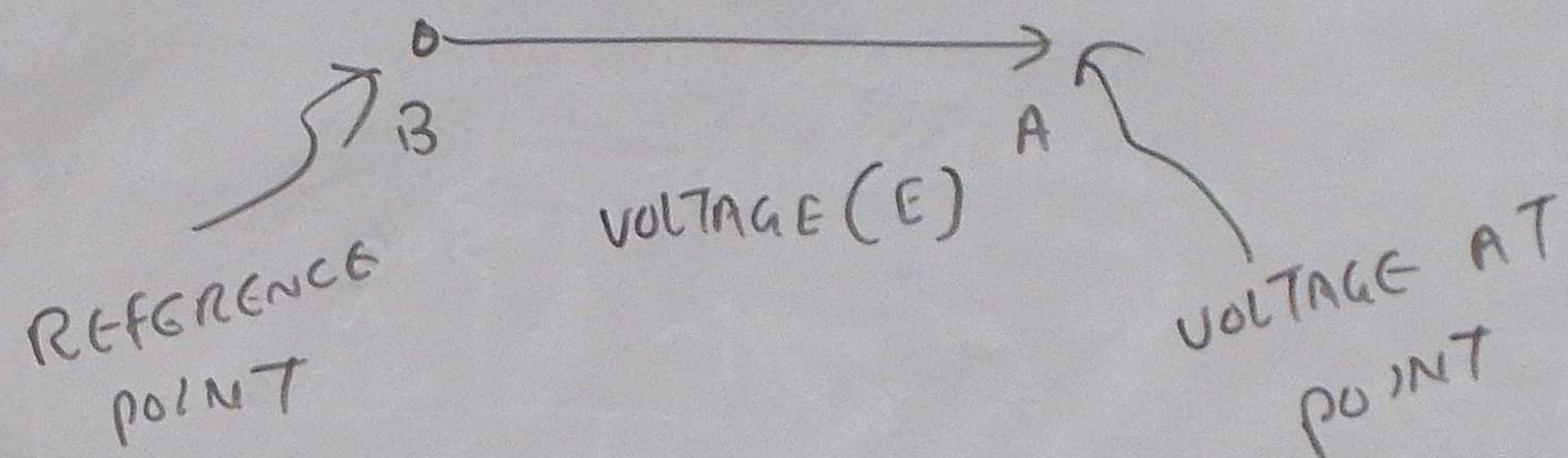
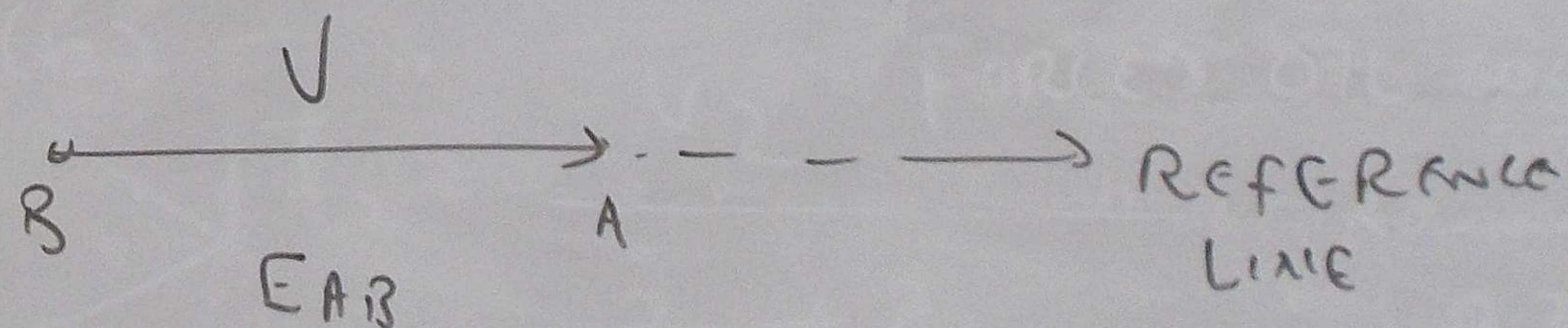


34 AC supplies

DOUBLE SUBSCRIPT NOTATION



VOLTAGE AT POINT A WITH REFERENCE
TO POINT (B) = E_{AB}



$$E_{AB} = V \text{ to } 0$$

E_{BA} = VOLT
REF

E_{BA} =

GENE
ELE

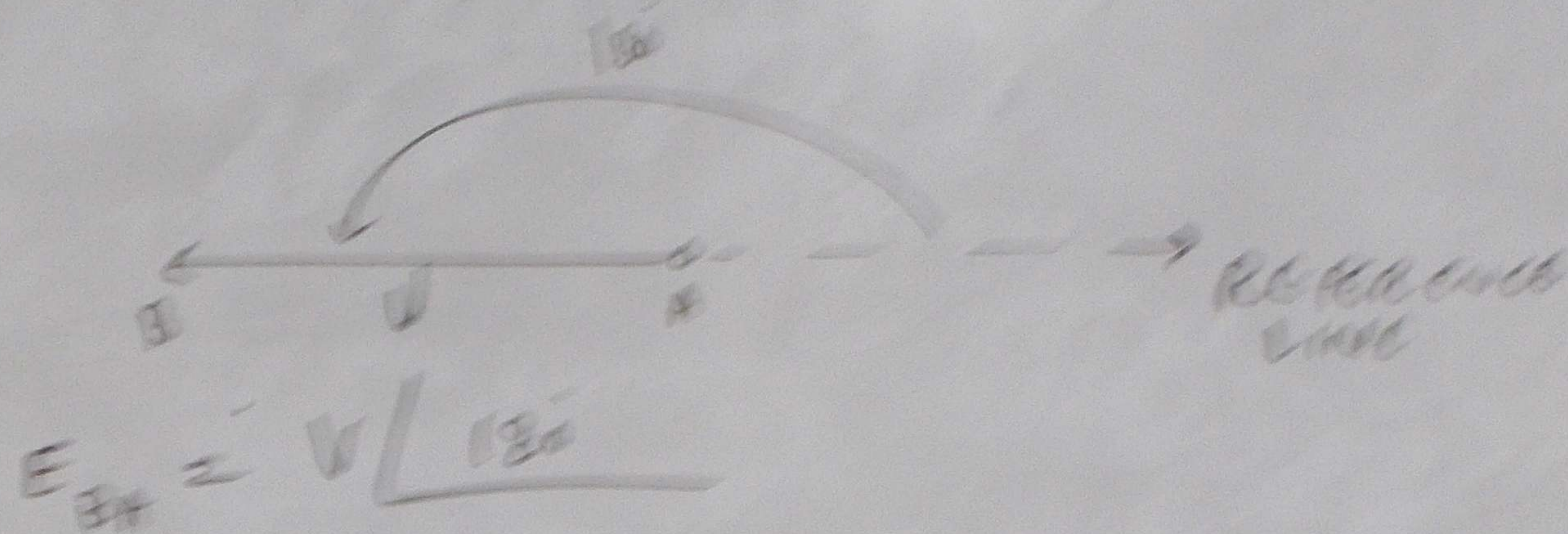
supply

script notation

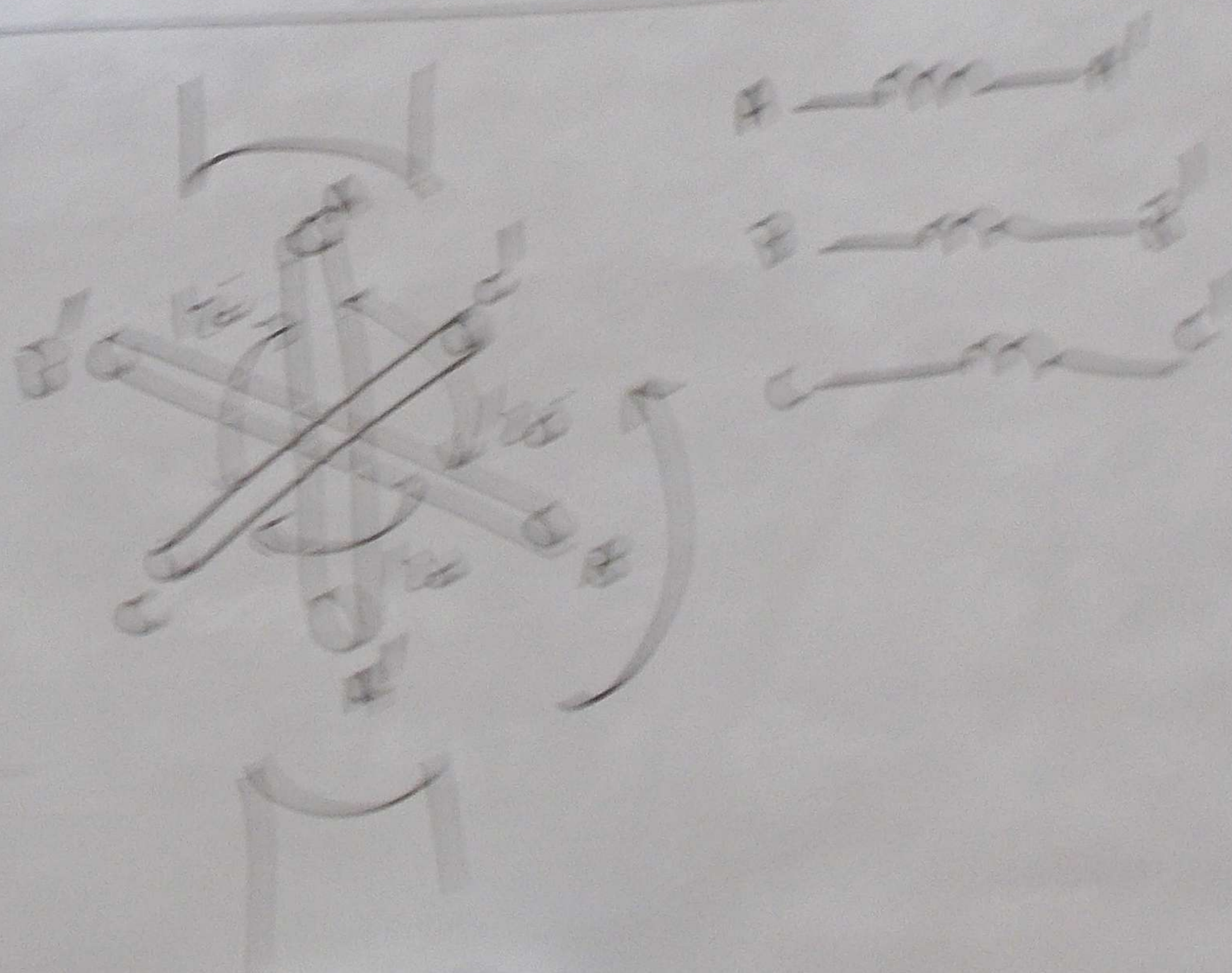
E_{AB} = voltage at point (B) with reference to point (A)
 $E_{AB} = E_{BA}$

$E_{AB} = V_{AB}$

E_{BA} = voltage at point (B) with reference to point (A)



Generation of a three phase set of electromotive forces

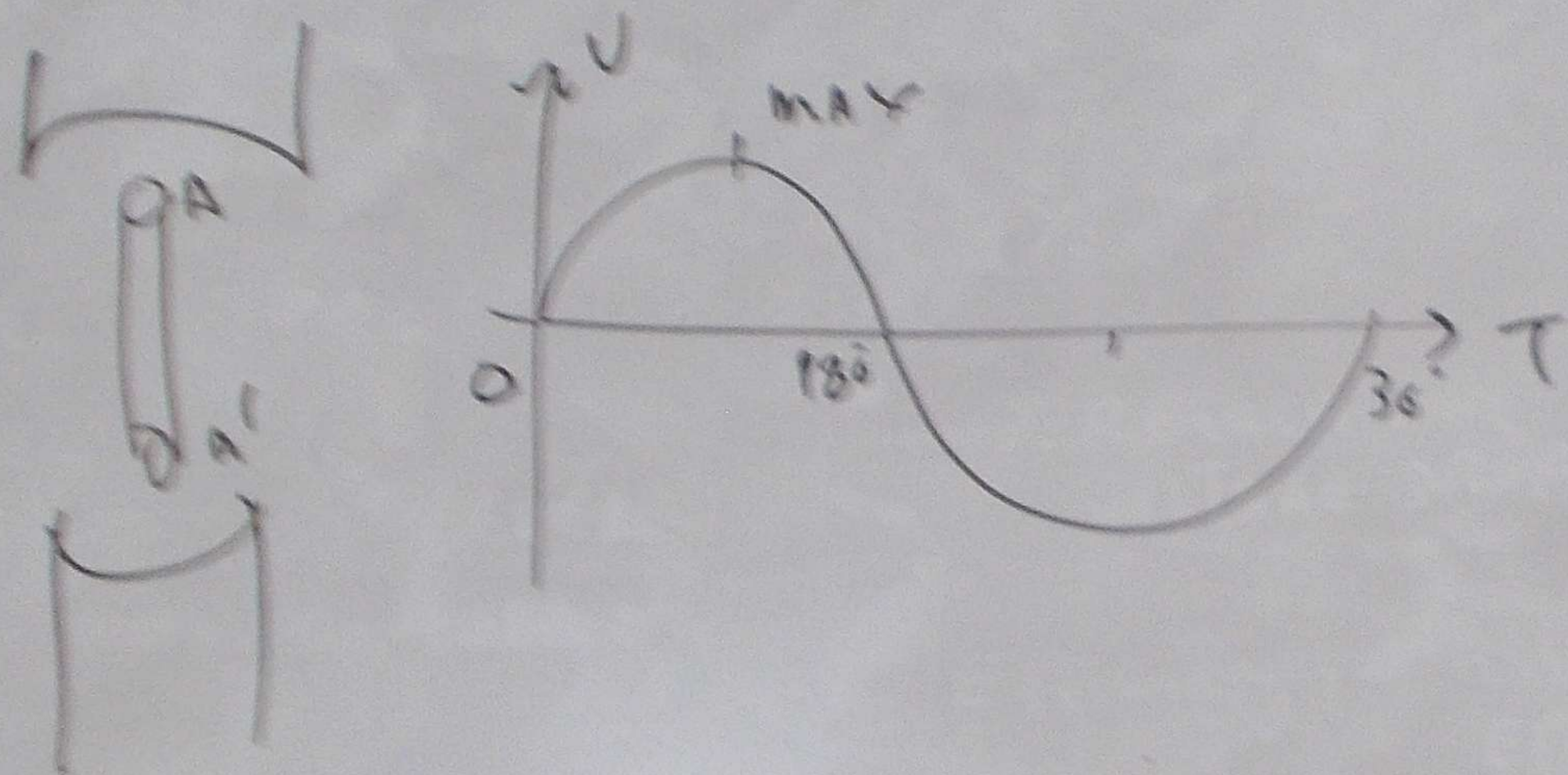


A machine
 rotating field
 EMF set



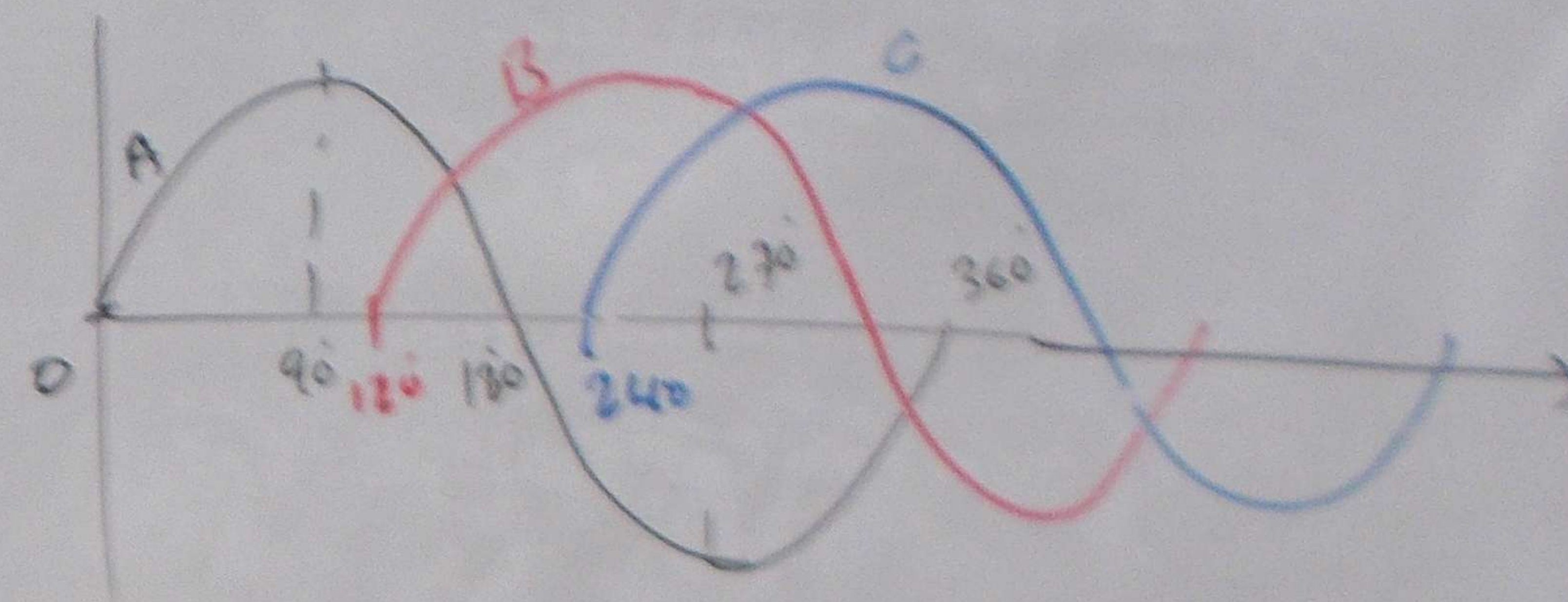
If three
 phases, so
 generates
 three sets
 of EMF

A MACHINE WITH A SINGLE ROTATING COIL IN A MAGNETIC FIELD GENERATES ONE CYCLE OF SINUSOIDAL EMF FOR REVOLUTION OF THE COIL.



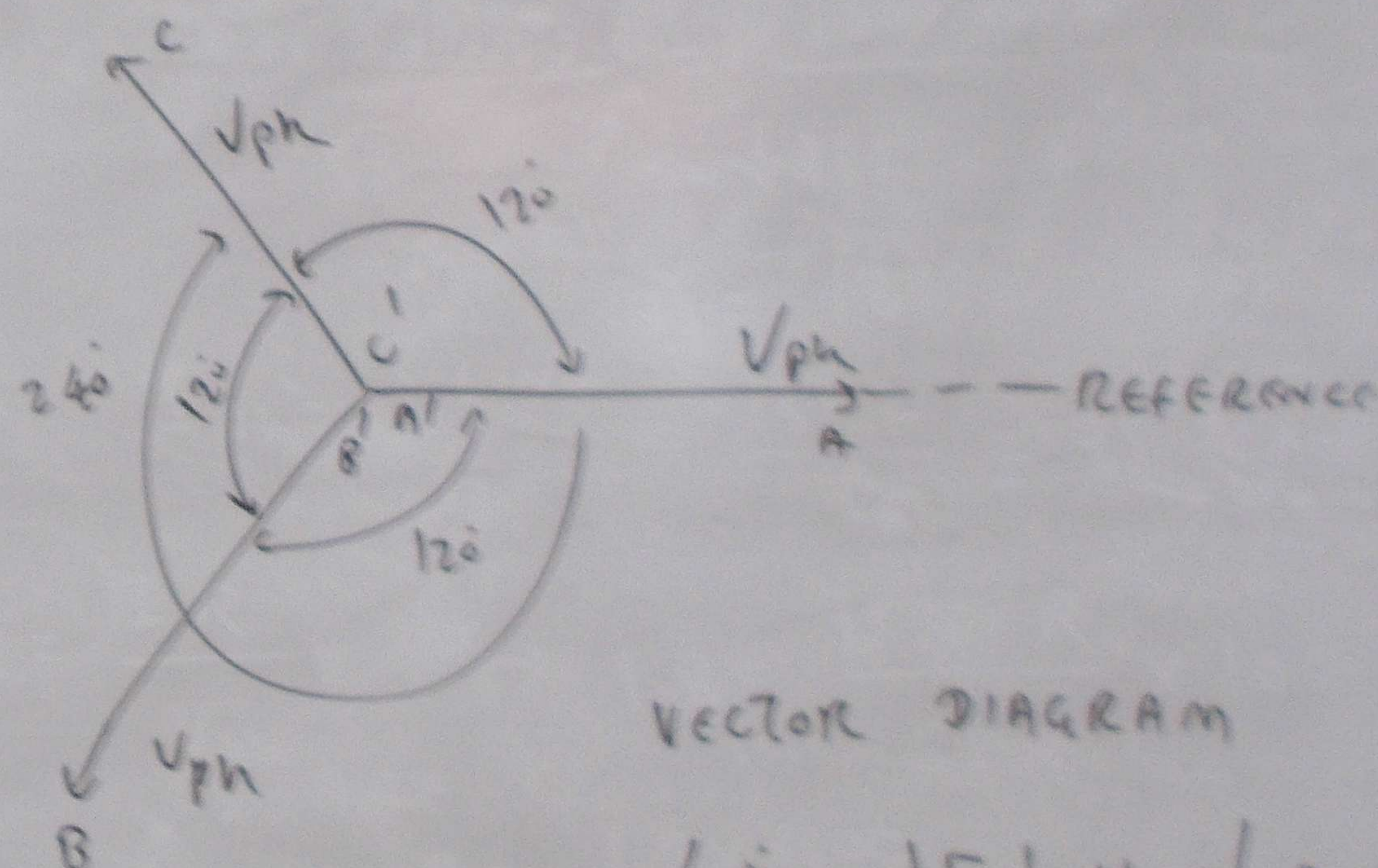
IF THREE COILS ARE SPACED EQUALLY 120° APART, AROUND THE MACHINE, THEN THE GENERATED EMF IN EACH COIL WILL PASS ZERO AND REACH PEAK AT DIFFERENT TIMES. THE THREE EMFS GENERATED ARE THREE SINGLE PHASE EMFS.

