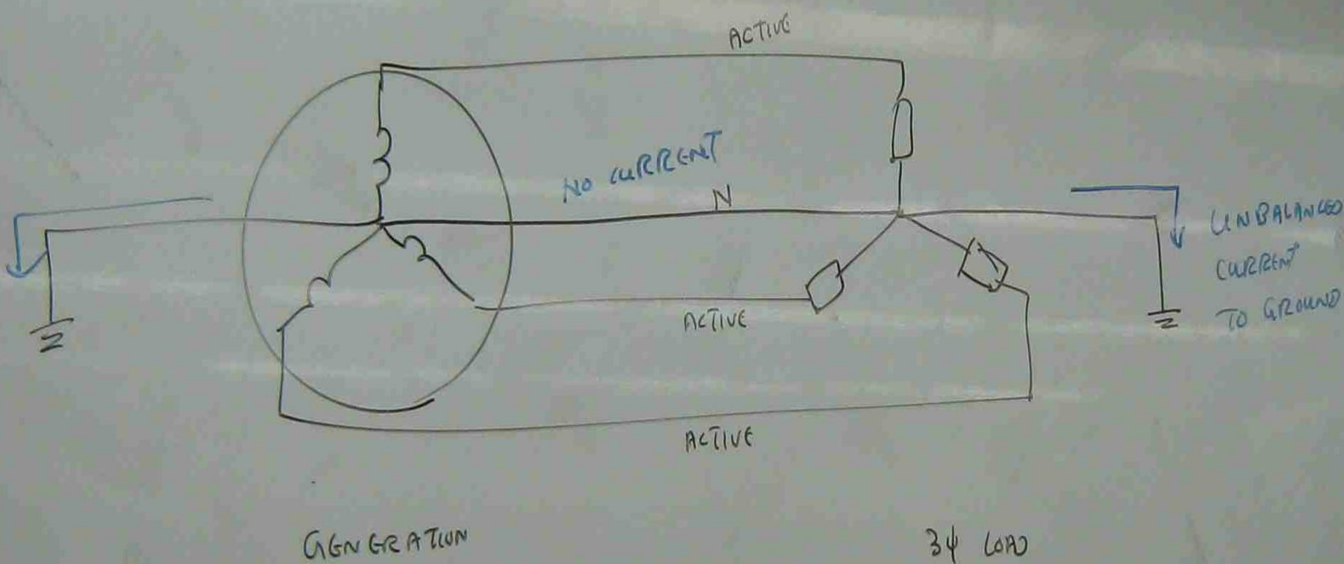
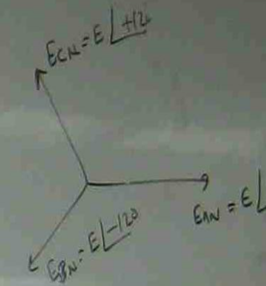
3ϕ 4WIRE ⅄ UNBALANCED LOAD





$$E_{AN} = \frac{E_{LINE}}{\sqrt{3}}$$

$$I_A = \frac{E_{AN}}{Z_A} = \frac{E\angle 0}{Z_A\angle\phi_A}$$

$$E_{BN} = \frac{E_{LINE}}{\sqrt{3}} =$$

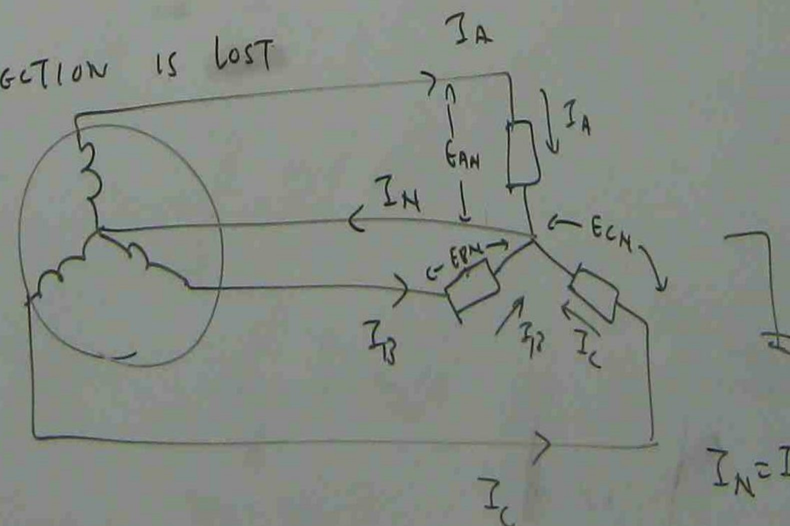
$$I_B = \frac{E_{BN}}{Z_B} = \frac{E\angle{-120}}{Z_B\angle\phi_B}$$

