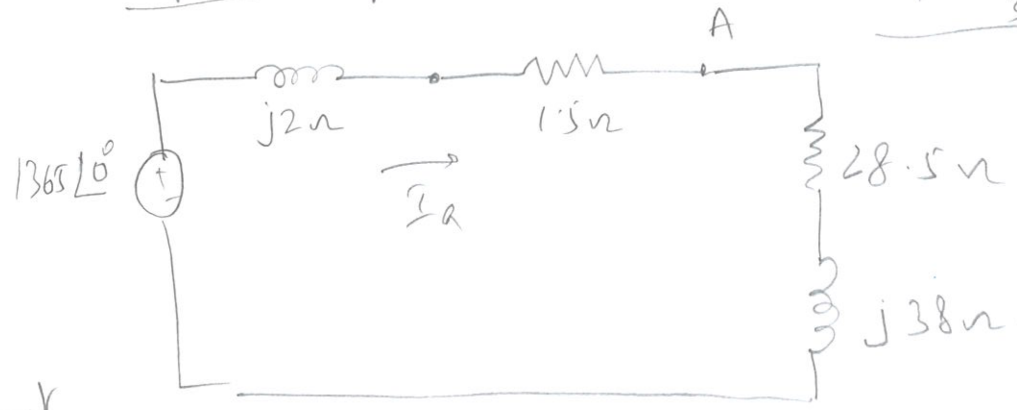
$V_{bc} = 499.42\angle{-120^\circ}$ V

$V_{ca} = 499.42\angle{120^\circ}$ V

P 11.23 The circuit is a Y-Δ connection, balanced!

Single-phase equivalent.

$Z_Y = \frac{Z_\Delta}{3} = 28.5 + j38\ \Omega$



Line current

$$I_a = \frac{1365\angle 0^\circ}{(28.5+1.5)+(j38+j2)} = 27.3\angle -53.15^\circ \text{ A (rms)}$$

$$I_c = I_a \angle -53.15 - 240^\circ = 27.3\angle -293.15^\circ = 27.3\angle 66.85^\circ$$

i.e. $I_c = I_{CA}(\sqrt{3}\angle -30^\circ) = 27.3\angle 66.85$

and so $I_{CA} = \frac{27.3}{\sqrt{3}}\angle 66.85 + 30^\circ = 15.76\angle 96.8^\circ$ A
(Phase current)

b). Complex power developed is $S_{1\phi} = -VI^*$

$= -1365\angle 0 * 27.3\angle +53.15^\circ$

$= -22{,}358 - j\,29811$ VA.

P developed/phase $= -22{,}358$ Watts

P absorbed/phase by load $= |I_a|^2\, 28.5 = 27.3^2 \times 28.5$

$= 21{,}241$ Watts

% delivered $= \frac{21{,}241}{22{,}358} \times 100 = 95\%$