A - 1st, B - 2nd, C - 3rd



3 ϕ AC WAVE FORMS

VECTOR DIAGRAM



VECTOR DIAGRAM

POLAR FORM
OF PHASE
VOLTAGES

$$\begin{aligned} E_{AA'} &= V_{ph} \angle 0^\circ & E_{CC'} &= V_{ph} \angle -240^\circ \\ E_{BB'} &= V_{ph} \angle -120^\circ \end{aligned}$$

SEQUENCE

A - 1st, B - 2nd, C - 3rd

SEQUENCE ABC

SEQUENCE

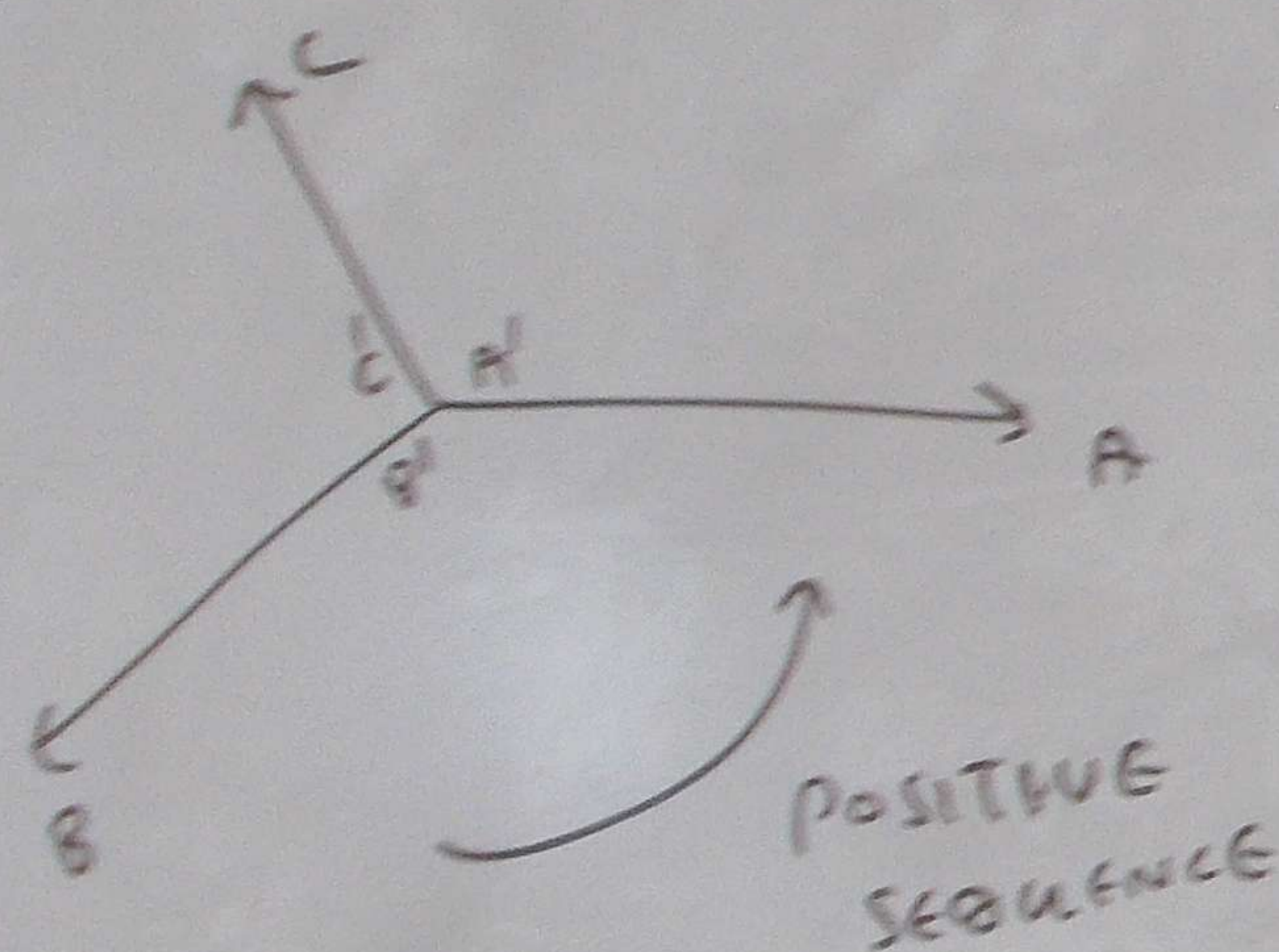
ABC

1 2 3

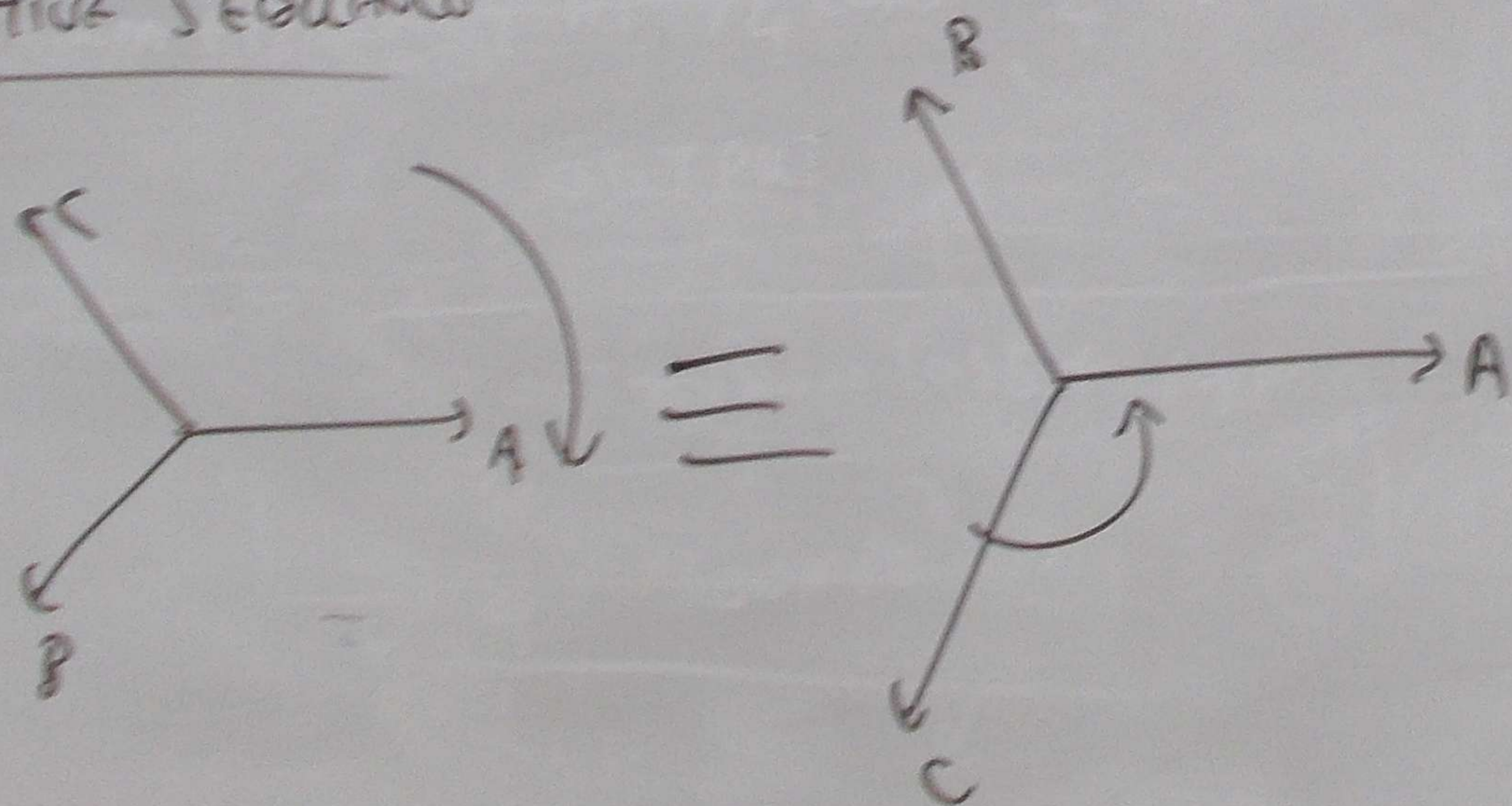
R Y B

R W B

— POSITIVE SEQUENCE



NEGATIVE SEQUENCE

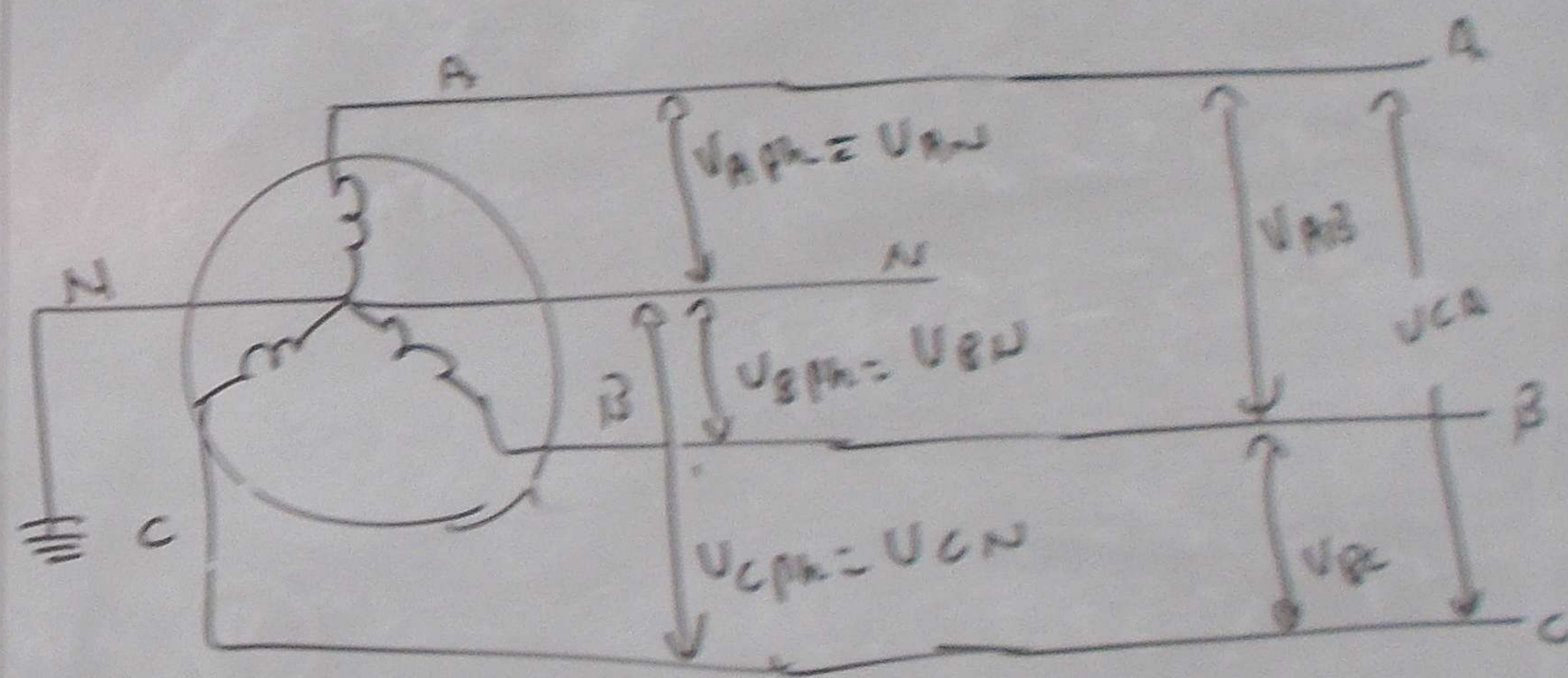


NEGATIVE SEQUENCE - A C B

$$E_{PA}^I = U_{PH} \angle 0$$

$$E_{CB}^I = U_{PH} \angle 120$$

$$E_{AC}^I = U_{PH} \angle -120$$



3 ϕ GENERATOR

U_{AN} = A LINE TO NEUTRAL VOLTAGE = PHASE VOLTAGE
 U_{BN} = B LINE TO NEUTRAL VOLTAGE
 U_{CN} = C LINE TO NEUTRAL VOLTAGE

V_{AB} = A LINE TO Φ LINE VOLTAGE
 V_{BC} = Φ LINE TO C LINE VOLTAGE
 V_{CA} = C LINE TO A LINE VOLTAGE

LINE TO LINE
 VOLTAGE (OR)
 LINE VOLTAGE

$V_{AN} = V_{ph} \angle 0^\circ$ A PHASE IS REFERENCE

$V_{BN} = V_{ph} \angle -120^\circ$

$V_{CN} = V_{ph} \angle -240^\circ$

$V_{AB} = \sqrt{3} V_{ph} \angle 30^\circ$

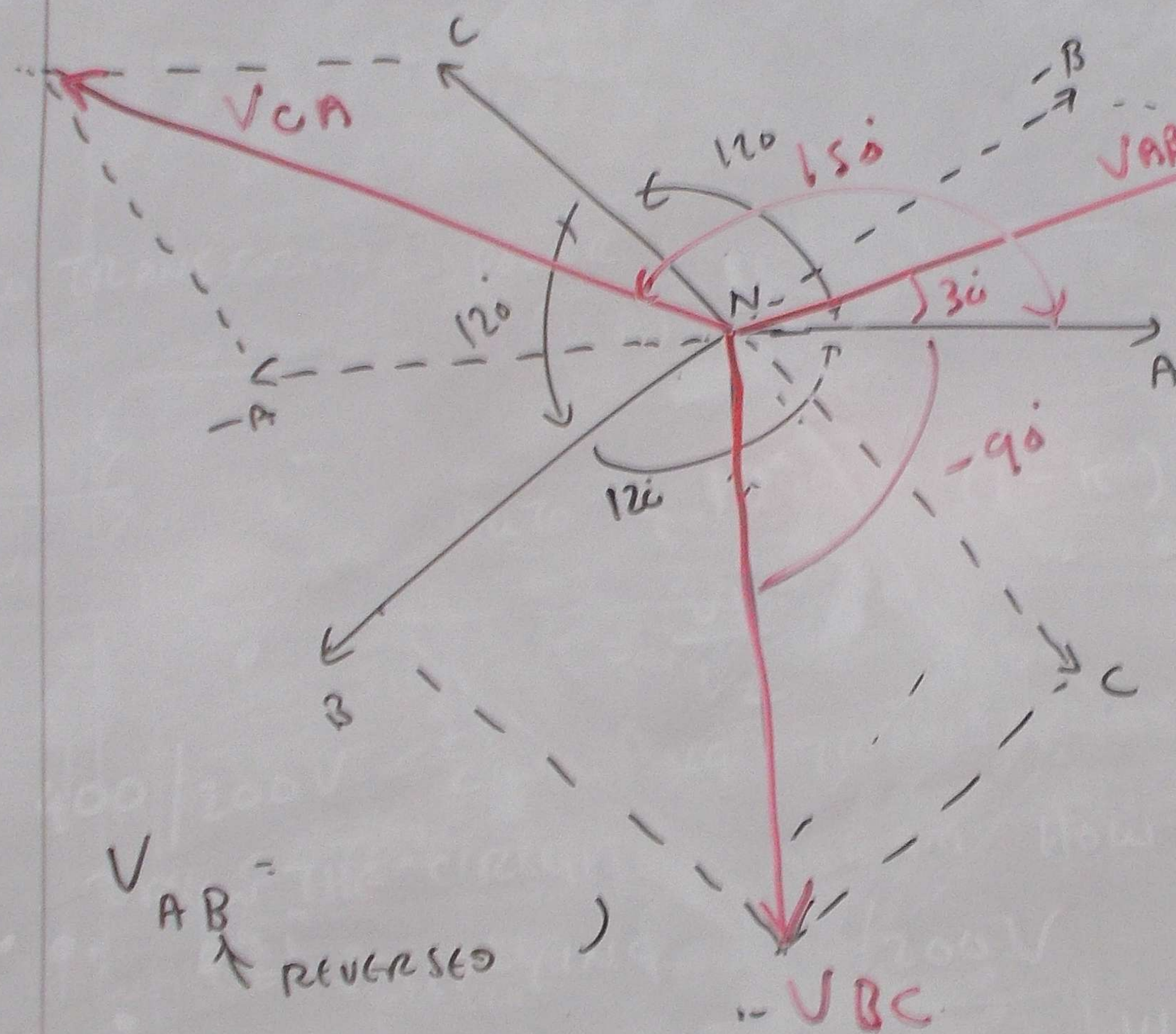
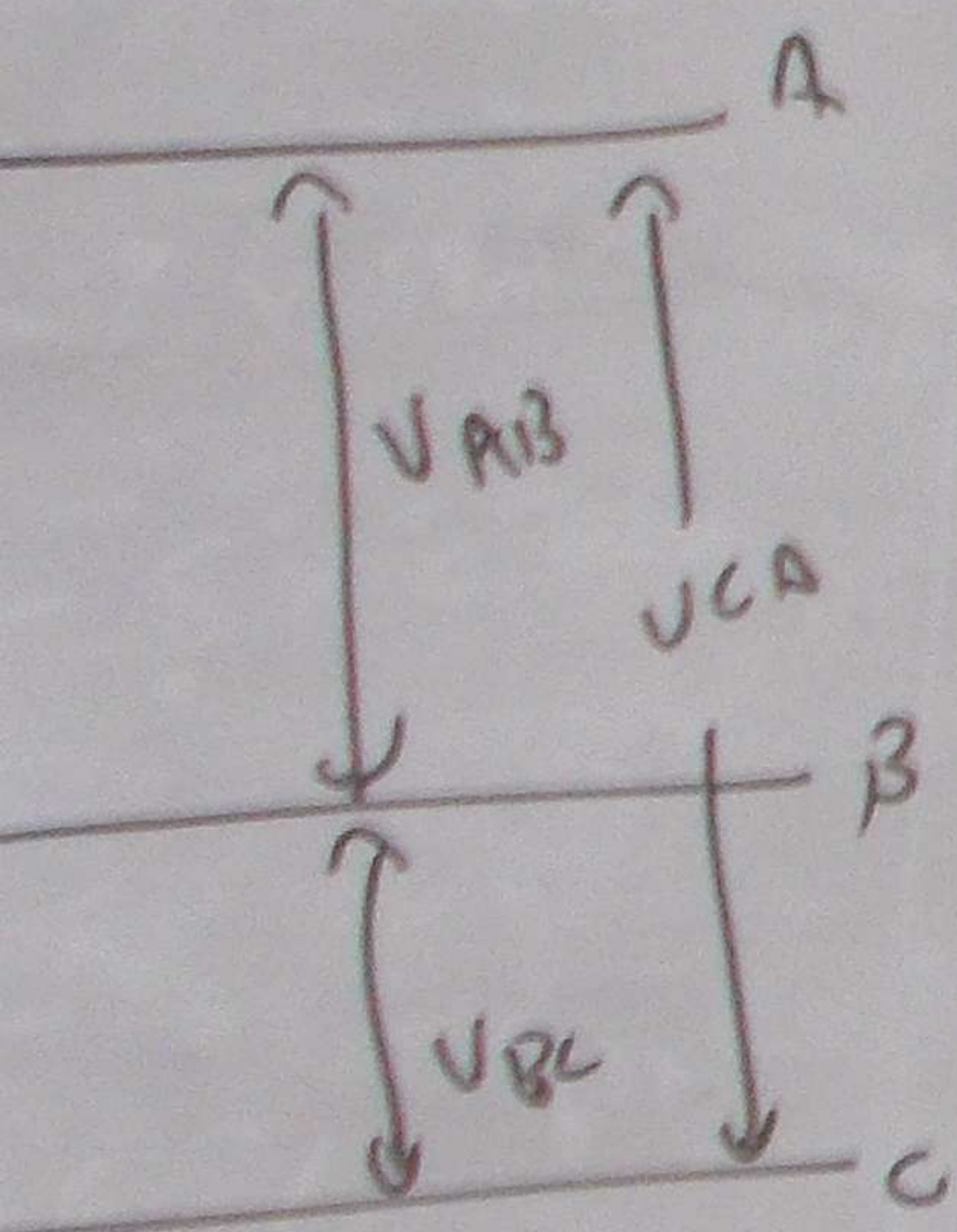
$V_{BC} = \sqrt{3} V_{ph} \angle -90^\circ$

$V_{CA} = \sqrt{3} V_{ph} \angle 150^\circ$
 (OR)

$\sqrt{3} V_{ph} \angle -210^\circ$

SEQUENCE A-B-C

PHASE AND LINE VOLTAGES



V_{AB} REVERSED

V_{BC} REVERSE

V_{CA} REVERSE

PHASE
 VOLTAGE

LINE TO LINE
VOLTAGE (OR)
LINE VOLTAGE

$$V_{AN} = V_{ph} \angle 0^\circ \quad \text{A PHASE IS REFERENCE}$$

$$V_{BN} = V_{ph} \angle -120^\circ$$

$$V_{CN} = V_{ph} \angle -240^\circ$$

$$V_{AB} = \sqrt{3} V_{ph} \angle 30^\circ$$

$$V_{BC} = \sqrt{3} V_{ph} \angle -90^\circ$$

$$V_{CA} = \sqrt{3} V_{ph} \angle 150^\circ$$

(OR)

$$\sqrt{3} V_{ph} \angle -210^\circ$$

SEQUENCE A-B-C

PHASE AND LINE VOLTAGES

$$\vec{V}_{AB} = \vec{V}_A + \vec{V}_B$$

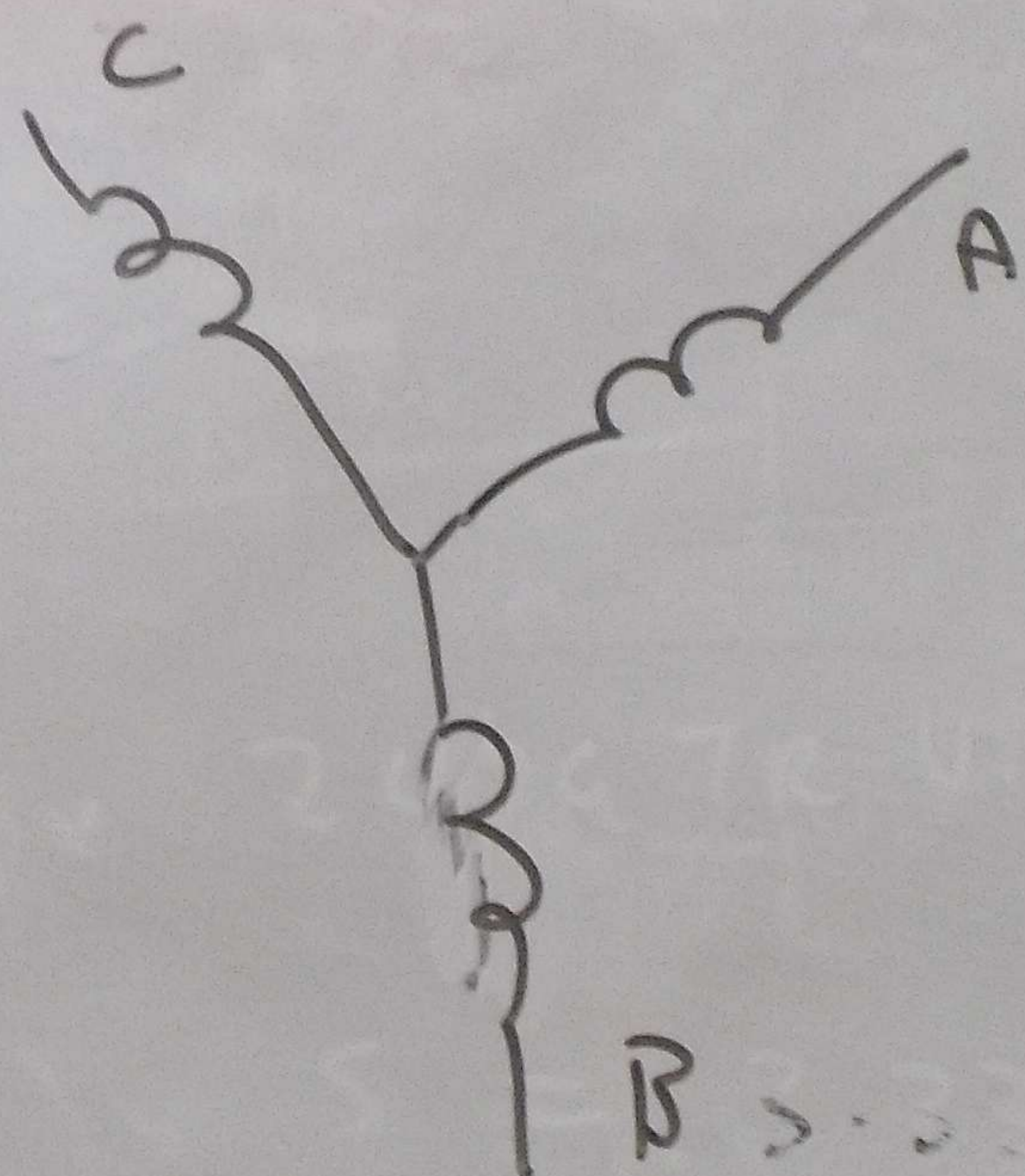
$$\vec{V}_{BC} = \vec{V}_B + \vec{V}_C$$

$$\vec{V}_{CA} = \vec{V}_C + \vec{V}_A$$

VECTOR SUM EQUATIONS

STAR CONNECTION

$$V_{ph} = V$$



$$V_{AB} = \sqrt{3} V$$

$$V_{BC} = \sqrt{3} V$$

$$V_{CA} = \sqrt{3} V$$



NOTE

TO CARRY OUT THESE VECTOR ADDITIONS ONE OF THE PHASE VOLTAGE MUST BE REVERSED

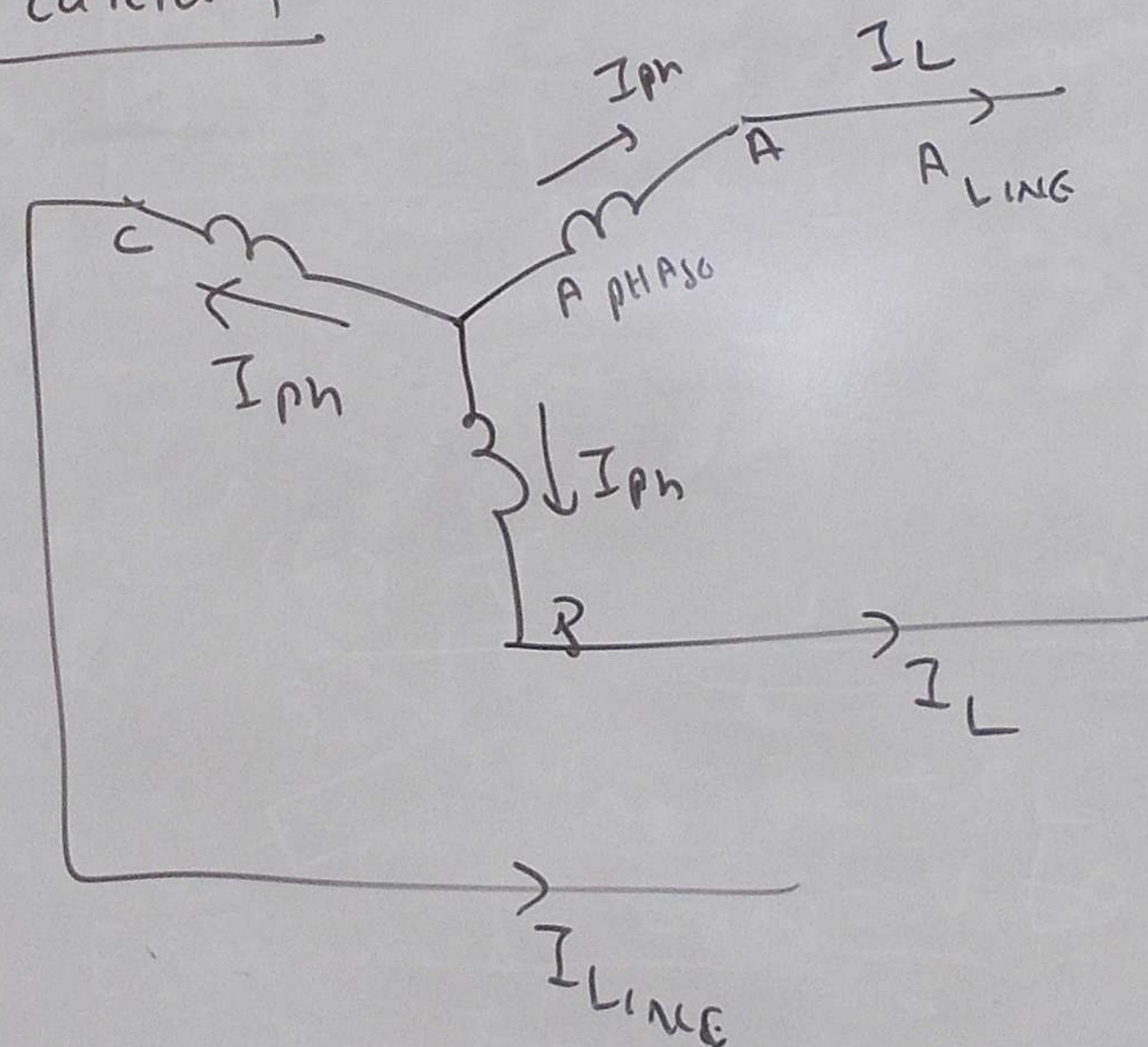
LINE VOLTAGES ARE ALL EQUAL IN MAGNITUDE

LINE VOLTAGES ARE $\sqrt{3}$ TIMES THE PHASE VOLTAGES

LINE VOLTAGE LEADS THE PHASE VOLTAGE BY 30°

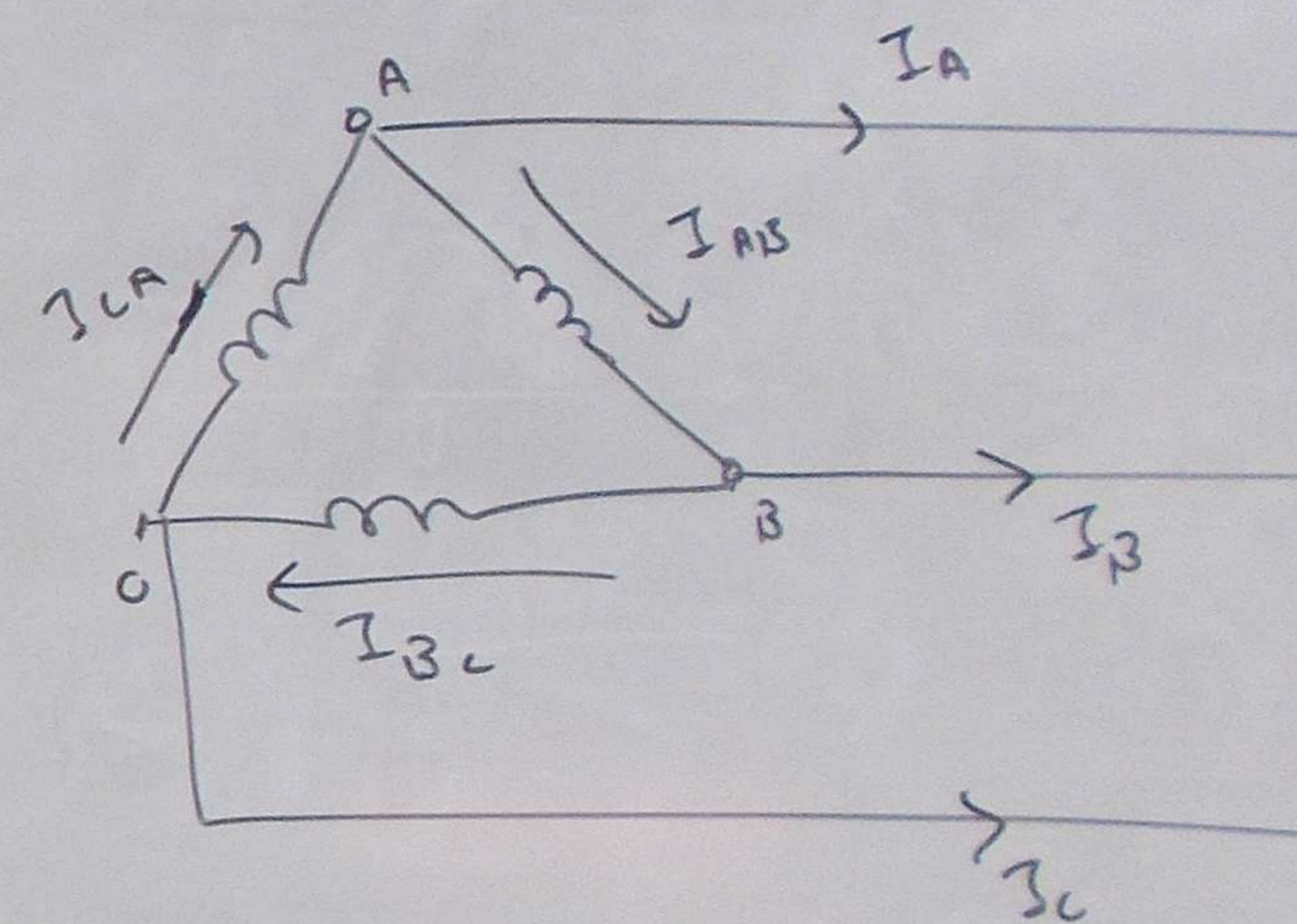
→ IT IS FOR STAR CONNECTION

CURRENT



LINE CURRENT = PHASE CURRENT

THREE PHASE DELTA CONNECTION (GENERATOR)



GENERATOR

SEQUENCE A B C (+ SEQUENCE)

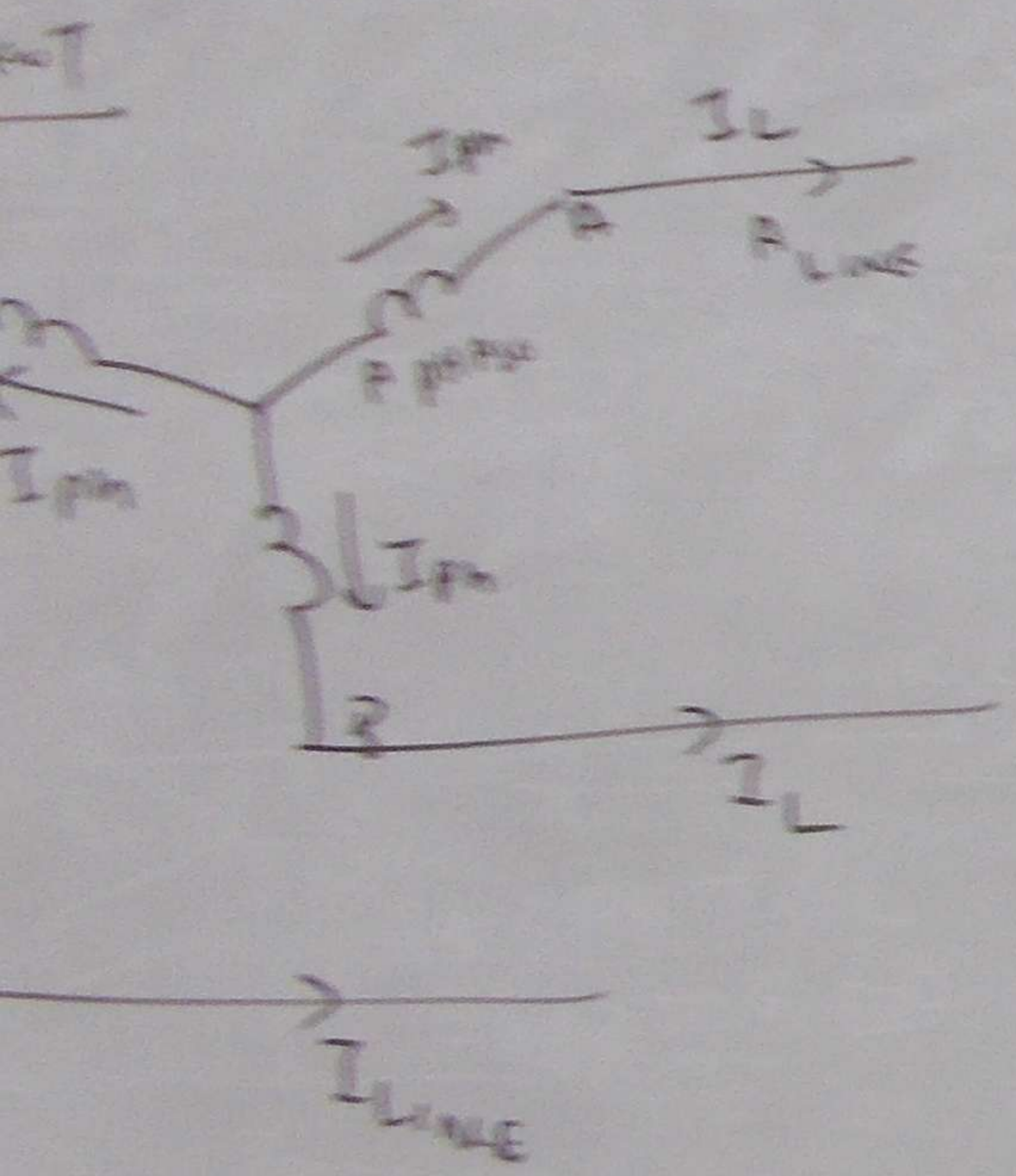
VOLTAGE

A - 1st
B - 2nd
C - 3rd

CURRENT

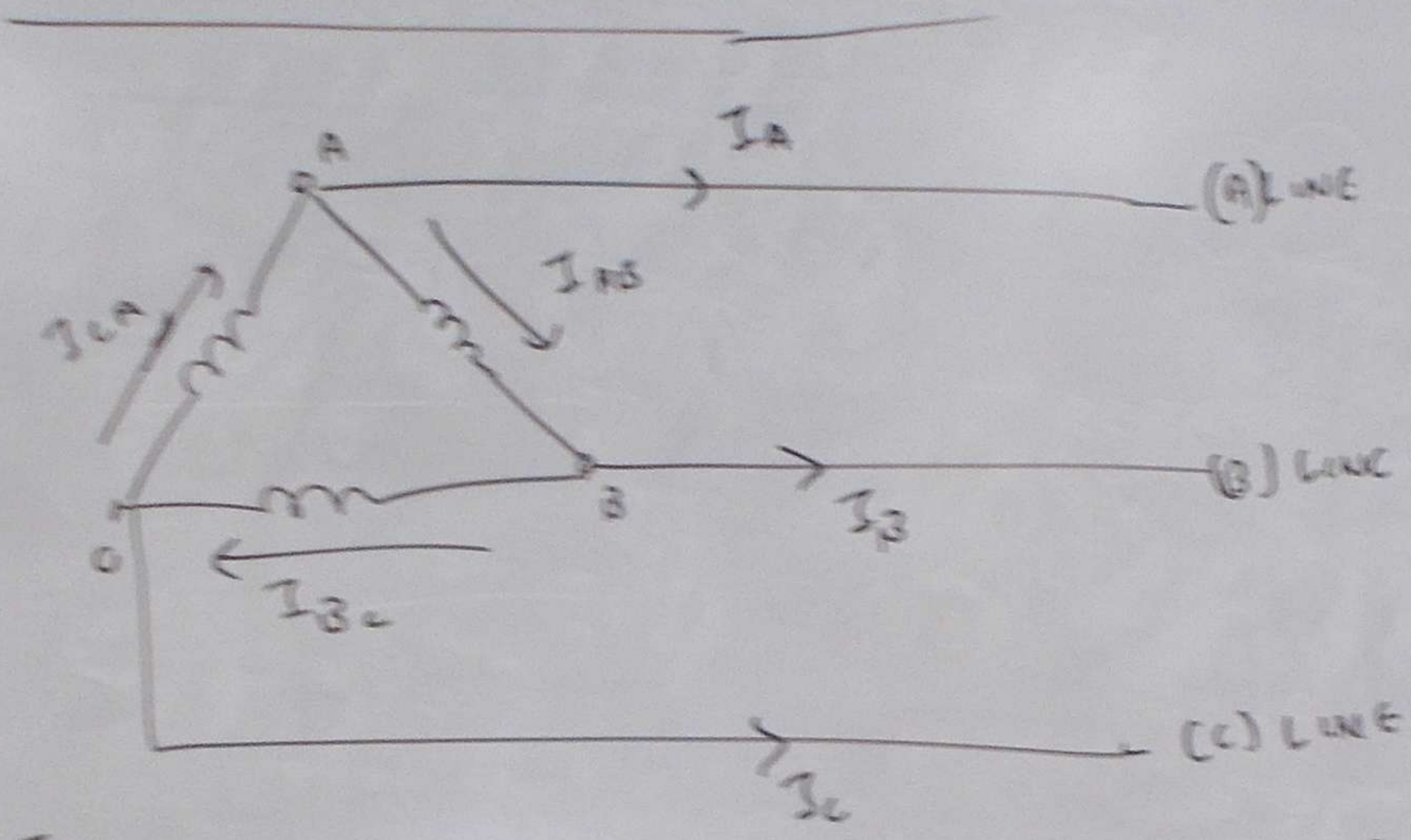
Flow from A to B
Flow from B to C
Flow from C to A

OUT THESE VECTOR ADDITIONS ONE OF THE
 PHASES MUST BE REVERSED
 PHASES ARE ALL EQUAL IN MAGNITUDE
 LINE VOLTAGES ARE $\sqrt{3}$ TIMES THE PHASE VOLTAGES
 LINE CURRENT LAGS THE PHASE VOLTAGE BY 30°
 THIS IS FOR STAR CONNECTION



LINE CURRENT = PHASE CURRENT

THREE PHASE DELTA CONNECTION (GENERATOR)



GENERATOR

SEQUENCE A B C (+ SEQUENCE)

VOLTAGE	CURRENT
A - 1st	Flow from A to B
B - 2nd	Flow from B to C
C - 3rd	Flow from C to A

SEQUENCE (A C B) NEGATIVE SEQUENCE

VOLTAGE	CURRENT
A - 1st	Flow from A to C
C - 2nd	Flow from C to B
B - 3rd	Flow from B to A

AT POINT (A)

Flow in = Flow out
 $I_{CA} = I_A + I_{AB} \rightarrow \vec{I}_A = \vec{I}_{CA} - \vec{I}_{AB}$

AT POINT (B)

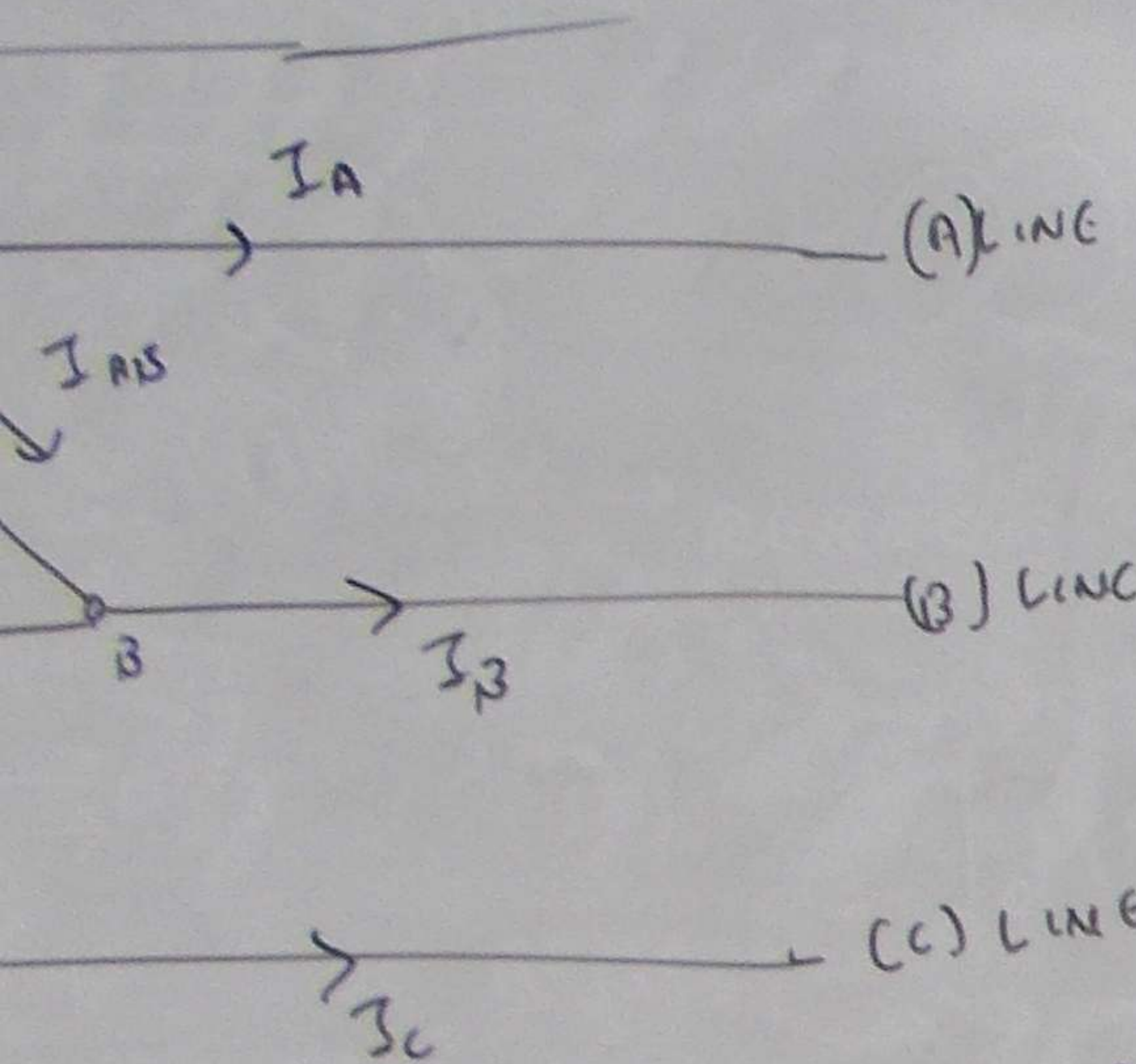
Flow in = Flow out
 $I_{AB} = I_B + I_{BC} \rightarrow \vec{I}_B = \vec{I}_{AB} - \vec{I}_{BC}$

AT POINT (C)

Flow in = Flow out
 $I_{BC} = I_C + I_{CA} \rightarrow \vec{I}_C = \vec{I}_{BC} - \vec{I}_{CA}$

$\vec{I}_A = \vec{I}_{CA} - \vec{I}_{AB} = i_c - i_a$
 $\vec{I}_B = \vec{I}_{AB} - \vec{I}_{BC} = i_a - i_b$
 $\vec{I}_C = \vec{I}_{BC} - \vec{I}_{CA} = i_b - i_c$

Δ CONNECTION (GENERATOR)



SEQUENCE)

CURRENT
Flow from A to B
Flow from B to C
Flow from C to A

SEQUENCE (ACB) NEGATIVE SEQUENCE	
VOLTAGE	CURRENT
A-1st	From A to C
C-2nd	From C to B
B-3rd	From B to A

AT POINT (A)

Flow IN = Flow OUT

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

$$\vec{I}_A = \vec{I}_{CA} - \vec{I}_{AB}$$

AT POINT (B)

Flow IN = Flow OUT

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

$$\vec{I}_B = \vec{I}_{AB} - \vec{I}_{BC}$$

AT POINT (C)

Flow IN = Flow OUT

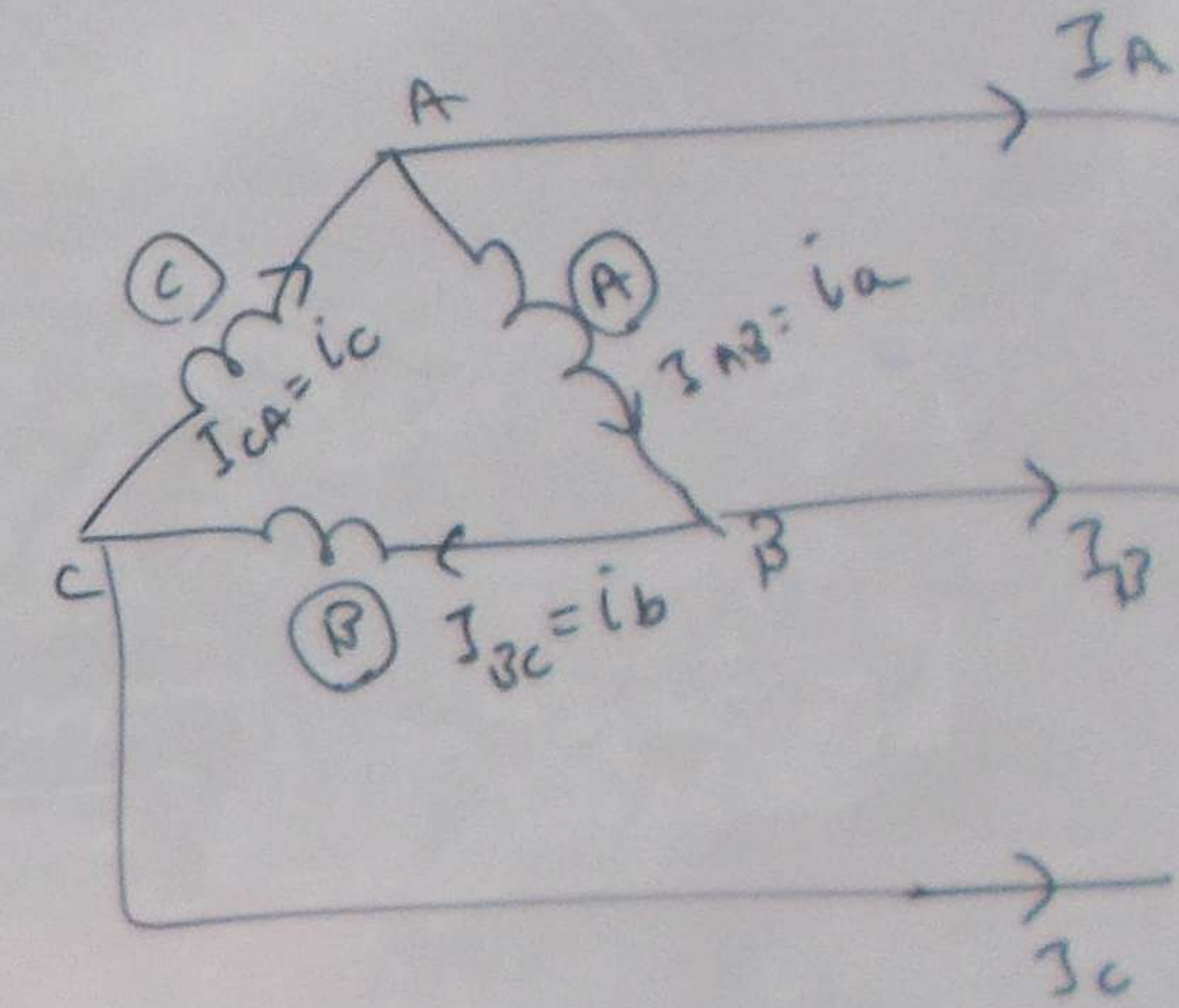
$$I_{BC} = I_C + I_{CA} \rightarrow$$

$$\vec{I}_C = \vec{I}_{BC} - \vec{I}_{CA}$$

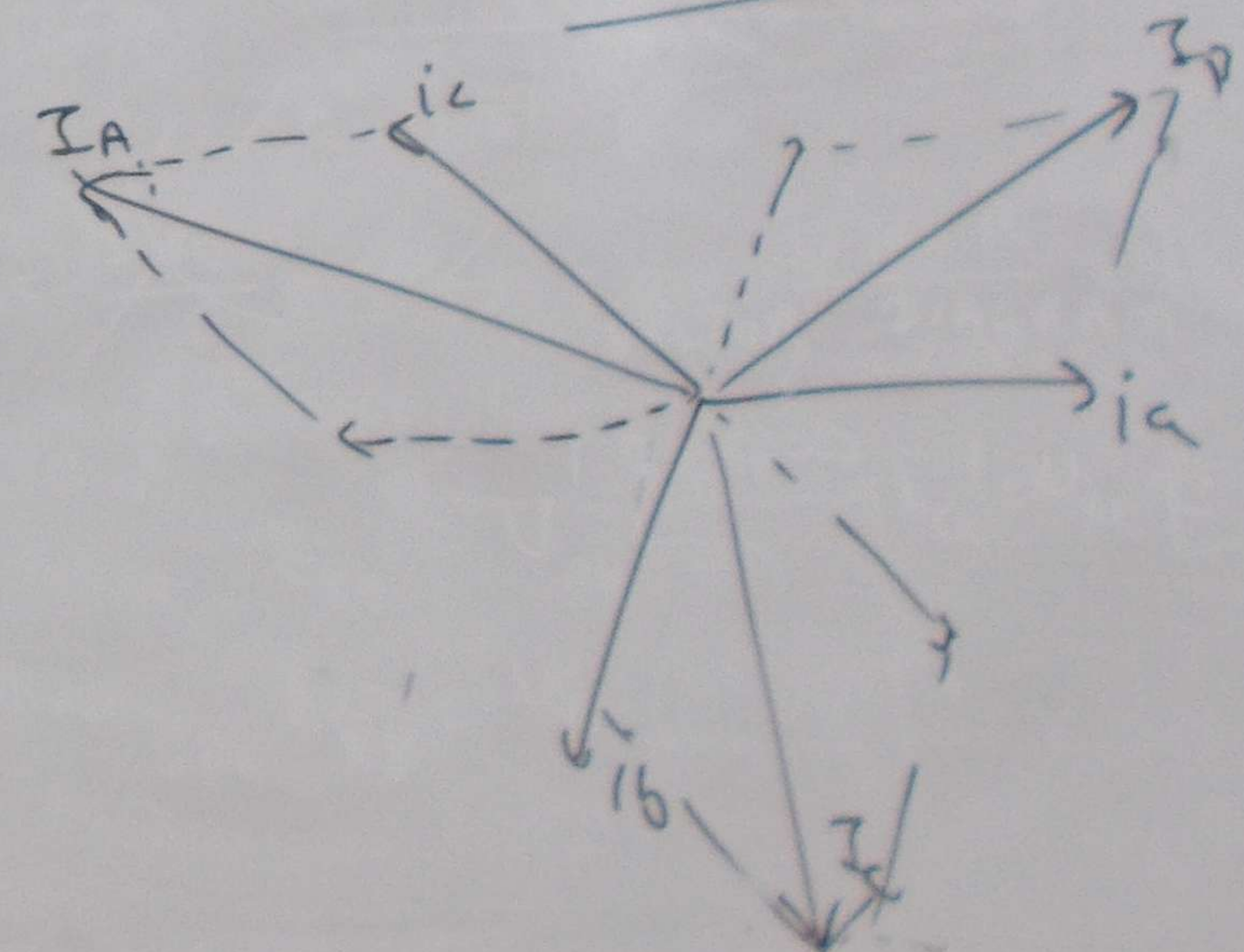
$$\vec{I}_A = \vec{I}_{CA} - \vec{I}_{AB} = i_c - i_a$$

$$\vec{I}_B = \vec{I}_{AB} - \vec{I}_{BC} = i_a - i_b$$

$$\vec{I}_C = \vec{I}_{BC} - \vec{I}_{CA} = i_b - i_c$$



CURRENT VECTOR DIAGRAM



BALANCE Δ

$$I_A = \sqrt{3} i_a$$

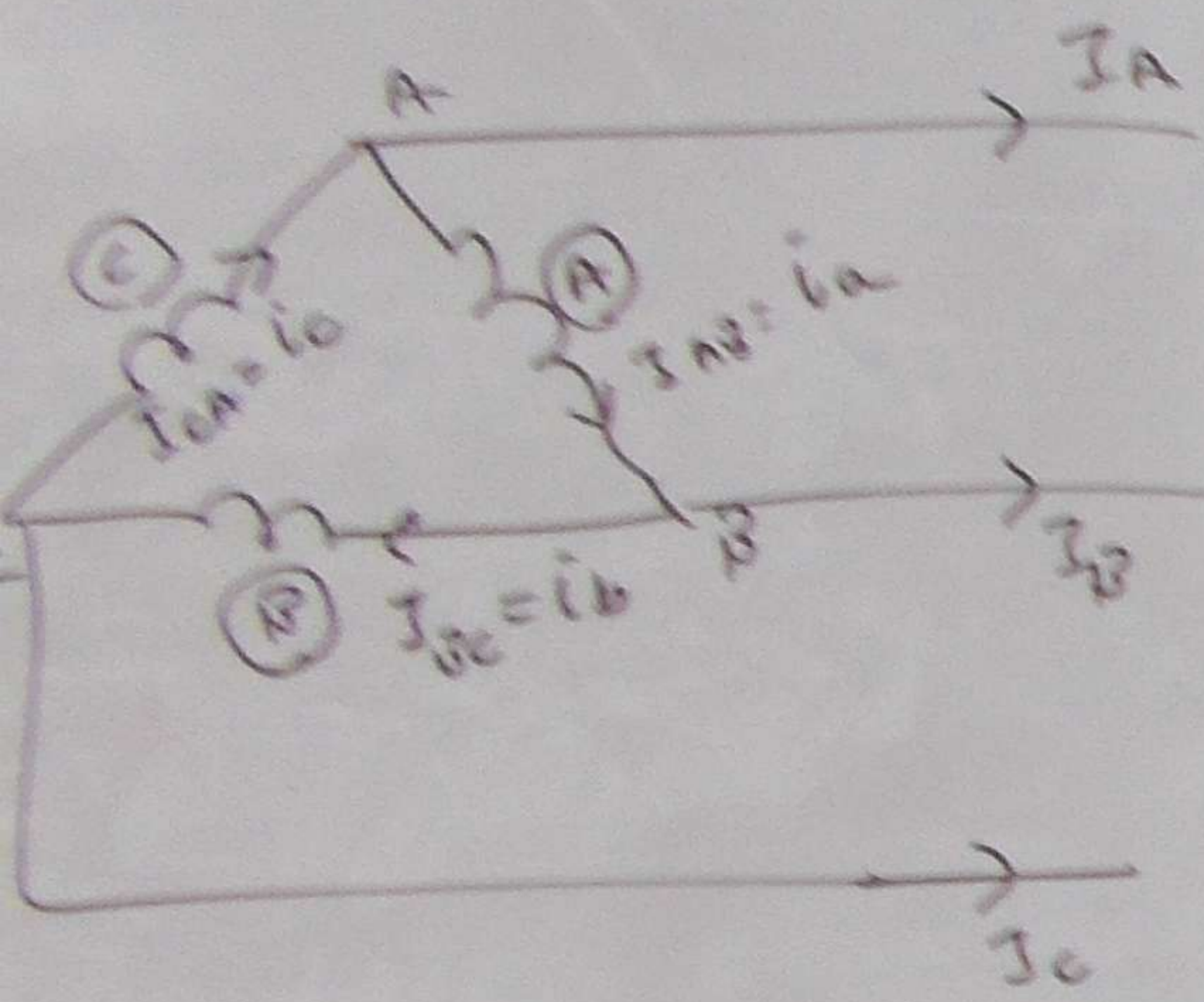
$$I_B = \sqrt{3} i_b$$

$$I_C = \sqrt{3} i_c$$

LINE CURRENTS ARE
MAGNITUDE

LINE CURRENTS ARE
PHASE

APPROPRIATE
FOOTWEAR
IN THIS BUILDING



BALANCE DELTA

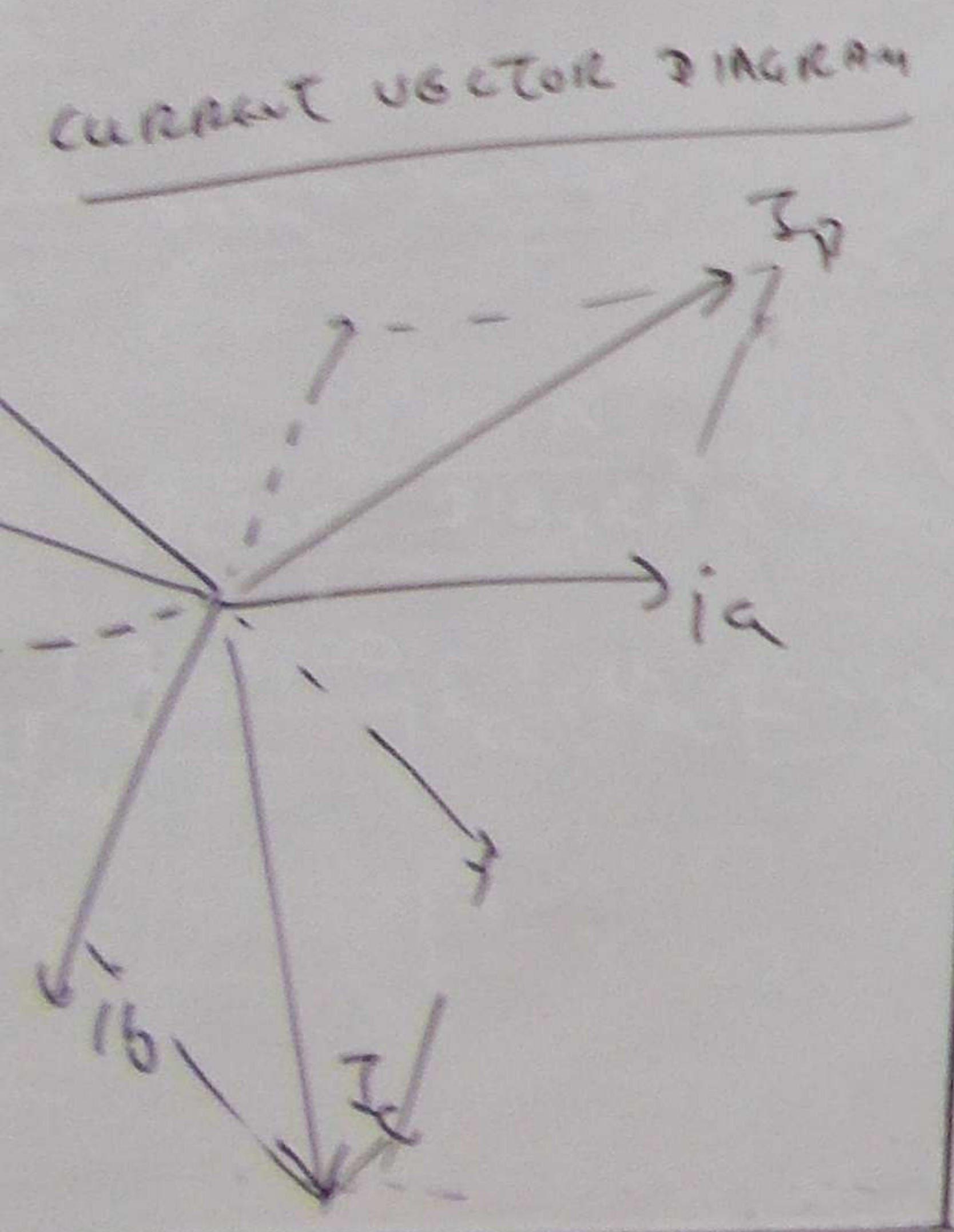
$$I_A = \sqrt{3} i_a$$

$$I_B = \sqrt{3} i_b$$

$$I_C = \sqrt{3} i_c$$

LINE CURRENTS ARE ALL EQUAL IN MAGNITUDE

LINE CURRENTS ARE $\sqrt{3}$ TIMES PHASE CURRENT



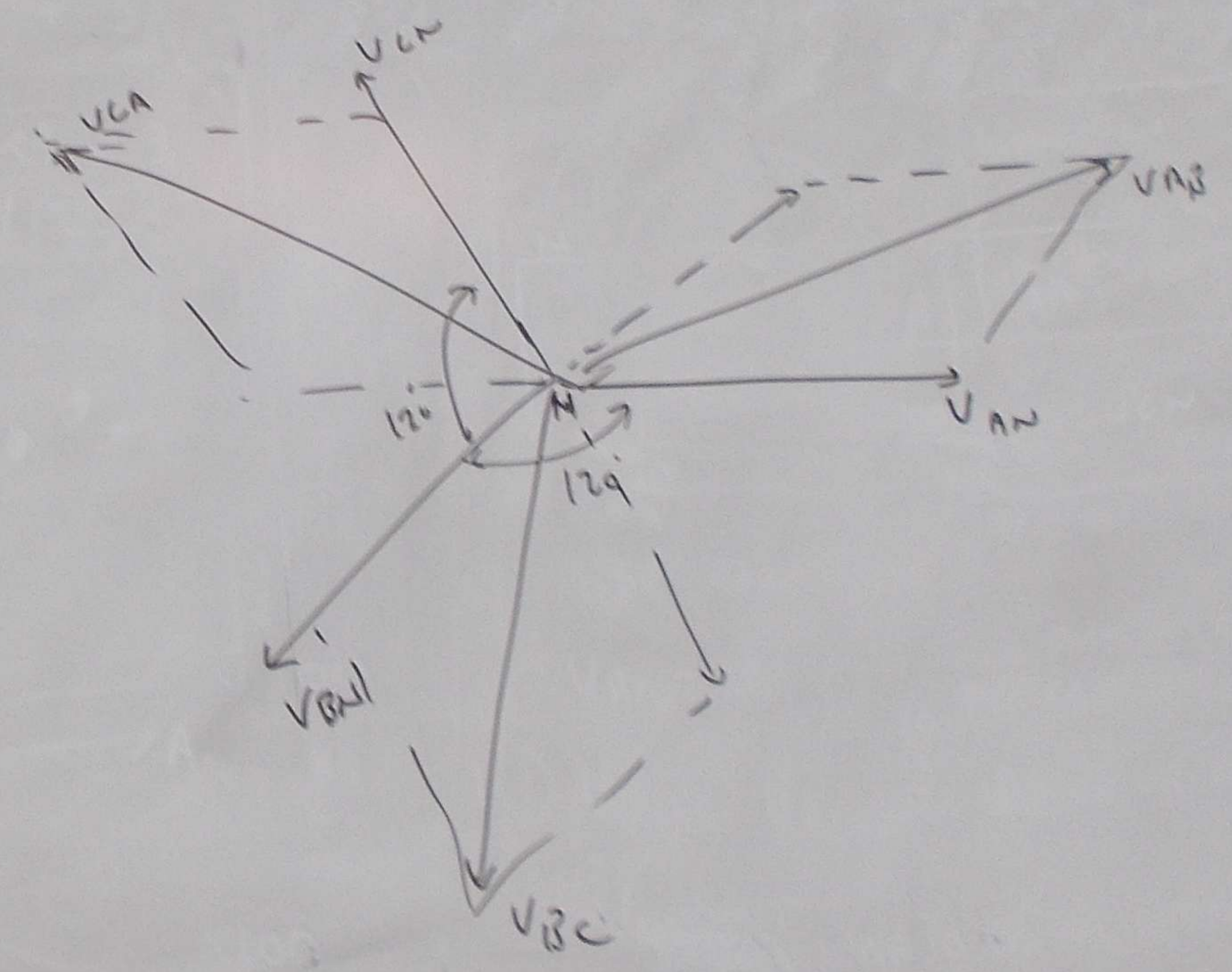
p6

$$V_A(\text{ph}) = 10V$$

$$V_B(\text{ph}) = 10V$$

$$V_C(\text{ph}) = 10V$$

SEQUENCE ABC, PLOT THE PHASE AND LINE VOLTAGE DIAGRAM BY SCALE

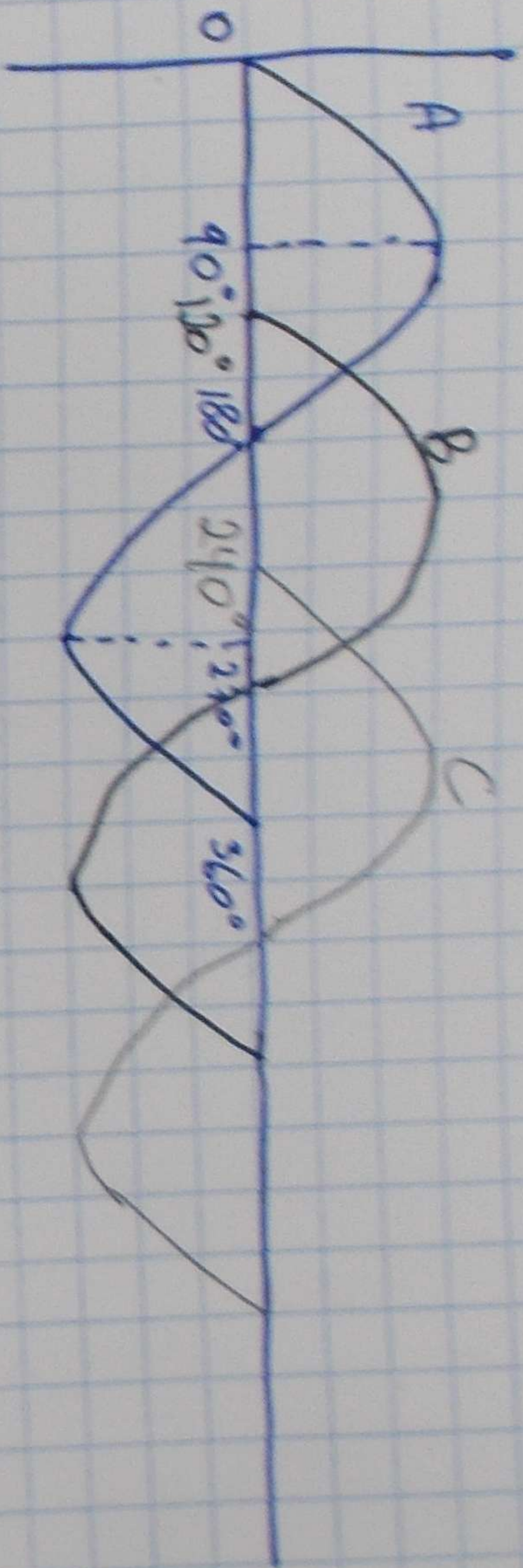


$$1V = 1cm$$

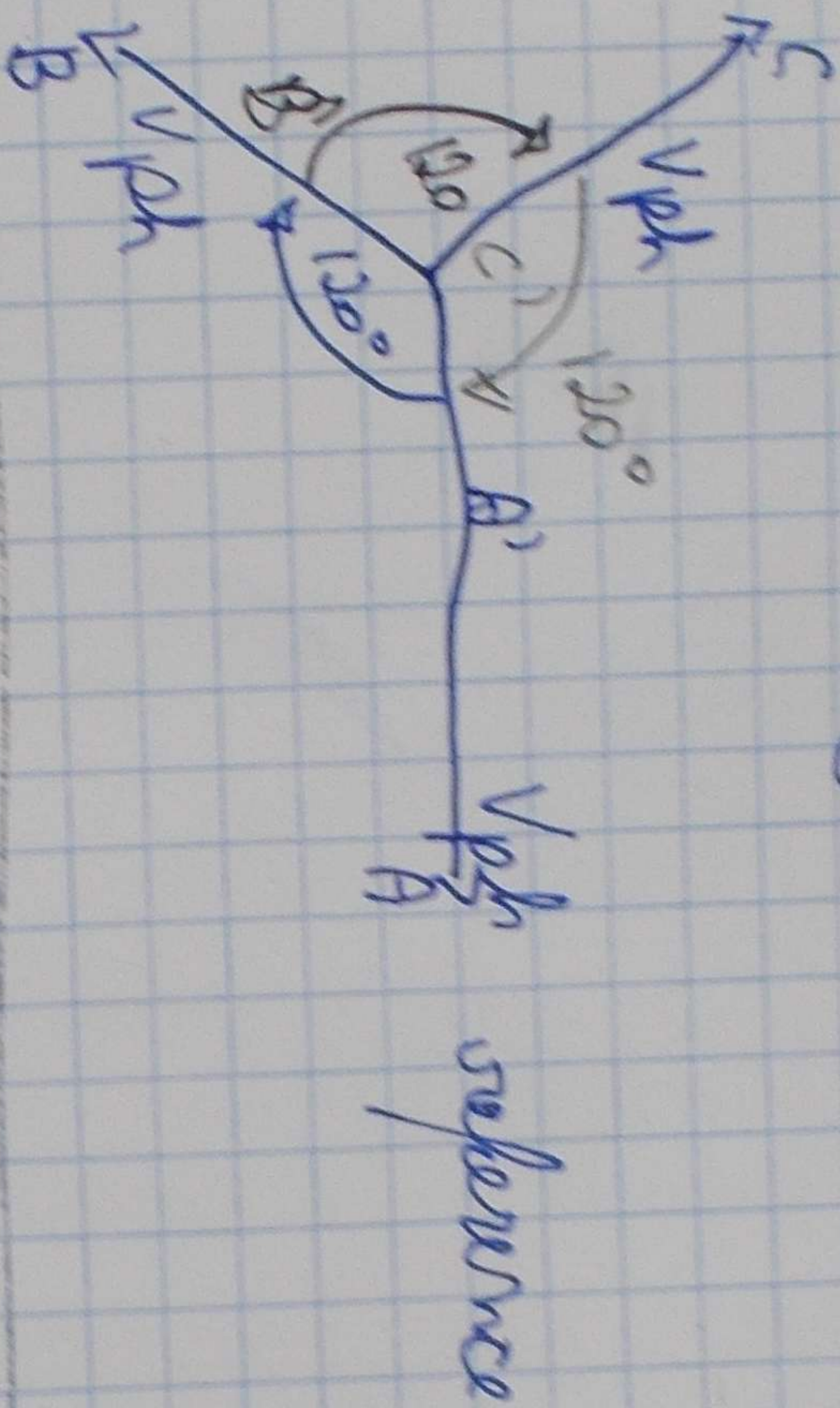
$$10V = 10cm$$

03/05/18

3Φ AC Supplies



Vector diagram



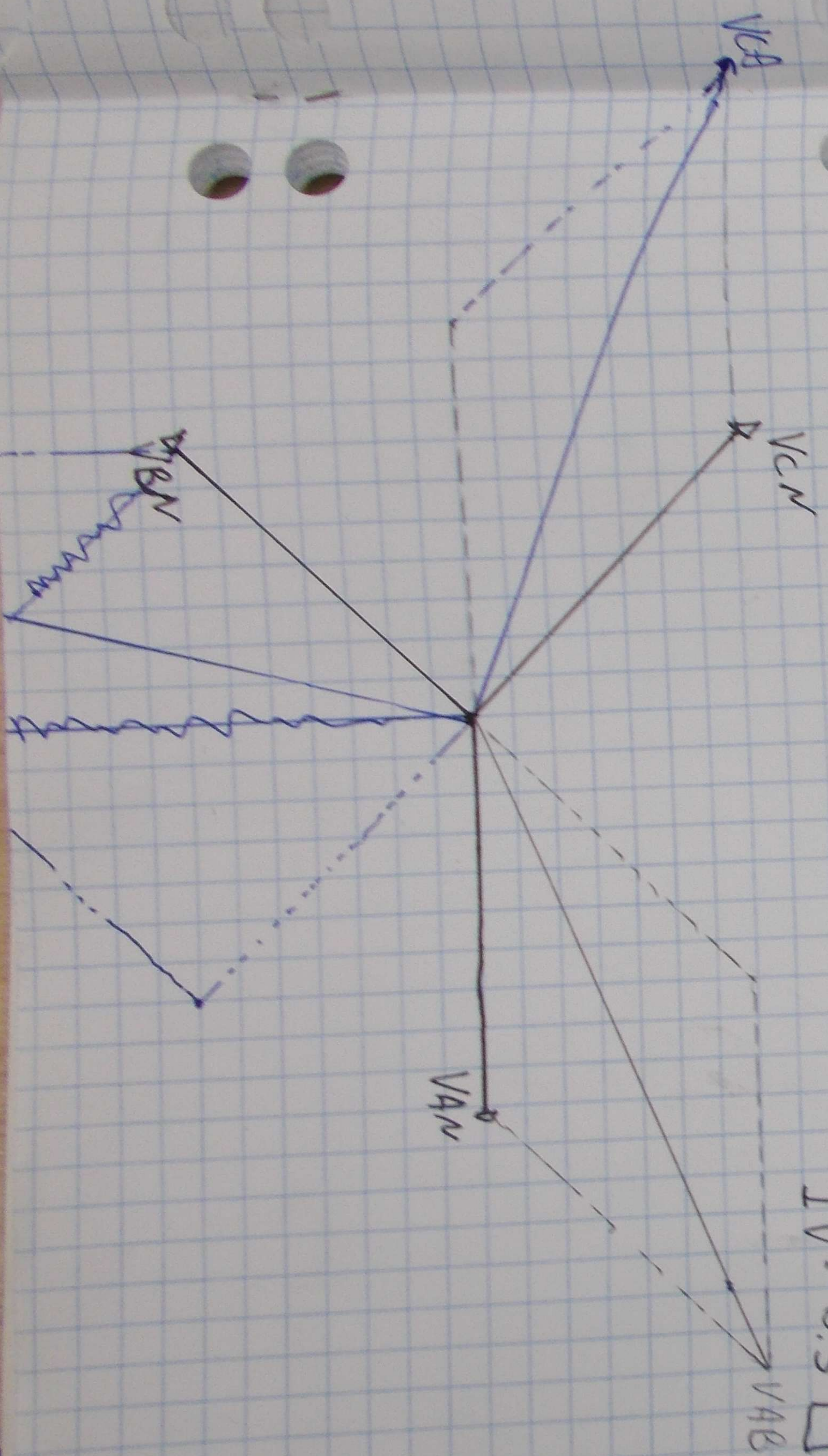
Phasor form

$E_{AN} = V_{ph} \angle 0^\circ$
 $E_{BN} = V_{ph} \angle -120^\circ$
 $E_{CN} = V_{ph} \angle -240^\circ$

$V_A (ph) = 10V$
 $V_B (ph) = 10V$
 $V_C (ph) = 10V$

Sequence ABC plot the phasor and line V diagram by scale

$LV = 0.5 \square$



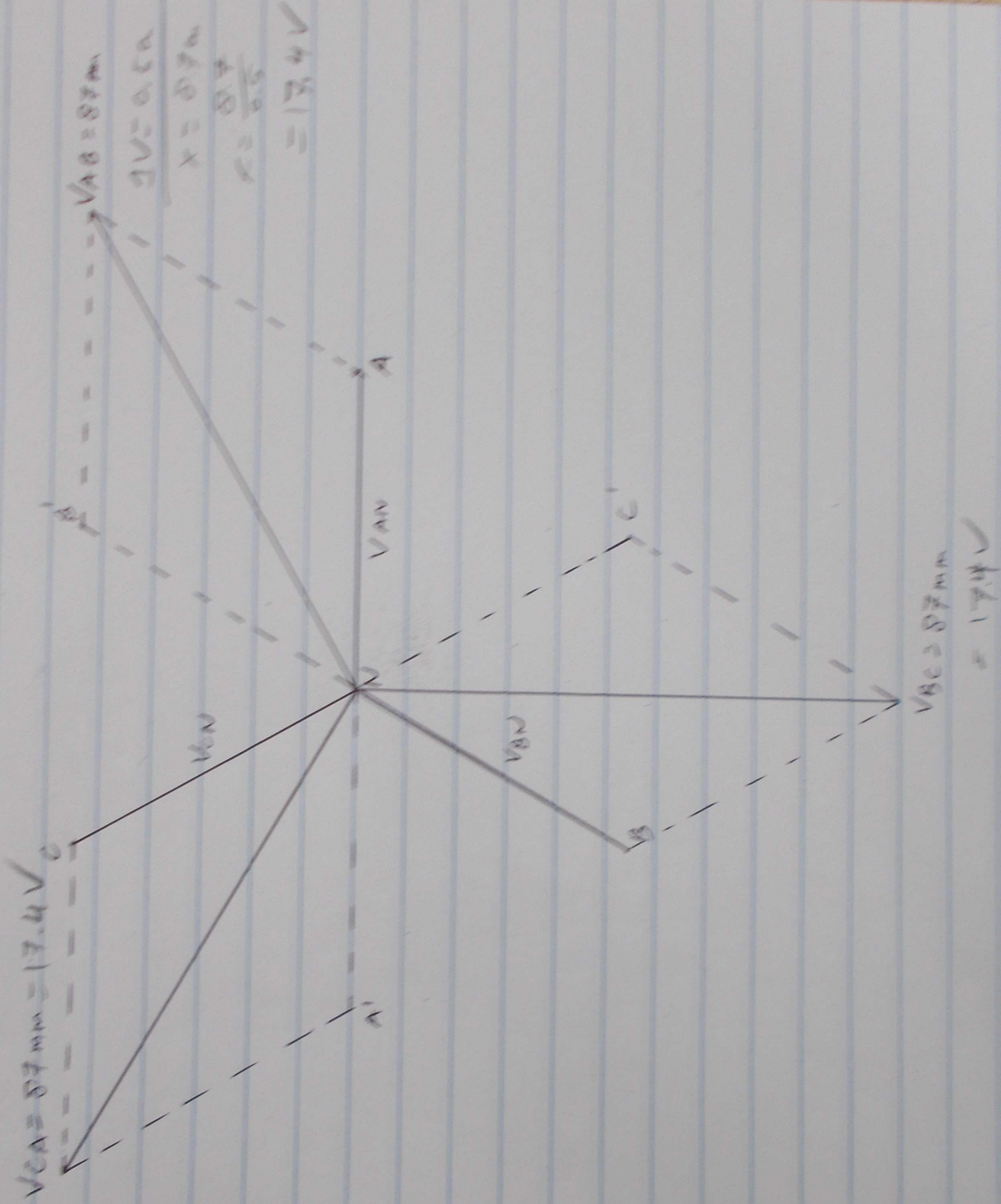
A.C

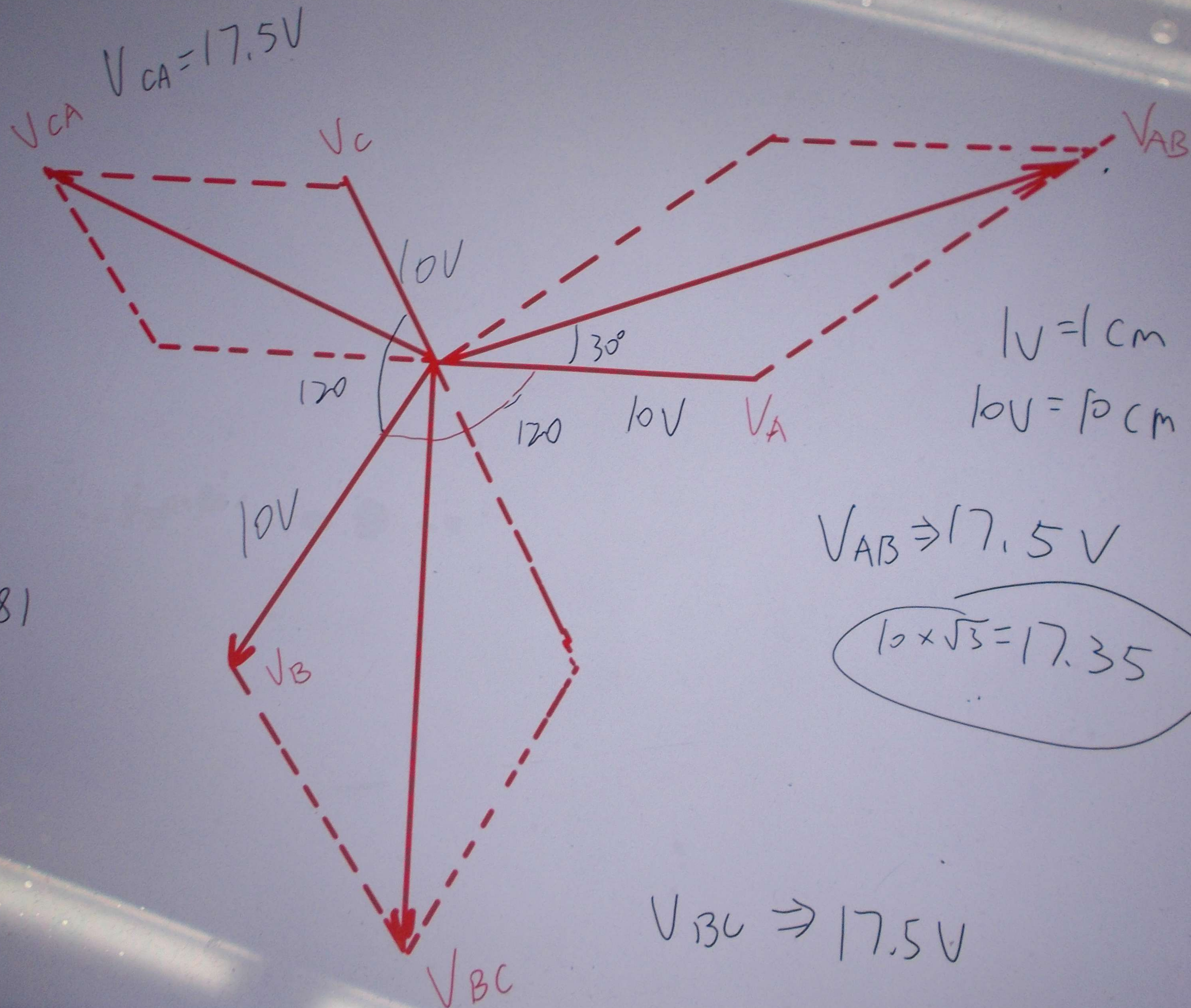
ERICK MATIAS 803737303

$V_A(Ph) = 10V$ Scale $1V = 5cm$

$V_B(Ph) = 10V$

$V_C(Ph) = 10V$





Lang Li
 802093781

$$V_{AB} \Rightarrow 17.5V$$

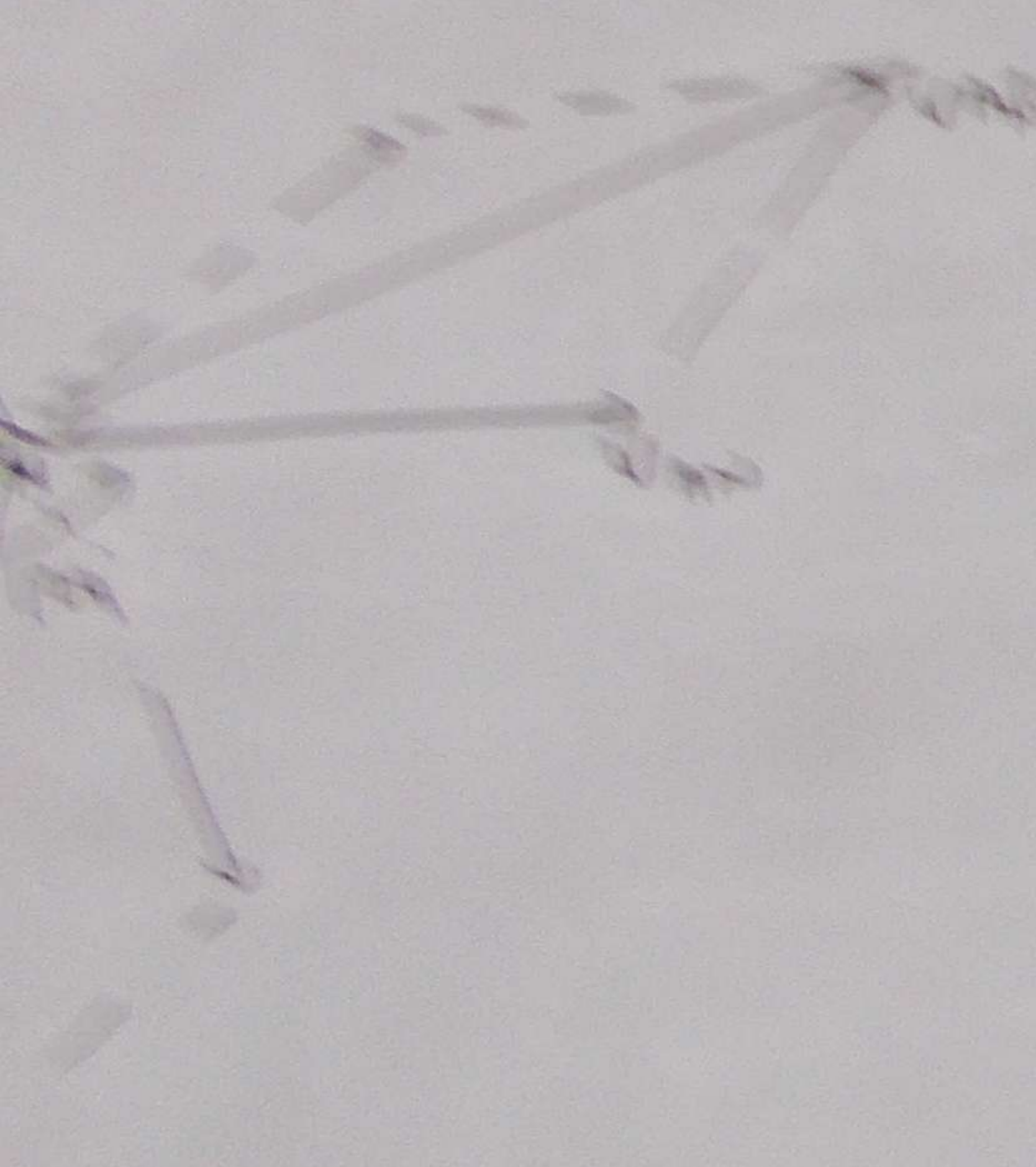
$$10 \times \sqrt{3} = 17.35$$

$$V_{BC} \Rightarrow 17.5V$$

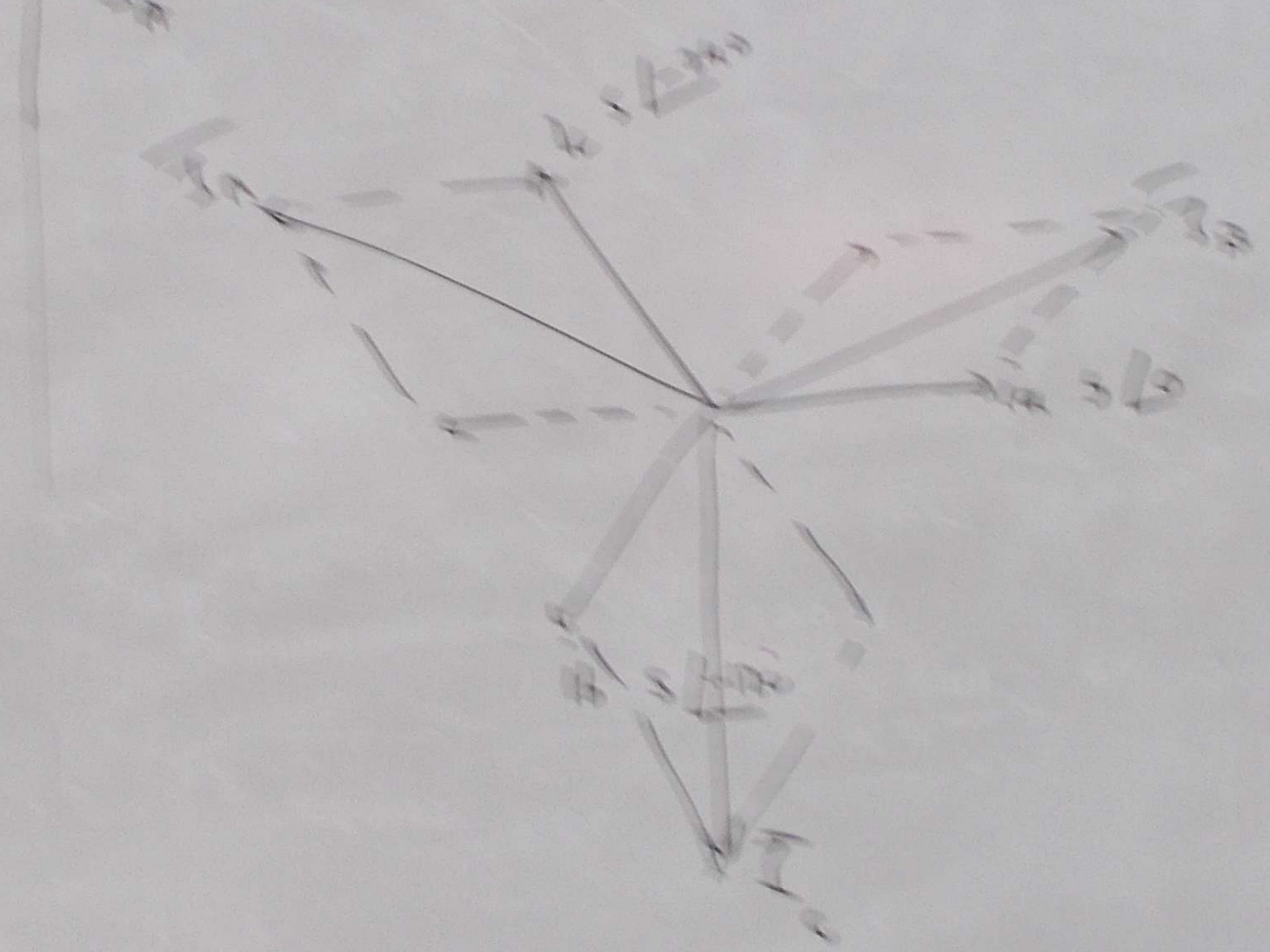
Find the phase and line
to phase difference of phase

$$I_0 = I_{L1}$$

$$I_0 = I_{L2}$$



Find I_{L1} , I_{L2} , I_0 by vector method
 $I_{L1} = I_0 - I_{L2}$, $I_{L2} = I_0 - I_{L1}$, $I_0 = I_{L1} - I_{L2}$



$$\vec{V}_{AB} = \vec{V}_A - \vec{V}_B$$

$$\vec{V}_{BC} = \vec{V}_B - \vec{V}_C$$

$$\vec{V}_{CA} = \vec{V}_C - \vec{V}_A$$

Vector sum should be zero

Star connection

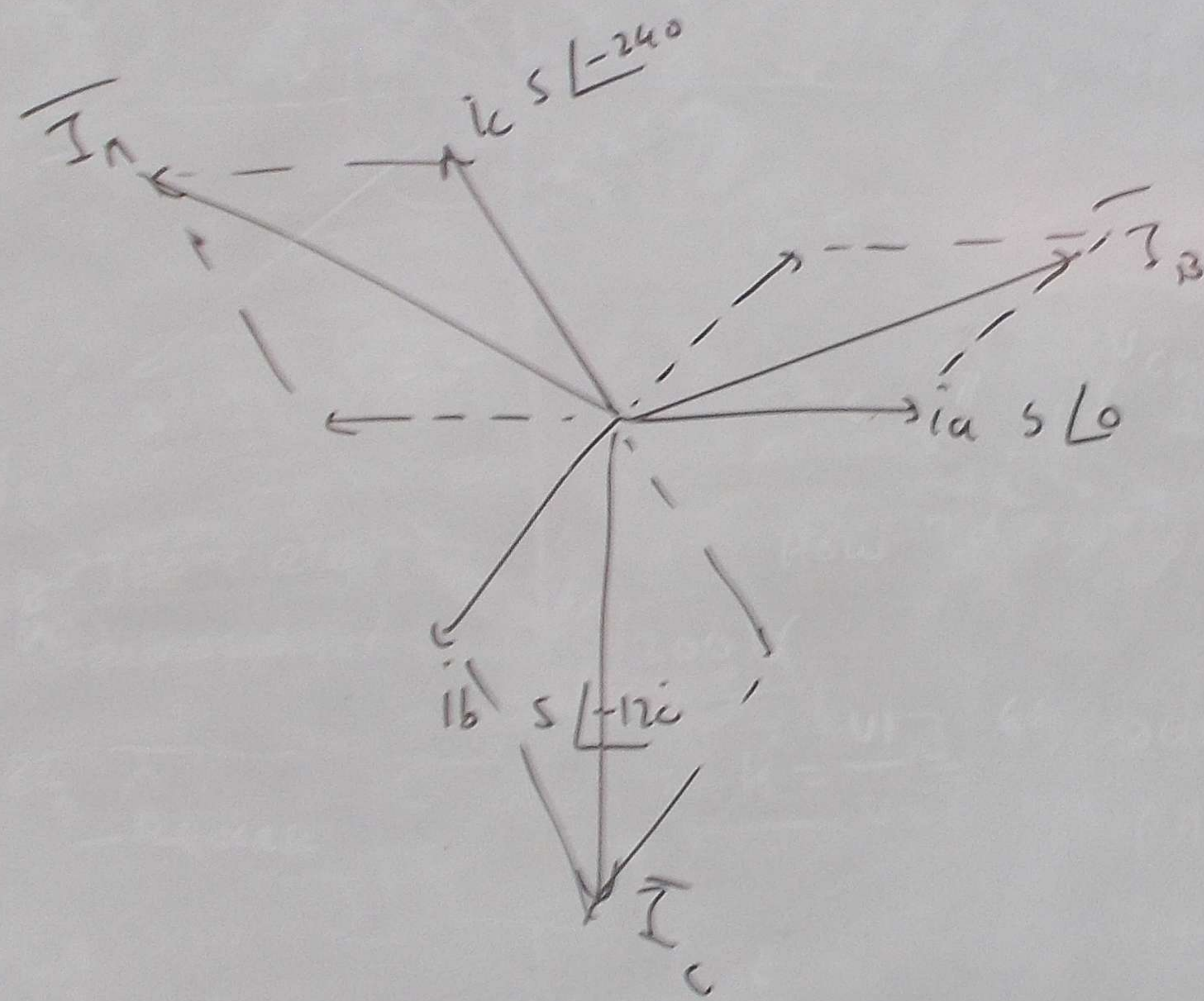


VOLTAGE

ph $i_a = 5 \angle 0^\circ \text{ Amp}$, $i_b = 5 \angle -120^\circ \text{ Amp}$, $i_c = 5 \angle -240^\circ \text{ Amp}$

FIND $\bar{I}_A$, $\bar{I}_B$, $\bar{I}_C$ BY VECTOR METHOD

$\bar{I}_A = i_c - i_a$, $\bar{I}_B = i_a - i_b$, $\bar{I}_C = i_b - i_c$



$1V = 1cm$
 $10V = 10cm$

$\vec{V}_{AB} = \vec{V}_A + \vec{V}_B$

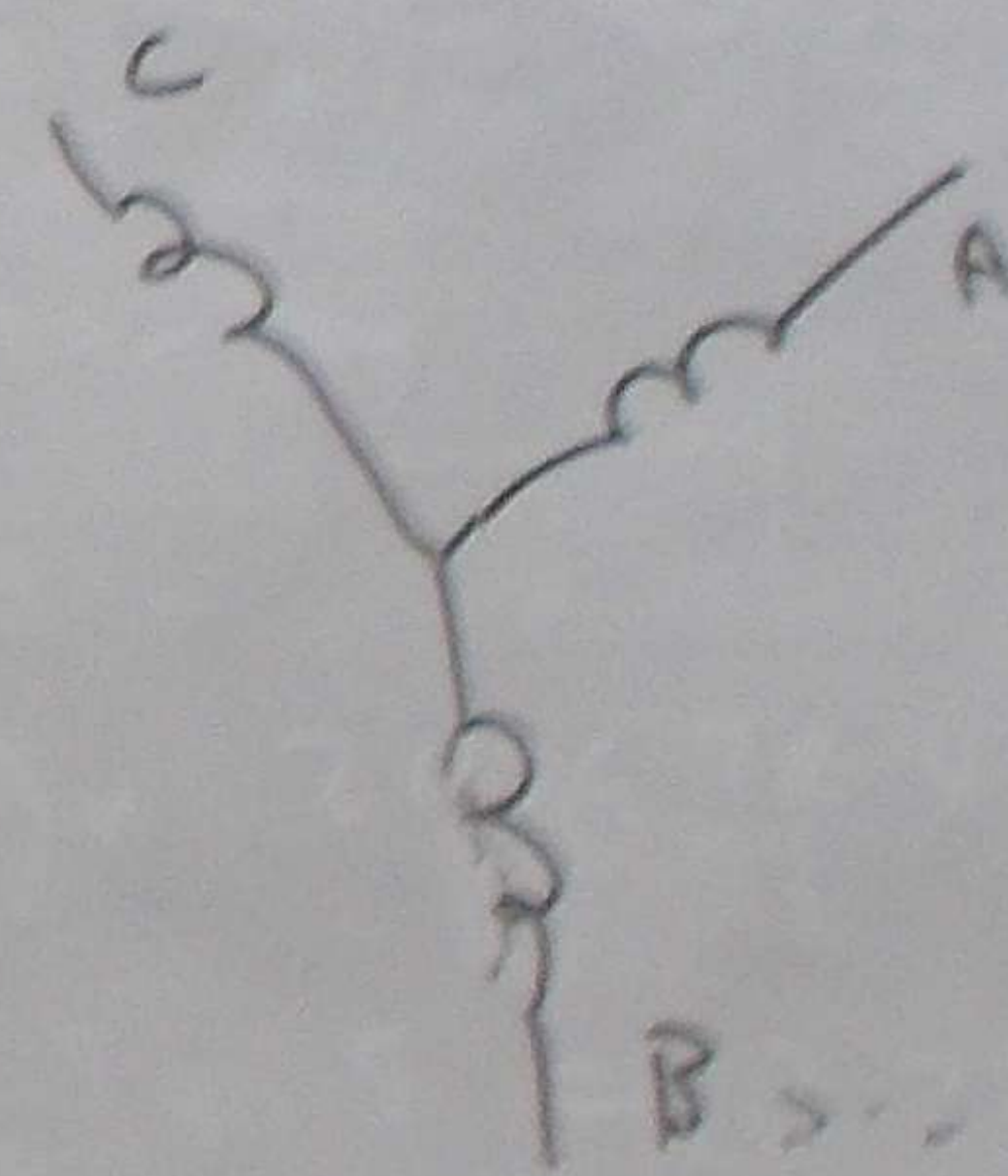
$\vec{V}_{BC} = \vec{V}_B + \vec{V}_C$

$\vec{V}_{CA} = \vec{V}_C + \vec{V}_A$

VECTOR SUM EQUATIONS

STAR CONNECTION

$V_{ph} = V$



$V_{AB} = \sqrt{3} V$

$V_{BC} = \sqrt{3} V$

$V_{CA} = \sqrt{3} V$

A.C

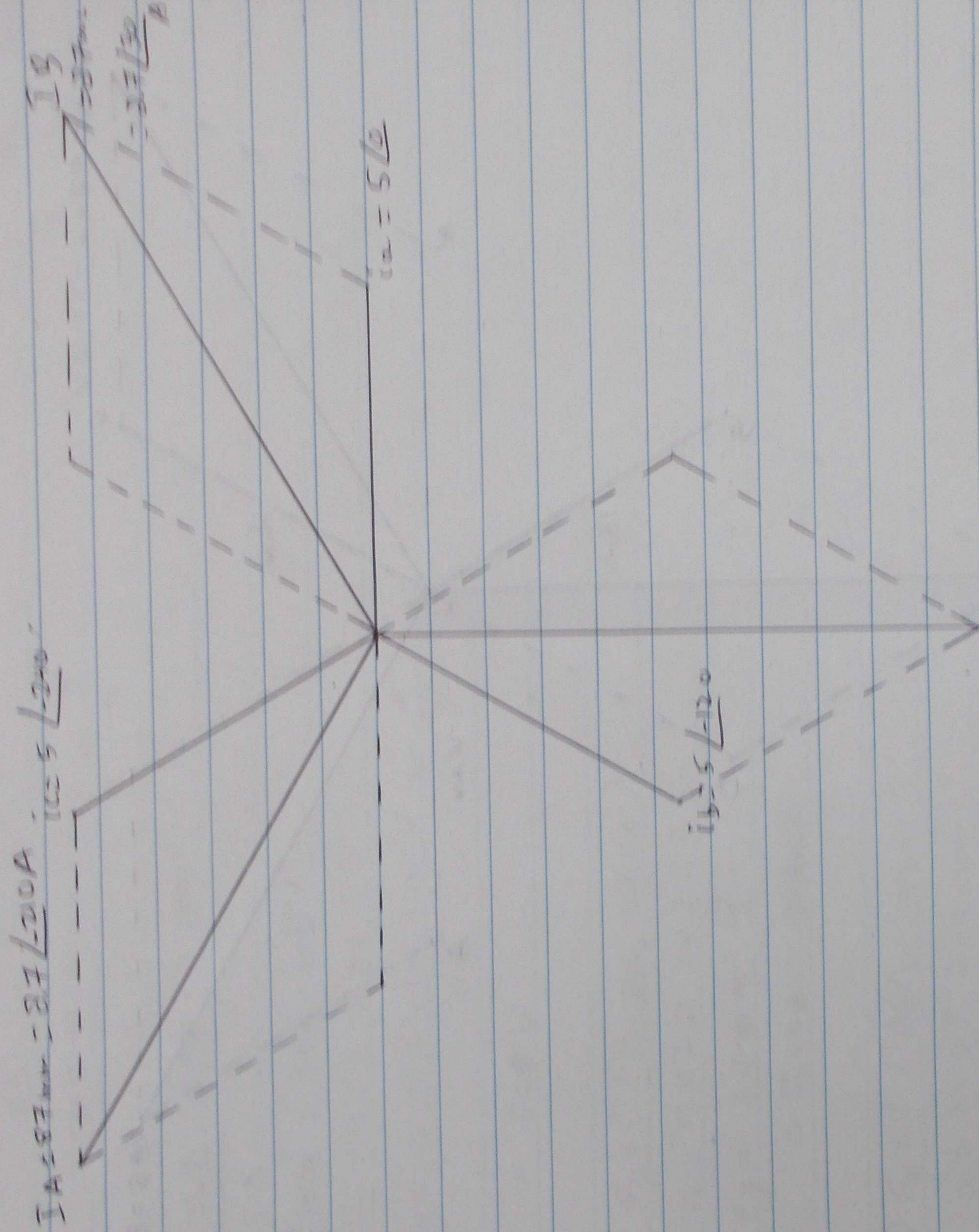
ERICK MATIAS 803737703

$$i_a = 5 \angle 0^\circ \text{ A}, i_b = 5 \angle -120^\circ, i_c = 5 \angle -240^\circ$$

$$\bar{i}_A, \bar{i}_B, \bar{i}_C$$

$$I_A = i_c - i_a, I_B = i_a - i_b, I_C = i_b - i_c$$

$$\text{scale} = 1 \text{ V} \Rightarrow 1 \text{ cm}$$



$$I_C = 8.7 \text{ A}$$

$$I_C = 8.7 \text{ A} \angle -90^\circ$$

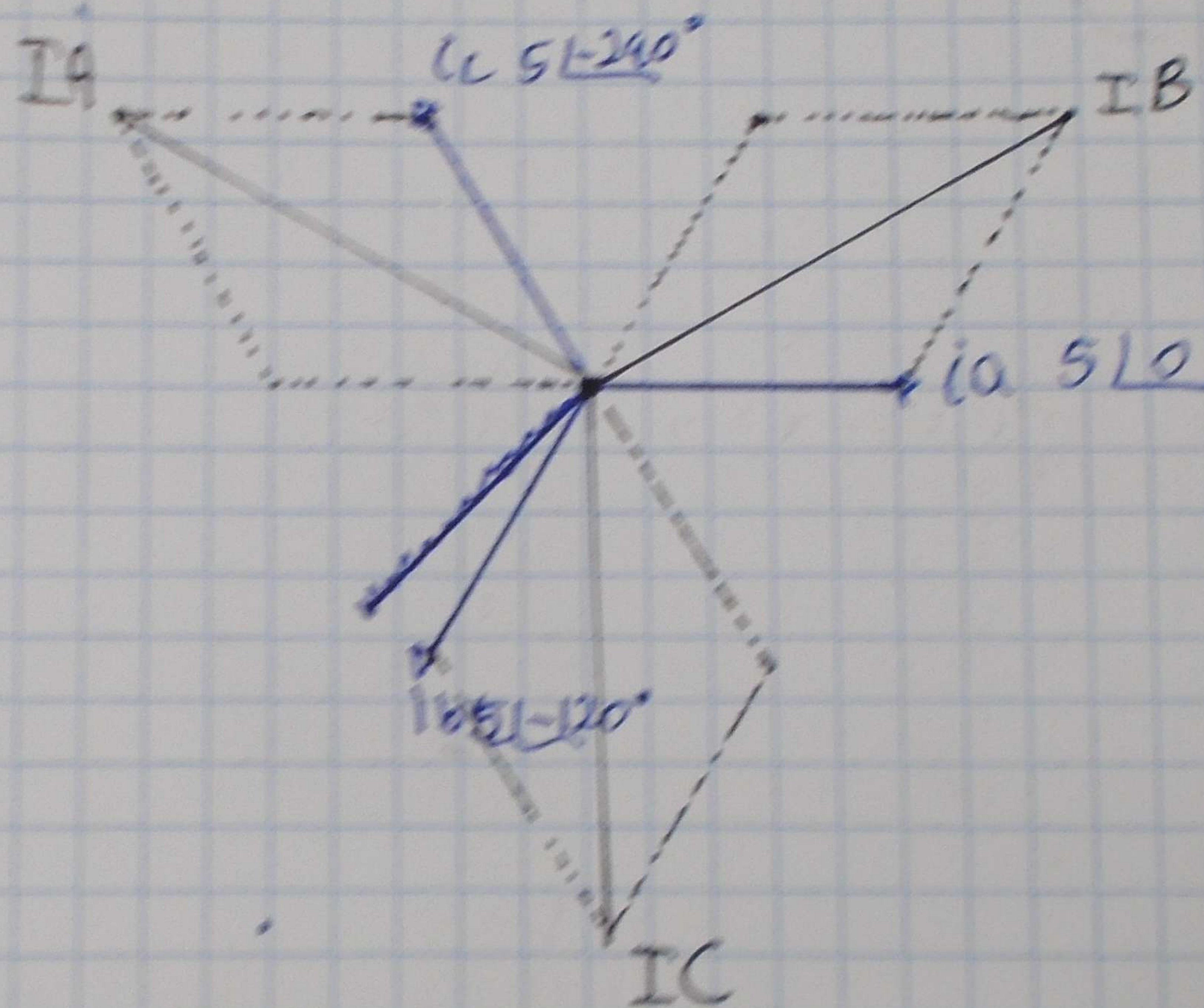
20 $i_a = 5 \angle 0^\circ$ $i_b = 5 \angle -120^\circ$ $i_c = 5 \angle -240^\circ$

find $\bar{I}_A$, $\bar{I}_B$, $\bar{I}_C$ by vector method

$\bar{I}_A = i_c - i_a$ $\bar{I}_B = i_a - i_b$ $\bar{I}_C = i_b - i_c$

$\angle A = \angle \square = 0,5 \text{ cm}$

NUMERUS G
803737657



$4,5 \times 0,5$

$\frac{9 \text{ cm}}{9 \text{ A}}$

Pb

$$V_A(LPN) = 10V$$

Sequence ABC, Plot the phase and line

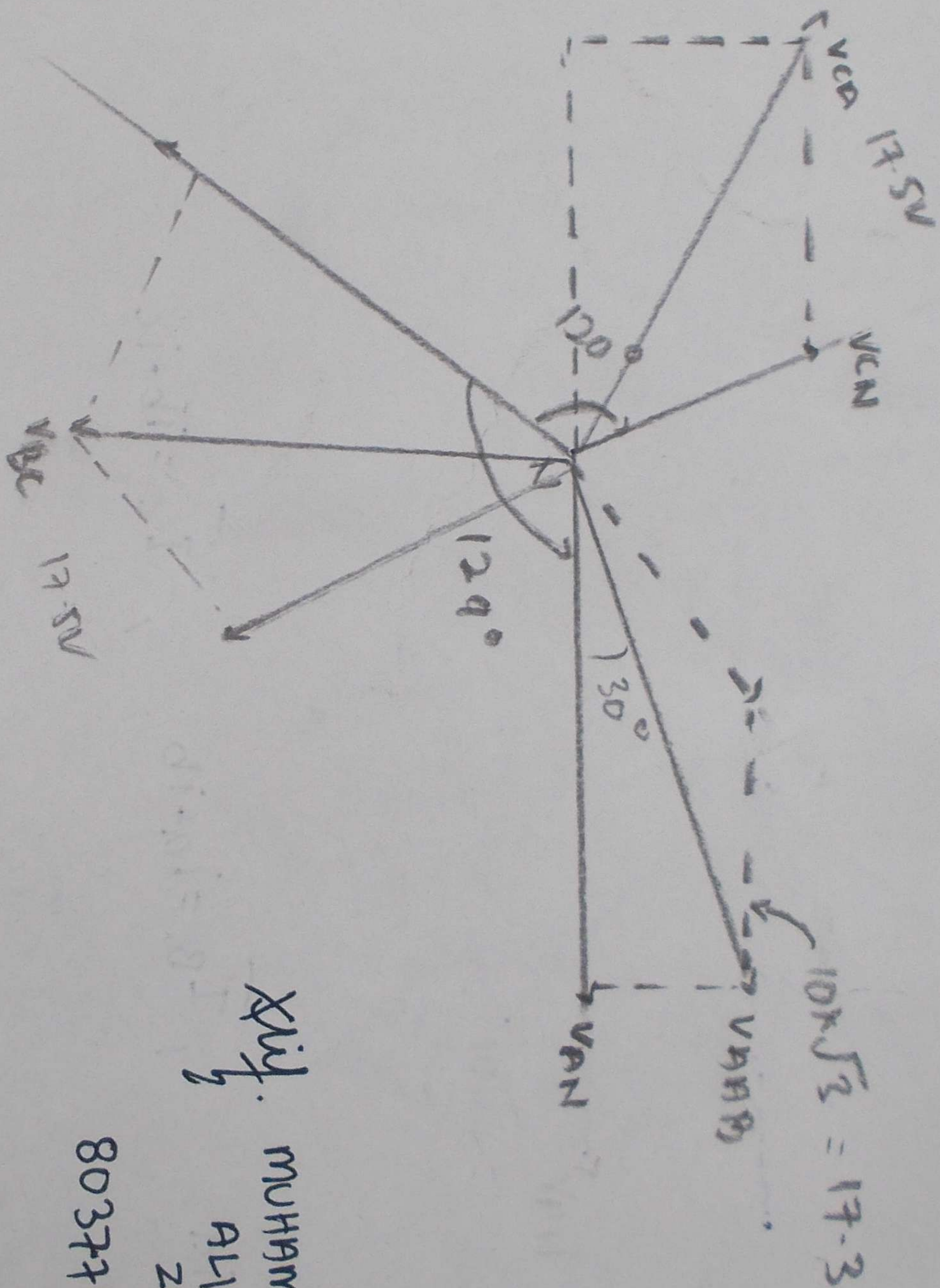
$$V_B(LPN) = 10V$$

voltage diagram by scale.

$$V_C(LPN) = 10V$$

$$1V = 1cm$$

$$10V = 10cm$$



Xid.

MUHAMMAD

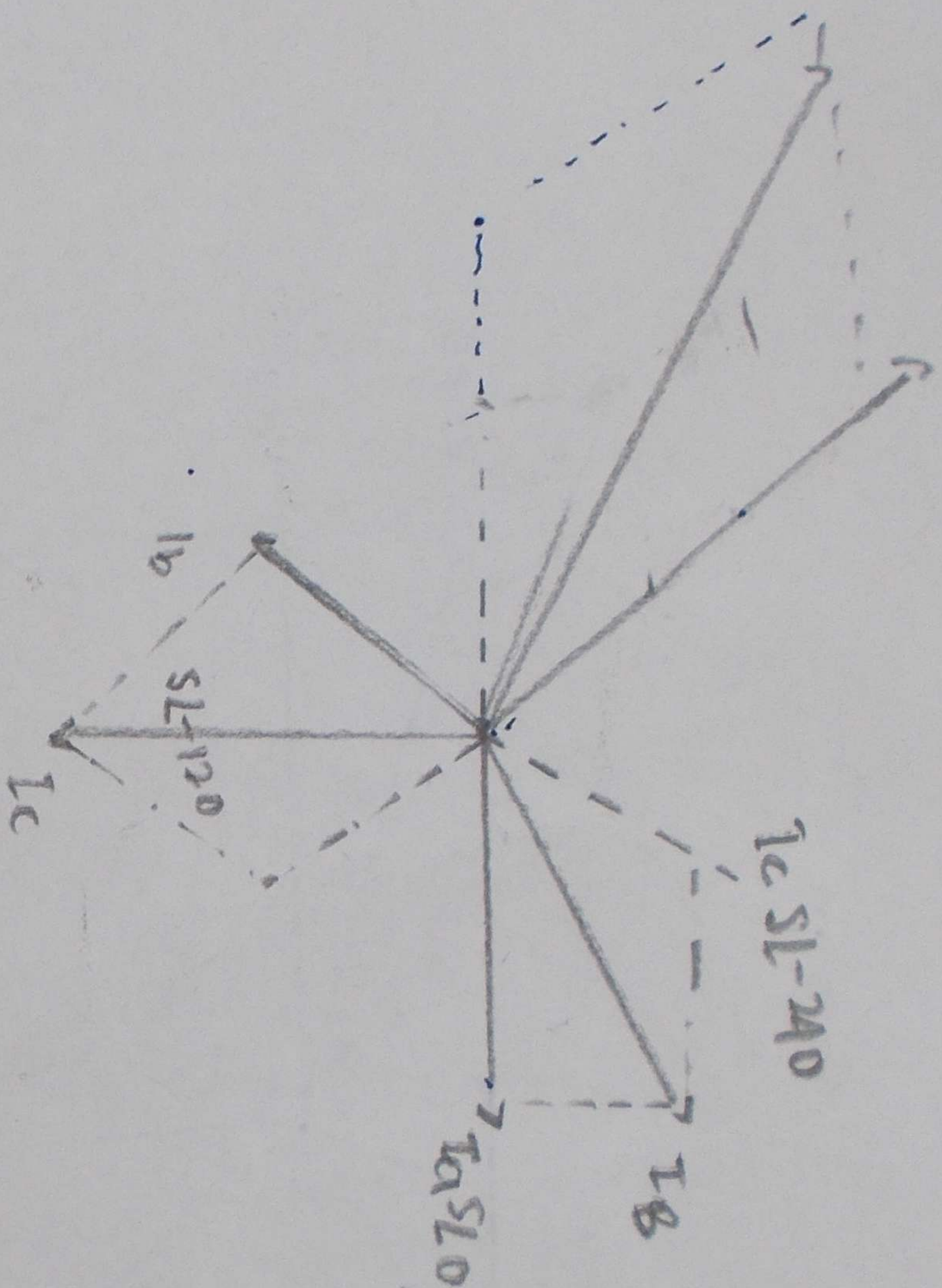
ALF

ZULKARNAINI

803748051

Pb $i_a = 5 \angle 0^\circ \text{ Amp}$, $i_b = 5 \angle -120^\circ \text{ Amp}$, $i_c = 5 \angle -240^\circ \text{ Amp}$

Find $\bar{I}_A$, $\bar{I}_B$, $\bar{I}_C$ By vector method.



$$\bar{I}_A = i_c - i_a$$

$$\bar{I}_B = i_a - i_b$$

$$\bar{I}_C = i_b - i_c$$

$$\bar{I}_A = 5 \angle -240^\circ - 5 \angle 0^\circ$$

$$= 5 \angle -240^\circ$$

$$\bar{I}_B = 5 \angle 0^\circ - 5 \angle -120^\circ$$

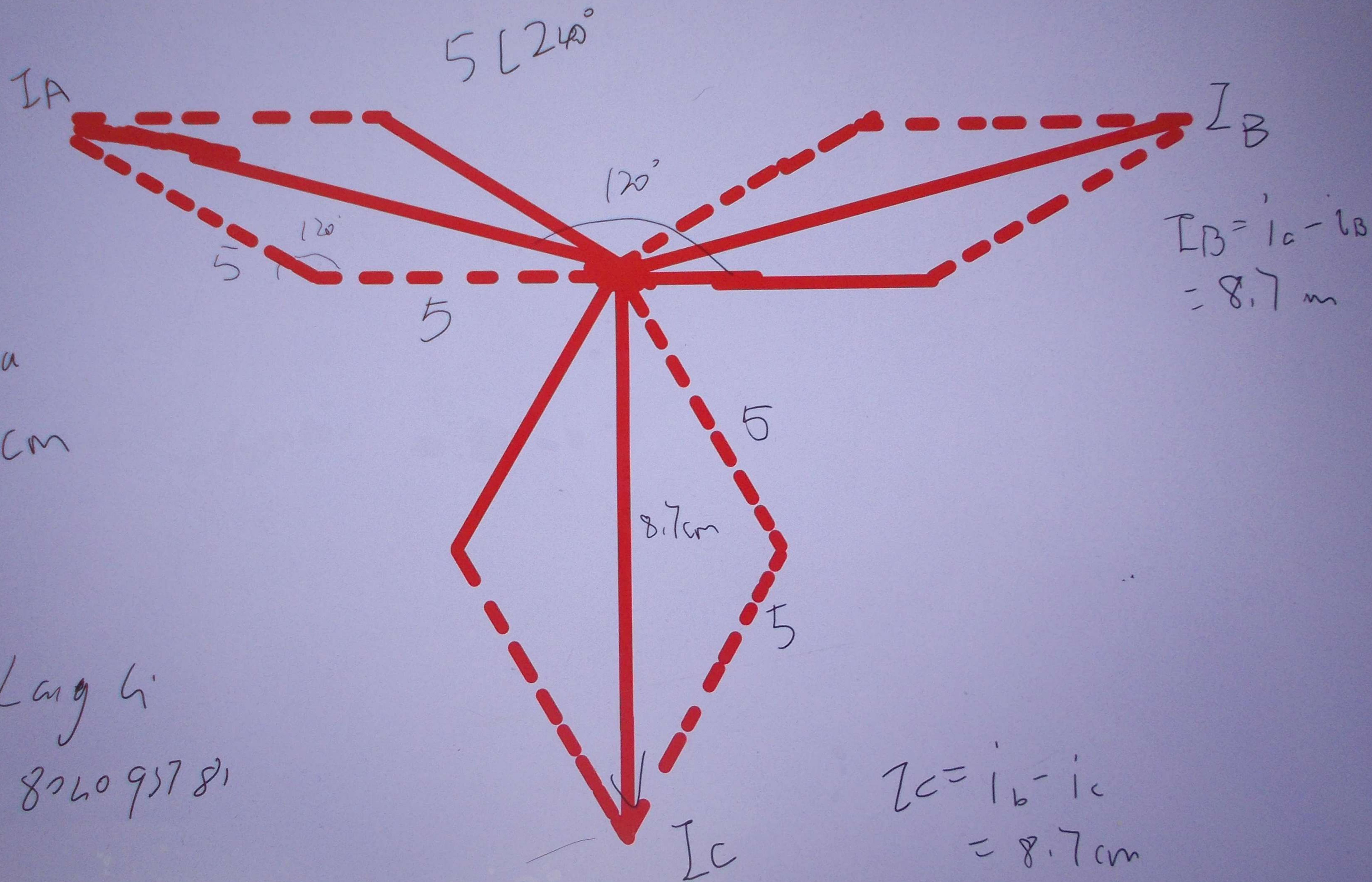
$$= 5 \angle 120^\circ$$

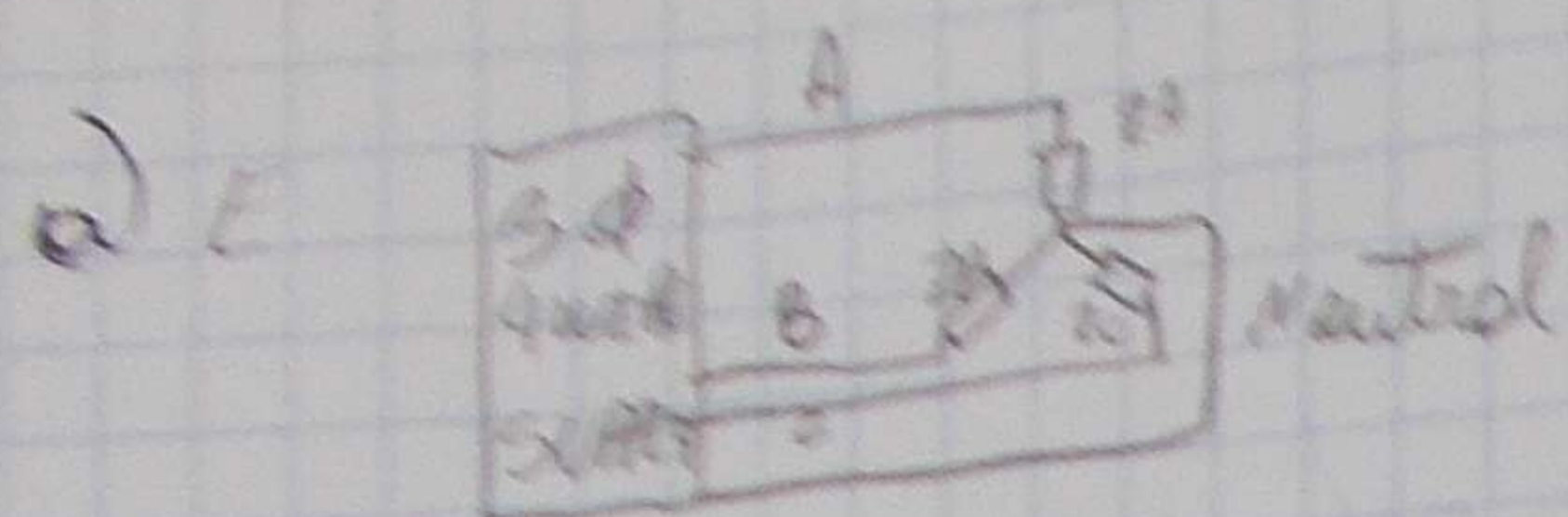
$$\bar{I}_C = 5 \angle -120^\circ - 5 \angle -240^\circ$$

$$= 5 \angle 120^\circ$$

$$I_A = i_c - i_a = 8.7 \text{ cm}$$

Lang 4:
8040 957 81





$$\begin{aligned} E_{AN} &= 240V = 240 \angle 0^\circ \\ E_{BN} &= 240V = 240 \angle -120^\circ \\ E_{CN} &= 240V = 240 \angle -240^\circ \end{aligned}$$

$$\begin{aligned} a) E_{AB} &= \sqrt{3} \times 240 \angle 30^\circ = 415.7 \angle 30^\circ V \\ E_{BC} &= \sqrt{3} \times 240 \angle -90^\circ = 415.7 \angle -90^\circ V \\ E_{CA} &= \sqrt{3} \times 240 \angle 150^\circ \text{ or } 210^\circ = 415.7 \angle -210^\circ \end{aligned}$$

$$b) I_A = I_{line} = I_{phase} = \frac{E_{AN}}{Z_A} = \frac{240 \angle 0^\circ}{20 \angle 0^\circ} = 12 \angle 0^\circ A$$

$$I_B = \frac{E_{BN}}{Z_B} = \frac{240 \angle -120^\circ}{20 \angle 0^\circ} = 12 \angle -120^\circ A$$

$$I_C = \frac{E_{CN}}{Z_C} = \frac{240 \angle -240^\circ}{20 \angle 0^\circ} = 12 \angle -240^\circ A$$

$$c) I_N = I_A + I_B + I_C$$

$$= 12 \angle 0^\circ + 12 \angle -120^\circ + 12 \angle -240^\circ \text{ convert to rectangular form}$$

$$= 12(\cos 0 + j \sin 0) + 12(\cos -120 + j \sin -120) + 12(\cos -240 + j \sin -240)$$

$$12(1 + j0) + 12(-0.5 + j0.86) + 12(-0.5 + j0.86)$$

$$12 + (-6 - j6) + (-6 - j6) \quad I_N = 0 A$$

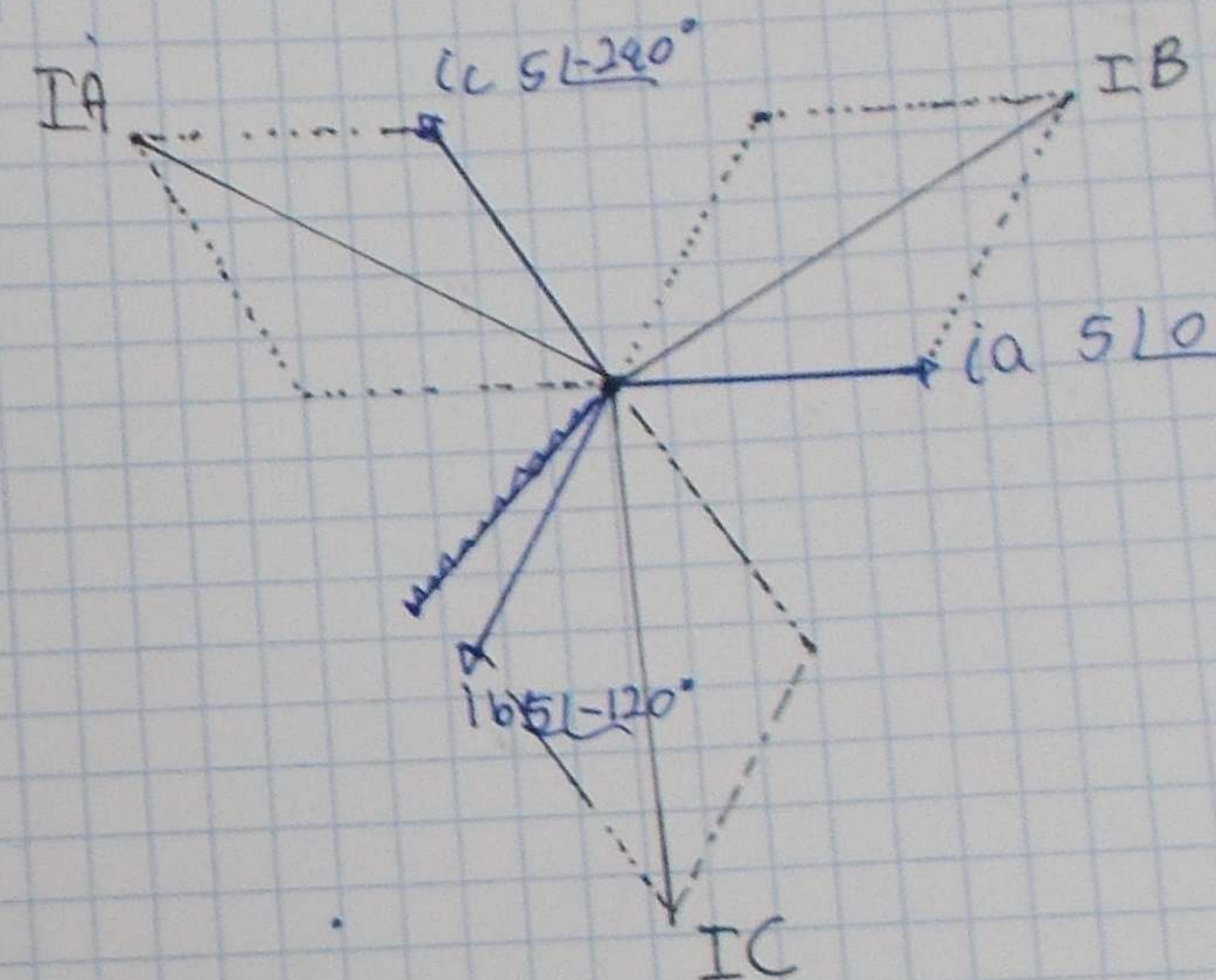
MATEUS G
803737657

Pb $i_a = 5 \angle 0^\circ$ $I_b = 5 \angle -120^\circ$ $I_c = 5 \angle -240^\circ$
find $\bar{I}_A, \bar{I}_B, \bar{I}_C$ by Vector method

$$\bar{I}_A = I_c - I_a \quad \bar{I}_B = I_a - I_b \quad \bar{I}_C = I_b - I_c$$

$$\Delta A \cdot 1 \square = 0.5 \text{ cm}$$

MATEUS G
803737657



$$4.5 \times 0.5$$

$$\frac{9 \text{ cm}}{9 \text{ A}}$$

Exercise A balanced 3-phase connected load consists of three $20 \angle 0^\circ \Omega$ resistors connected via 3-wire load line to neutral voltage 240V.

- calculate
- line voltage in polar form
 - line current in " "
 - neutral current.

A.C

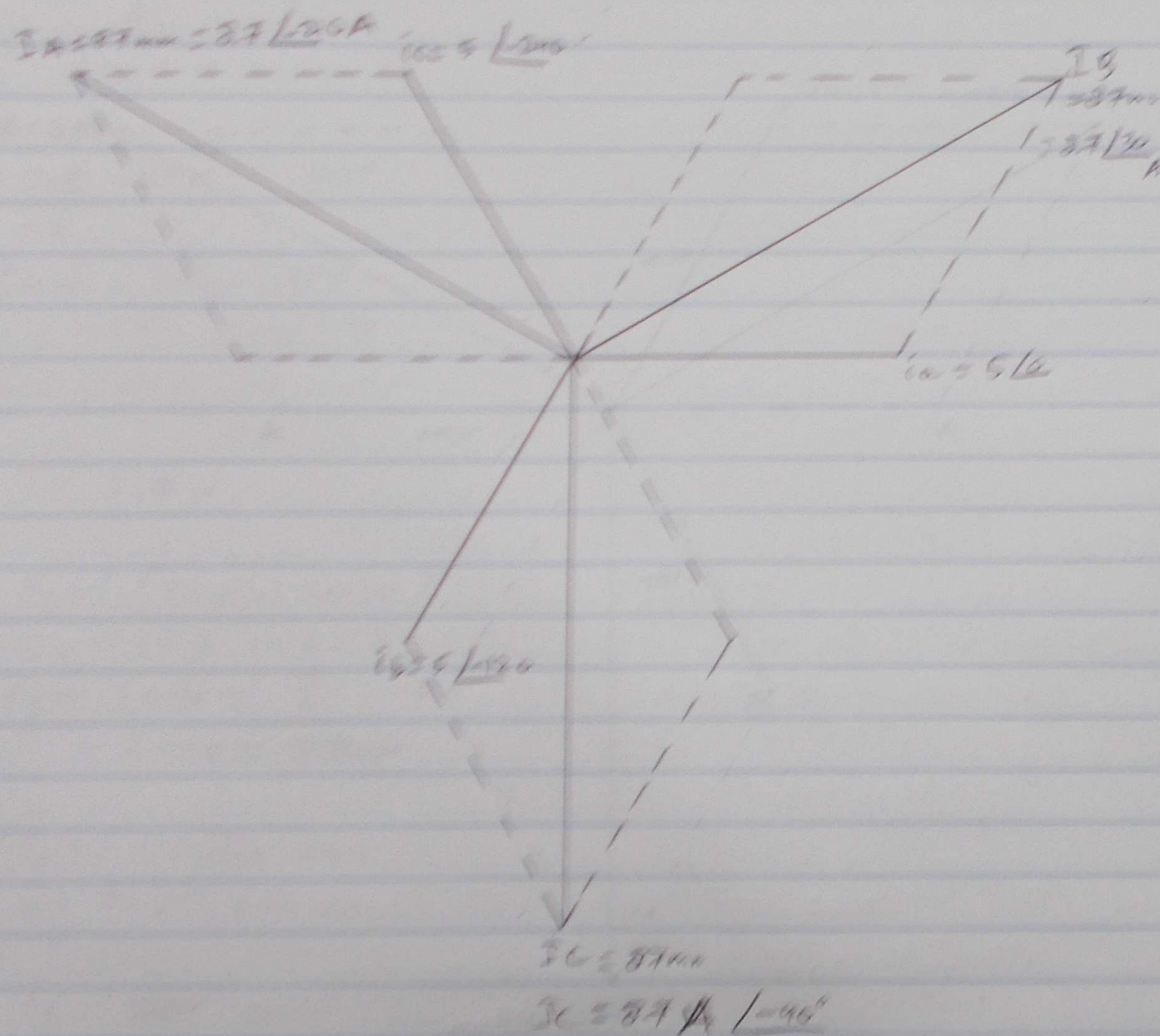
ERICK MATIAS 803737703

$$i_{a1} = 5 \angle 0^\circ, i_{a2} = 5 \angle 120^\circ, i_{a3} = 5 \angle 240^\circ$$

$$\bar{I}_A, \bar{I}_B, \bar{I}_C$$

$$I_A = I_C - I_B, I_B = I_C - I_A, I_C = I_B - I_A$$

$$\text{scale} = 1 \text{ V} = 1 \text{ A}$$



A.C

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3 ϕ Y with 20Ω

$$E_{AN} = 240 \angle 0^\circ \text{ V}$$

$$E_{BN} = 240 \angle 120^\circ \text{ V}$$

$$E_{CN} = 240 \angle 240^\circ \text{ V}$$

$$(a) E_{ab} = ?, E_{bc} = ?, E_{ca} = ?$$

$$E_{AB} = \sqrt{3} \times 240 \angle 30^\circ = 415.7 \angle 30^\circ \text{ V}$$

$$E_{BC} = \sqrt{3} \times 240 \angle -90^\circ = 415.7 \angle -90^\circ \text{ V}$$

$$E_{CA} = \sqrt{3} \times 240 \angle 210^\circ = 415.7 \angle 210^\circ \text{ V}$$

$$(b) I_A = \frac{E_{AN}}{Z_A} = \frac{240 \angle 0^\circ \text{ V}}{20 \angle 0^\circ \Omega} = 12 \angle 0^\circ \text{ A}$$

$$I_B = \frac{E_{BN}}{Z_B} = \frac{240 \angle 120^\circ \text{ V}}{20 \angle 0^\circ \Omega} = 12 \angle 120^\circ \text{ A}$$

$$I_C = \frac{E_{CN}}{Z_C} = \frac{240 \angle 240^\circ \text{ V}}{20 \angle 0^\circ \Omega} = 12 \angle 240^\circ \text{ A}$$

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

$$= 12 \angle 0^\circ + 12 \angle 120^\circ + 12 \angle 240^\circ$$

$$= 12 (\cos 0^\circ + j \sin 0^\circ) + 12 (\cos 120^\circ + j \sin 120^\circ) + 12 (\cos 240^\circ + j \sin 240^\circ)$$

$$= 12 (1 + j0) + 12 (-0.5 + j0.866) + 12 (-0.5 - j0.866)$$

$$= 0 \text{ A}$$

$$a) \quad E_{AB} = \sqrt{3} \times 240 \angle 30^\circ$$

$$= 415.7 \angle 30^\circ$$

$$E_{AC} = \sqrt{3} \times 240 \angle -90^\circ = 415.7 \angle -90^\circ$$

$$E_{CA} = \sqrt{3} \times 240 \angle 150^\circ = 415.7 \angle 150^\circ$$

$$b) \quad I_A = \frac{E_{AN}}{Z_A} = \frac{240 \angle 0^\circ}{20 \angle 0^\circ} = 12 \angle 0^\circ \text{ A}$$

$$I_B = \frac{E_{BN}}{Z_B} = \frac{240 \angle -120^\circ}{20 \angle 0^\circ} = 12 \angle -120^\circ \text{ A}$$

$$I_C = \frac{E_{CN}}{Z_C} = \frac{240 \angle 120^\circ}{20 \angle 0^\circ} = 12 \angle 120^\circ \text{ A}$$

$$c) \quad I_N = \bar{I}_A + \bar{I}_B + \bar{I}_C$$

$$= 12 \angle 0^\circ + 12 \angle -120^\circ + 12 \angle 120^\circ$$

$$= 12(\cos 0^\circ + j \sin 0^\circ) + 12[\cos(-120^\circ) + j \sin(-120^\circ)] + 12[\cos 120^\circ + j \sin 120^\circ]$$

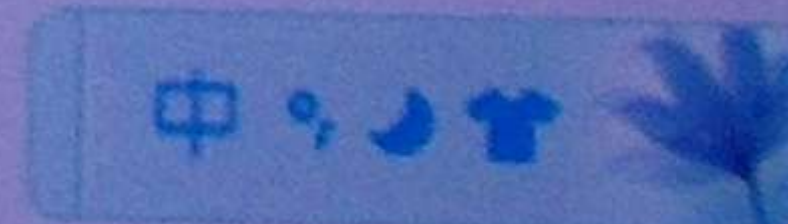
$$= 12(1 + 0) + 12(-0.5 - 0.87j) + 12(-0.5 + 0.87j)$$

$$= 12 - 6 - 6$$

$$= 0$$

Lany Li

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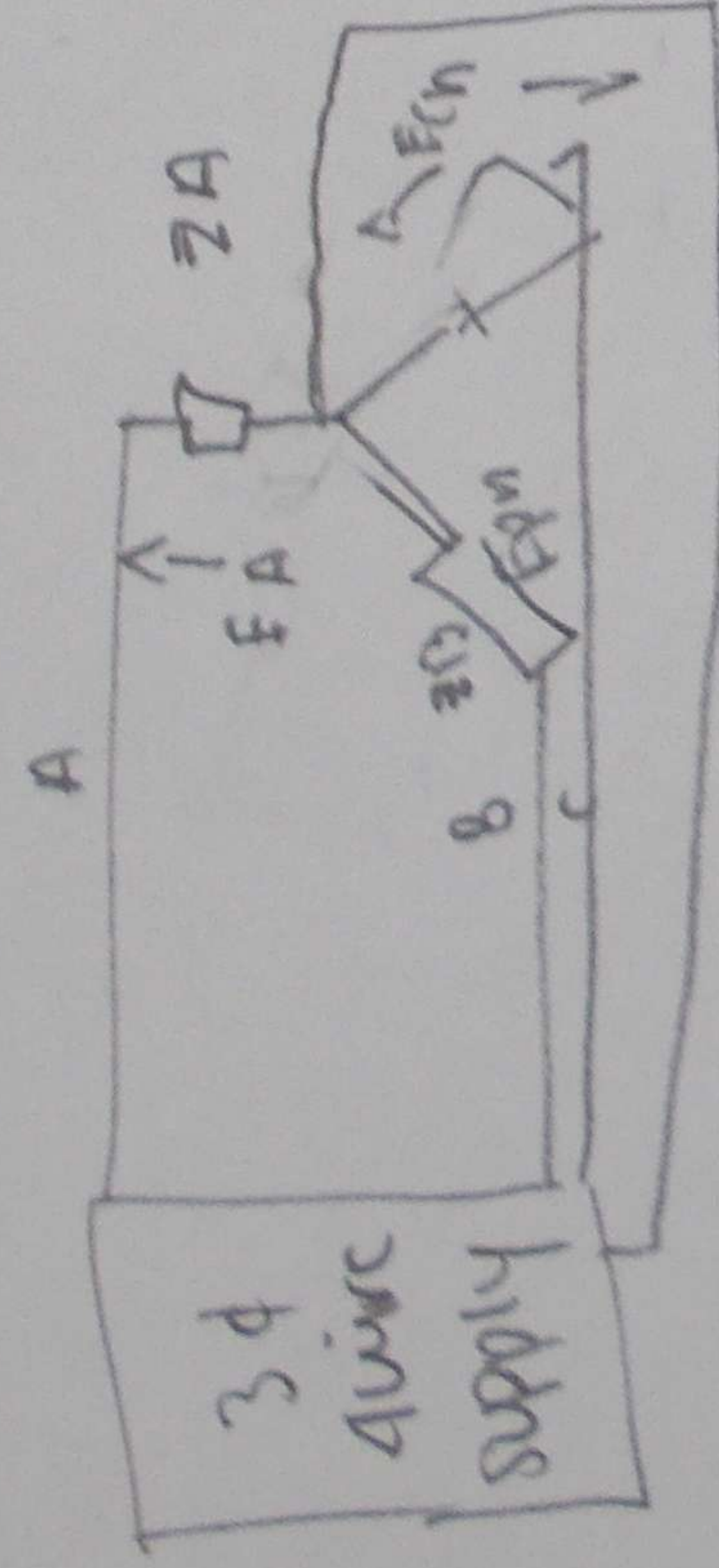
Exercise

A Balanced three phase star connected load consists of three 20Ω resistor connected via 3+4 wire load. Line to neutral voltage $240V$.

Calculate a) Line voltage in polar form

b) Line current in polar form

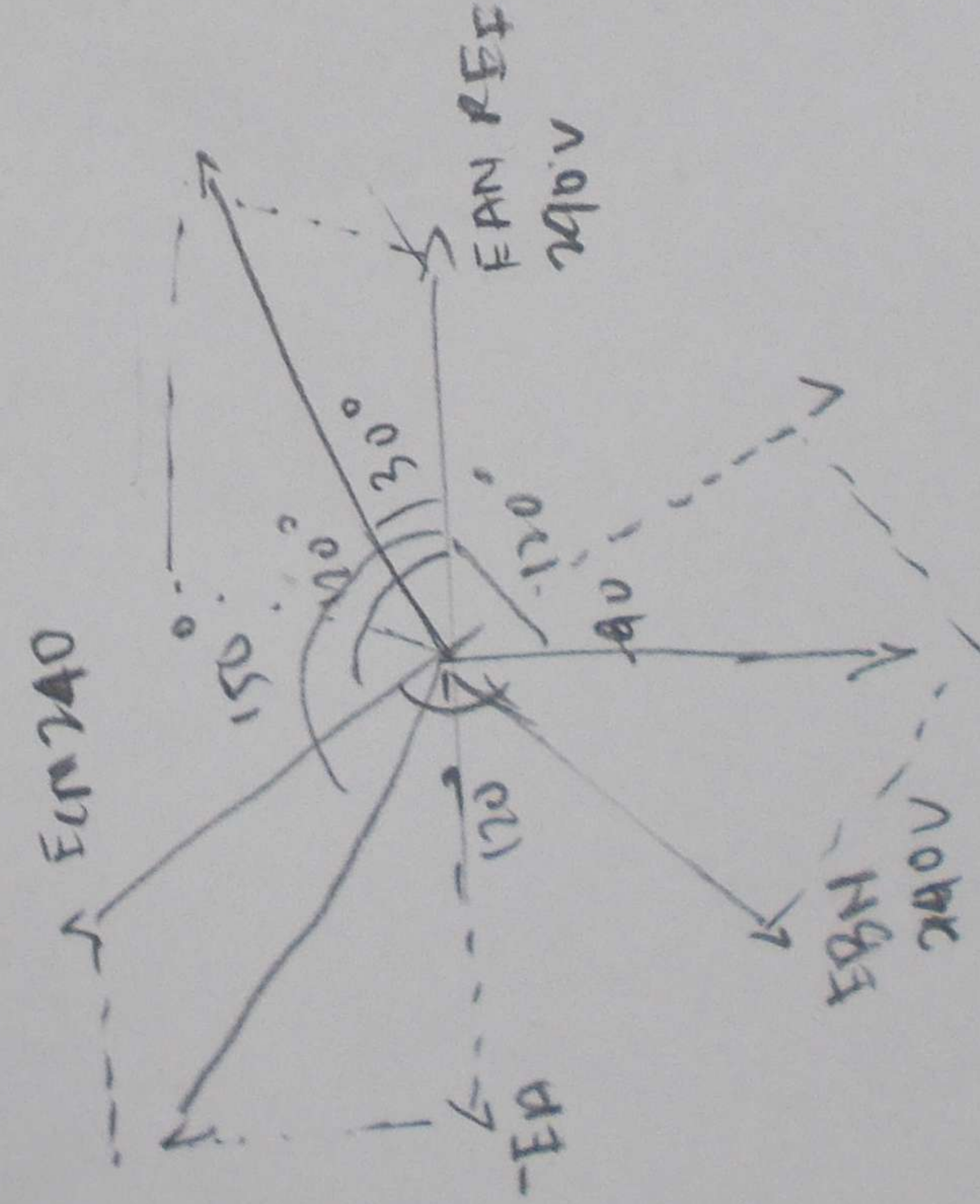
c) Neutral current.



$$\begin{aligned} E_{AN} &= 240V \\ E_{BN} &= 240V \\ E_{CN} &= 240V \\ E_{AN} &= 240 \angle 0^\circ \\ E_{BN} &= 240 \angle -120^\circ \\ E_{CN} &= 240 \angle -240^\circ \\ E_{CN} &= 240 \angle -240^\circ \end{aligned}$$

or

$$240 \angle +120^\circ$$



$$\begin{aligned} E_{AB} &= \sqrt{3} \times 240 \angle 30^\circ = 415.7 \angle 30^\circ \\ E_{BC} &= \sqrt{3} \times 240 \angle -90^\circ = 415.7 \angle -90^\circ \\ E_{CA} &= \sqrt{3} \times 240 \angle 150^\circ = 415.7 \angle 150^\circ \\ I_A &= I_B = I_C = 20A \end{aligned}$$

$$\begin{aligned} I_N &= I_A + I_B + I_C \\ &= 12 \angle 0^\circ + 12 \angle -120^\circ + 12 \angle 120^\circ \\ &= 12 (\cos 0^\circ + j \sin 0^\circ) + 12 (\cos(-120^\circ) + j \sin(-120^\circ)) + 12 (\cos 120^\circ + j \sin 120^\circ) \\ &= 12 (1 + j0) + 12 (-0.5 - j0.866) + 12 (-0.5 + j0.866) \\ &= 0 \end{aligned}$$

$$\begin{aligned} I_A &= I_{line} = \frac{E_{AN}}{Z_A} = \frac{240 \angle 0^\circ}{20 \angle 0^\circ} = 12 \angle 0^\circ \text{ Amp} \\ I_B &= \frac{E_{BN}}{Z_B} = \frac{240 \angle -120^\circ}{20 \angle 0^\circ} = 12 \angle -120^\circ \text{ Amp} \\ I_C &= \frac{E_{CN}}{Z_C} = \frac{240 \angle +120^\circ}{20 \angle 0^\circ} = 12 \angle +120^\circ \text{ Amp} \end{aligned}$$

Aliy.

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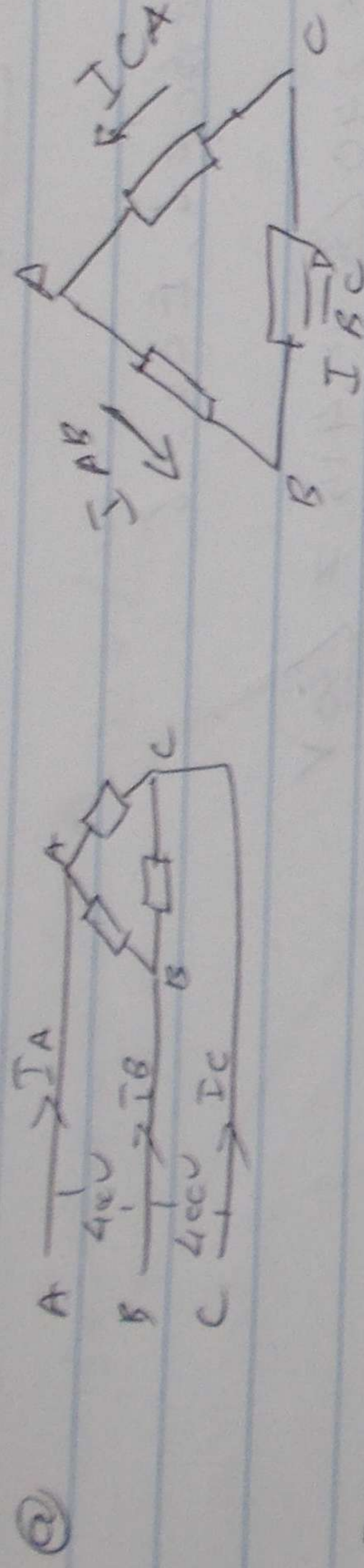
A, C

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$$E_{AB} = 400 \text{ V } \angle 0^\circ \quad \Delta \quad R = 10 \Omega / \text{phase}$$

$$E_{BC} = 400 \text{ V } \angle -120^\circ$$

$$E_{CA} = 400 \text{ V } \angle -240^\circ$$



$$I_{AB} = \frac{E_{AB}}{Z_{AB}} = \frac{400 \angle 0^\circ}{10 \angle 0^\circ} = 40 \angle 0^\circ \text{ A}$$

$$I_{BC} = \frac{E_{BC}}{Z_{BC}} = \frac{400 \angle -120^\circ}{10 \angle 0^\circ} = 40 \angle -120^\circ \text{ A}$$

$$I_{CA} = \frac{E_{CA}}{Z_{CA}} = \frac{400 \angle -240^\circ}{10 \angle 0^\circ} = 40 \angle -240^\circ \text{ A}$$

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

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

$$= 40 \angle 0^\circ - 40 \angle -240^\circ$$

$$= 40 + j0 - (-20 + j34.64)$$

$$= 40 + j0 + 20 - j34.64$$

$$= 60 - j34.64$$

$$= 69.28 \angle -30^\circ$$

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

$$= 40 \angle -120^\circ - 40 \angle 0^\circ$$

$$= -20 - j34.64 - 40$$

$$= -60 - j34.64$$

$$= 69.28 \angle -150^\circ$$

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

$$= 40 \angle -240^\circ - 40 \angle -120^\circ$$

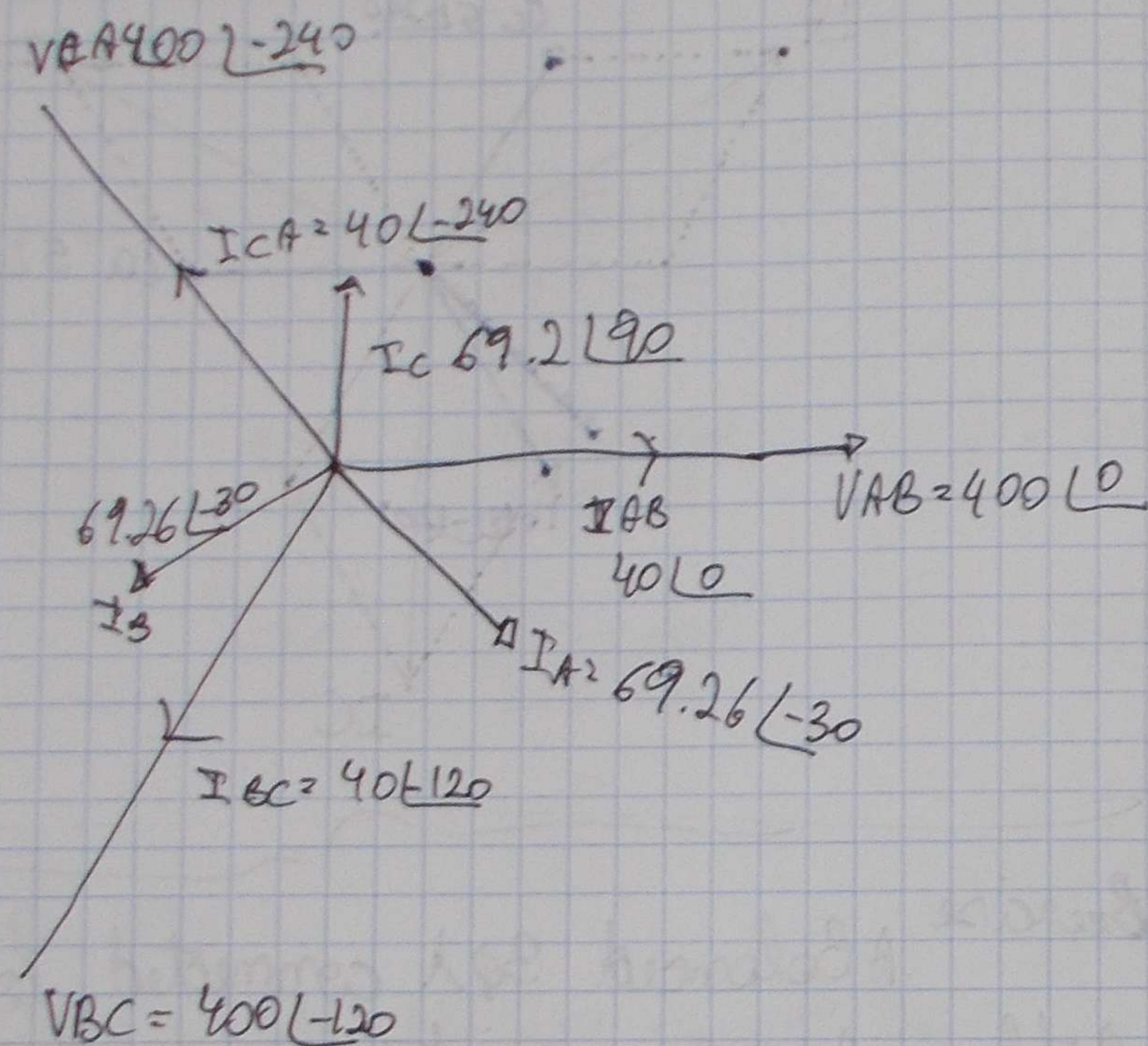
$$= -20 + j34.64 - (-20 - j34.64)$$

$$= -20 + j34.64 + 20 + j34.64$$

$$= 0 + j69.28$$

$$= 69.28 \angle 90^\circ$$

c)



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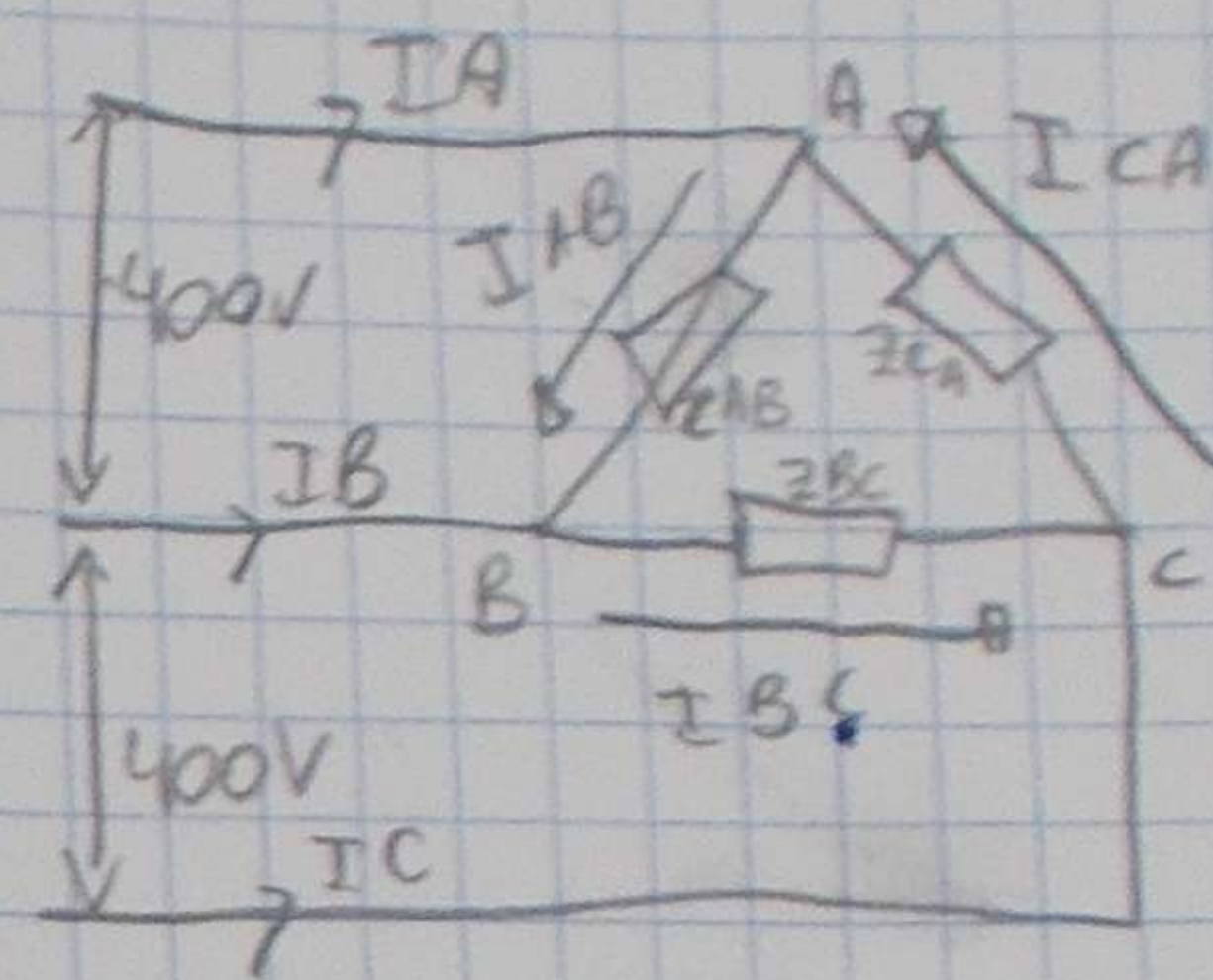
Exercise

Balanced Δ load $R = 10 \Omega / \phi$, supply $V = 400V$

find a) all phase current in polar form

b) all line I

c) phasor diagram



$$\begin{aligned} E_{AB} &= 400 \angle 0^\circ \\ E_{BC} &= 400 \angle -120^\circ \\ E_{CA} &= 400 \angle -240^\circ \end{aligned}$$

$$a) I_{AB} = \frac{E_{AB}}{Z_{AB}} = \frac{400 \angle 0^\circ}{10 \angle 0^\circ}$$

$$I_{AB} = 40 \angle 0^\circ \quad 40 + j0$$

$$I_{BC} = \frac{E_{BC}}{Z_{BC}} = \frac{400 \angle -120^\circ}{10 \angle 0^\circ}$$

$$I_{BC} = 40 \angle -120^\circ \quad -20 - j34.6$$

$$I_{CA} = \frac{E_{CA}}{Z_{CA}} = \frac{400 \angle -240^\circ}{10 \angle 0^\circ}$$

$$I_{CA} = 40 \angle -240^\circ \quad -20 + j34.6$$

b) PT $\oplus$ flow in = flow out

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

$\oplus$

$$I_A = 40 \angle 0^\circ - 40 \angle -240^\circ$$

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

$$I_B = 40 \angle -120^\circ - 40 \angle 0^\circ$$

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

$$I_C = 40 \angle -240^\circ - 40 \angle -120^\circ$$

convert to rectangular

$$40 - (-20 + j34.6) \\ 60 - j34.6$$

$$\sqrt{60^2 + 34.6^2} \angle \tan^{-1} \frac{34.6}{60}$$

$$I_A = 69.26 \angle -30^\circ$$

$$I_B = (-20 - j34.6) - (40) \\ -60 - j34.6$$

$$\sqrt{60^2 + 34.6^2} \angle \tan^{-1} \frac{34.6}{60}$$

$$I_B = 69.26 \angle -150^\circ$$

$$I_C = (-20 + j34.6) - (-20 - j34.6) \\ 0 + j69.2$$

$$\sqrt{69.2^2} \angle \tan^{-1} \frac{69.2}{0}$$

$$I_C = 69.2 \angle 90^\circ$$

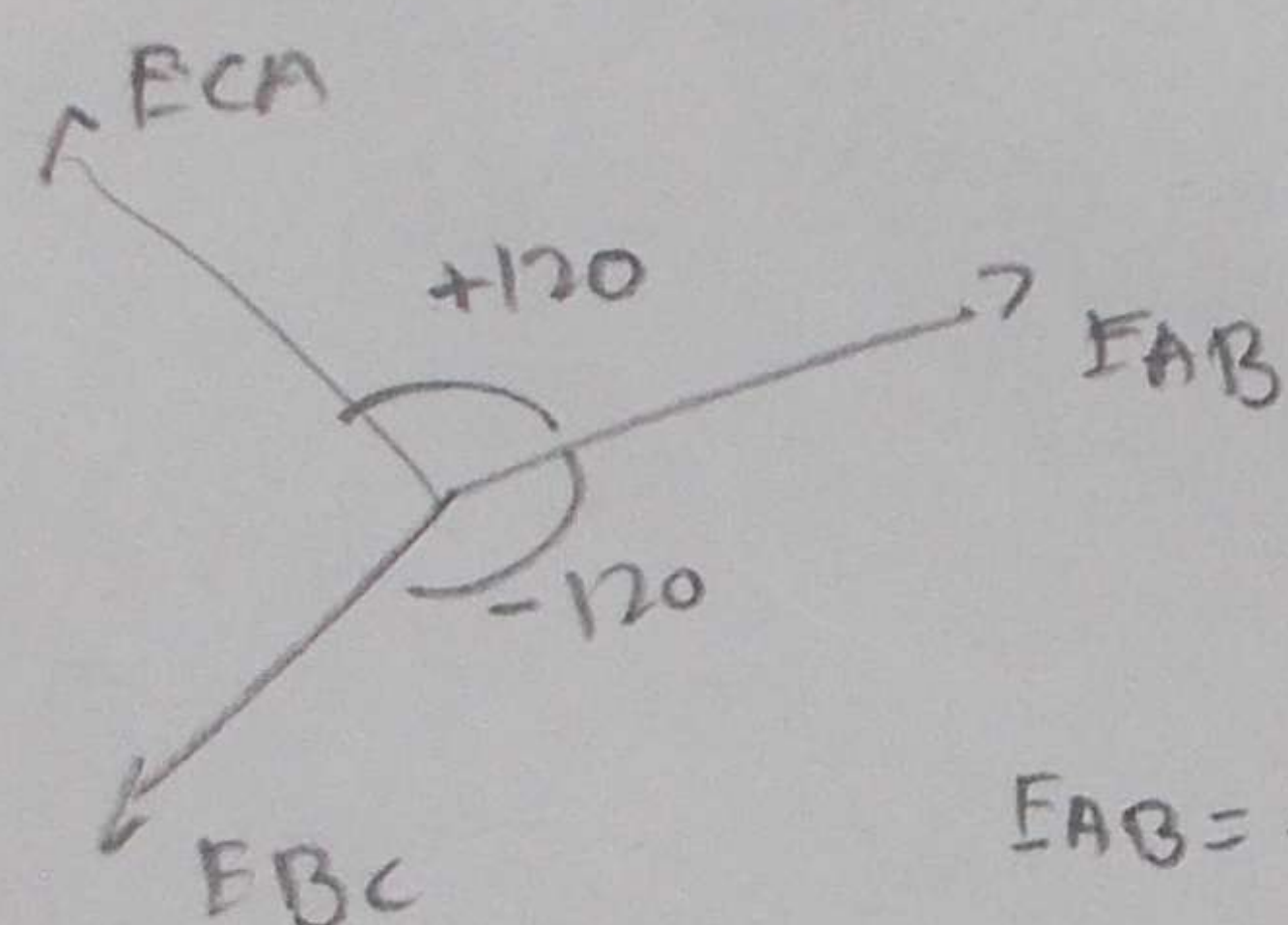
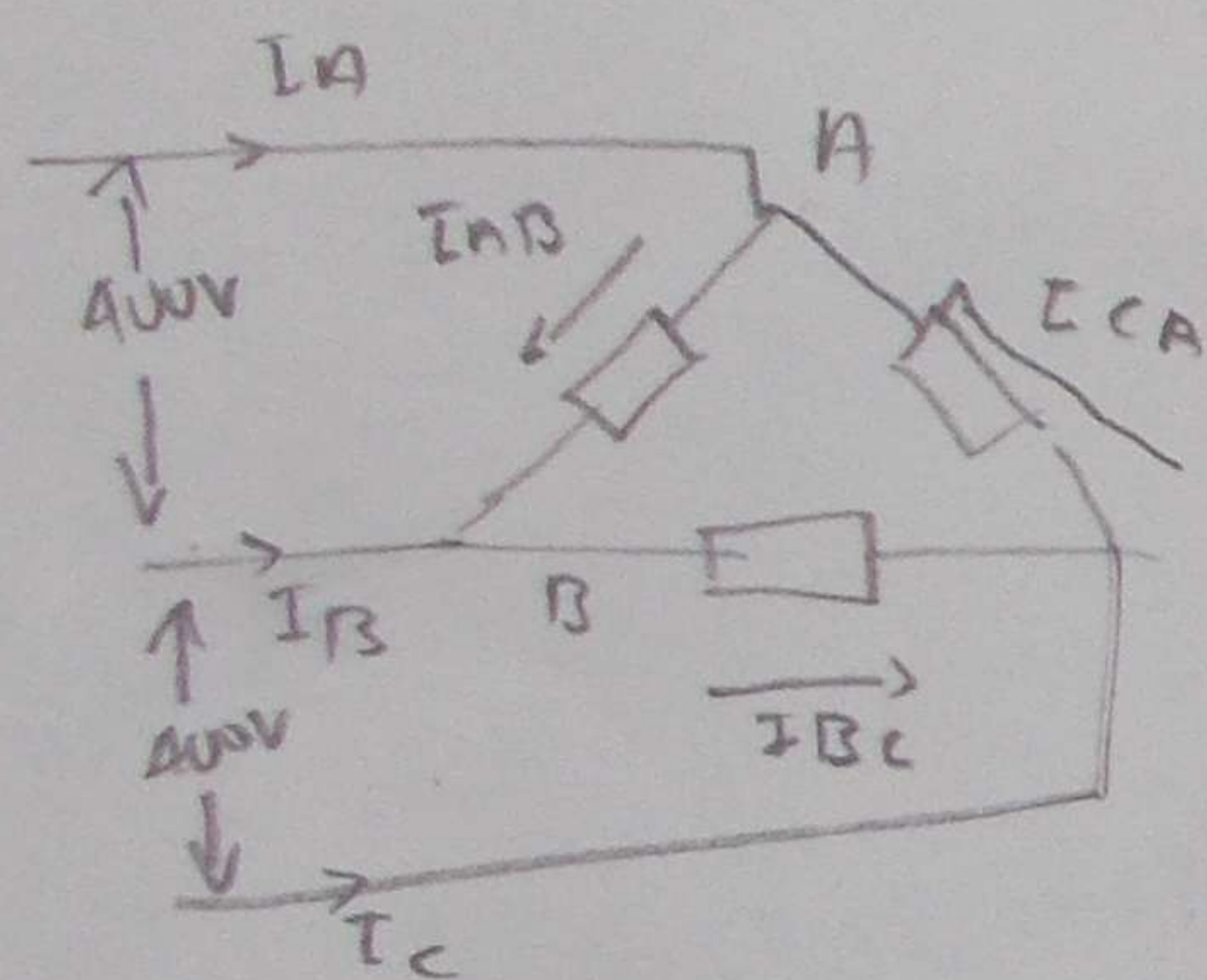
Exercise

A balanced delta load $Z = 10\Omega/\text{phase}$ is connected to 3 ϕ Balanced supply
400V rms line

calculate a) All phase currents in polar form

b) All line currents in polar form

c) Draw the phasor diagram



$$\begin{aligned} E_{AB} &= 400\angle 0^\circ \text{ V} \\ E_{BC} &= 400\angle -120^\circ \text{ V} \\ E_{CA} &= 400\angle +120^\circ \text{ V} \end{aligned}$$

$$I_{AB} = \frac{E_{AB}}{Z_{AB}} = \frac{400\angle 0^\circ}{10\angle 0^\circ} = 40\angle 0^\circ \text{ A}$$

$$I_{BC} = \frac{E_{BC}}{Z_{BC}} = \frac{400\angle -120^\circ}{10\angle 0^\circ} = 40\angle -120^\circ \text{ A}$$

$$I_{CA} = \frac{E_{CA}}{Z_{CA}} = \frac{400\angle +120^\circ}{10\angle 0^\circ} = 40\angle +120^\circ \text{ A}$$

PT(A) Flow in = Flow out

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

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

$$= 40\angle 0^\circ - 40\angle +120^\circ$$

$$= 40(\cos 0 + j\sin 0) - 40(\cos 120 + j\sin 120)$$

$$I_A = 69.36\angle -30^\circ$$

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PT(B) Flow in = Flow out

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

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

$$= 40\angle -120^\circ - 40\angle 0^\circ$$

$$= 40(\cos(-120) + j\sin(-120)) - 40(\cos 0 + j\sin 0)$$

$$I_B = 69.36\angle -150^\circ$$

PT(C) Flow in = Flow out

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

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

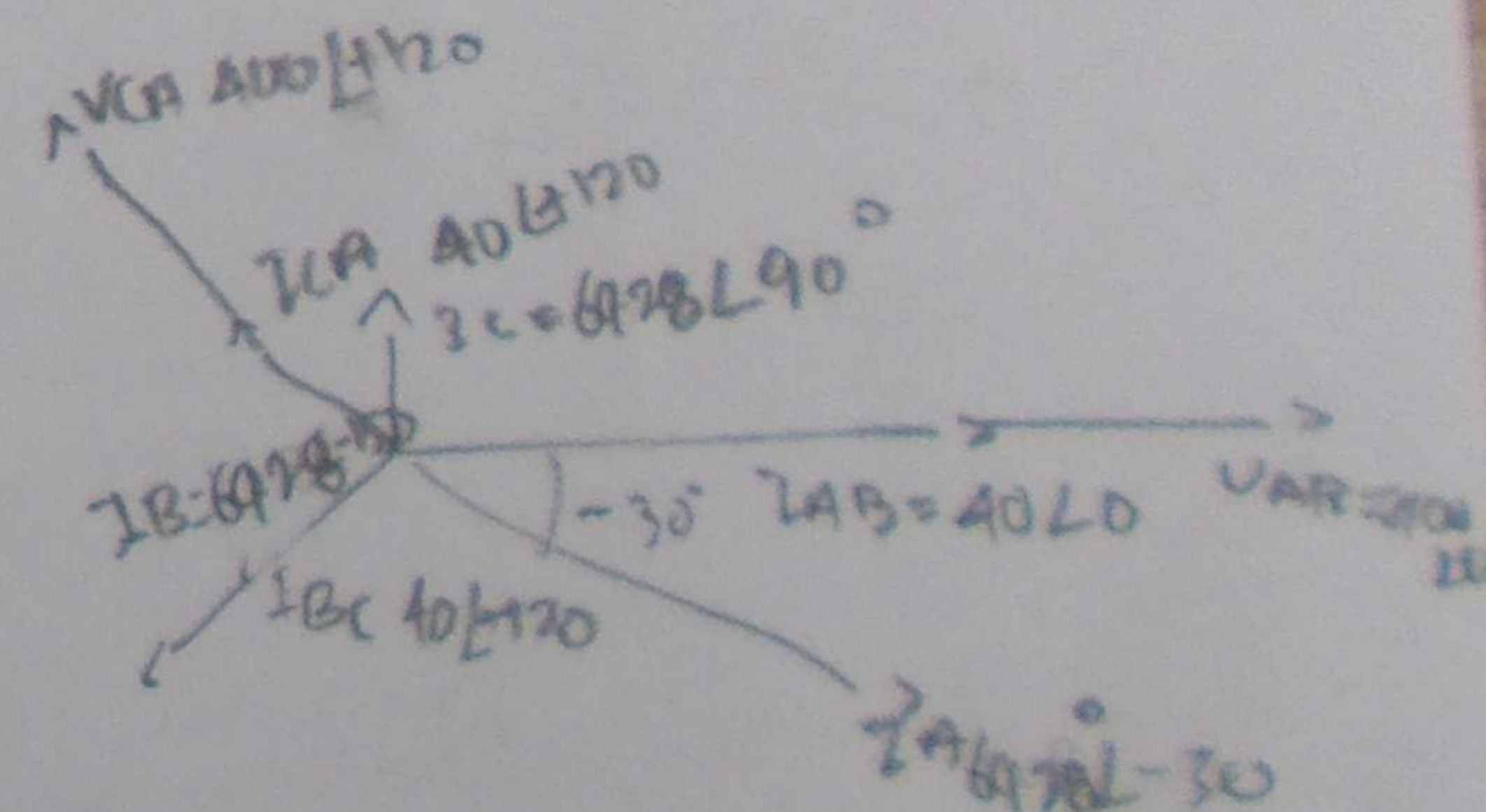
$$= 40\angle +120^\circ - 40\angle -120^\circ$$

$$= 40(\cos 120 + j\sin 120) - 40(\cos(-120) + j\sin(-120))$$

$$= 69.28\angle 90^\circ$$

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Xij



$$E_{AB} = 400 \angle 0^\circ \text{ V}$$

$$E_{BC} = 400 \angle -120^\circ \text{ V}$$

$$E_{CA} = 400 \angle 120^\circ \text{ V}$$

$$I_{AB} = \frac{400 \angle 0^\circ}{10 \angle 0^\circ} = 40 \angle 0^\circ \text{ A}$$

$$I_{BC} = \frac{400 \angle -120^\circ}{10 \angle 0^\circ} = 40 \angle -120^\circ \text{ A}$$

$$I_{CA} = \frac{400 \angle 120^\circ}{10 \angle 0^\circ} = 40 \angle 120^\circ \text{ A}$$

Long Li

8:29 378.1

a) Flow in = Flow out

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

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

$$= 40 \angle 0^\circ - 40 \angle 120^\circ$$

$$= 40 (\cos 0 + j \sin 0) - 40 (\cos 120 + j \sin 120)$$

$$= 40 (1 + j0) - 40 (-0.5 + 0.87j)$$

$$= 40 + 20 - 34.8j$$

$$= 60 - 34.8j$$

$$I_A = \sqrt{60^2 + 34.8^2} \angle -\tan^{-1} \frac{34.8}{60}$$

$$= 69.36 \angle -30.1^\circ$$

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

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

$$= 40 \angle -120^\circ - 40 \angle 0^\circ$$

$$= 40 [\cos(-120) + j \sin(-120)] - 40$$

$$= 40 (-0.5 - 0.87j) - 40$$

$$= -60 - 34.8j$$

$$I_B = \sqrt{60^2 + 34.8^2} \angle -(180 + \tan^{-1} \frac{34.8}{60})$$

$$= 69.36 \angle -150^\circ$$

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

$$= 40 \angle 120^\circ - 40 \angle -120^\circ$$

$$= 40 (-0.5 + 0.87j) - [40 (-0.5 - 0.87j)]$$

$$= -20 + 34.8j - [-20 - 34.8j]$$

$$= 69.2 \angle 90^\circ$$