$$E_{CN} = \frac{E_{LINE}}{\sqrt{3}}$$

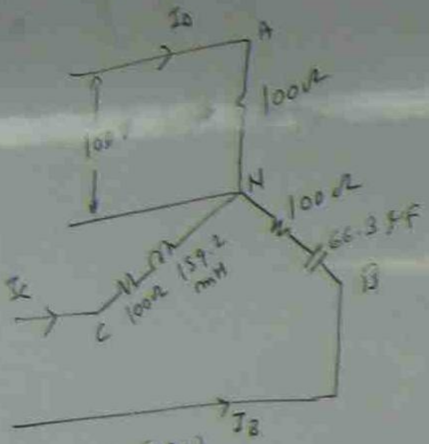
$$I_C = \frac{E_{CN}}{Z_C} = \frac{E\angle{+120}}{Z_C\angle\phi_C}$$

IF GROUND CONNECTION IS LOST

NEUTRAL WILL CARRY CURRENT.



$$I_N = I_A + I_B + I_C$$



SEQUENCE (ABC)

FIND LINE CURRENTS & NEUTRAL CURRENT.

$Z_A = 100\ \Omega$

$Z_B = 100 - jX_C \qquad X_C = \dfrac{1}{2\pi fC}$

$= 100 - j\dfrac{1}{2\pi fC}$

$= 100 - j\dfrac{1}{2\times 3.1416\times 50\times 66.3\times 10^{-6}}$

$= 100 - j\dfrac{10^{6}}{2\times 3.1416\times 50\times 66.3}$

$Z_B = 100 - j48\ \Omega = \sqrt{100^2+48^2}\ \angle -\tan^{-1}\dfrac{48}{100}$

$= 111\ \angle -26.5^\circ\ \Omega$

$X_L = 2\pi fL$

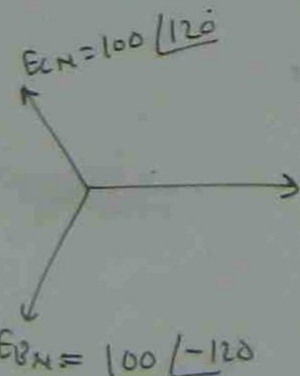
$Z_C = 100 + jX_L$

$= 100 + j2\pi fL$

$= 100 + j\,2\times 3.1416\times 50\times 159.2\times 10^{-3}$

$= 100 + j50 = \sqrt{100^2+50^2}\ \angle \tan^{-1}\dfrac{50}{100}$

$= 111.8\ \angle 26.5^\circ\ \Omega$



$I_A = \dfrac{E_{AN}}{Z_A} = \dfrac{100\angle 0}{100} = 1\angle 0\ \text{A}$

$$I_B = \frac{E_{BN}}{Z_B} = \frac{100\angle -120}{111\angle -25.6} = 0.929\angle -120-(-25.6)$$

$$= 0.929\angle -120+25.6$$

$$I_B = 0.929\angle -94.4 \text{ A}$$

$$I_C = \frac{E_{CN}}{Z_C} = \frac{100\angle 120}{111.8\angle 26.5}$$

$$= 0.894\angle 120-26.5$$

$$I_C = 0.894\angle 93.5$$

$$I_N = I_A + I_B + I_C$$

$$= 1\angle 0 + 0.929\angle -94.4 + 0.894\angle 93.5$$

$$= 1 + 0.929(\cos(-94.4) + j\sin(-94.4))$$

$$+ 0.894(\cos 93.5 + j\sin 93.5)$$

$$= 1 - 0.0684 - j0.891 - 0.053 + j0.8922$$

$$= 0.878 + j0.0012$$

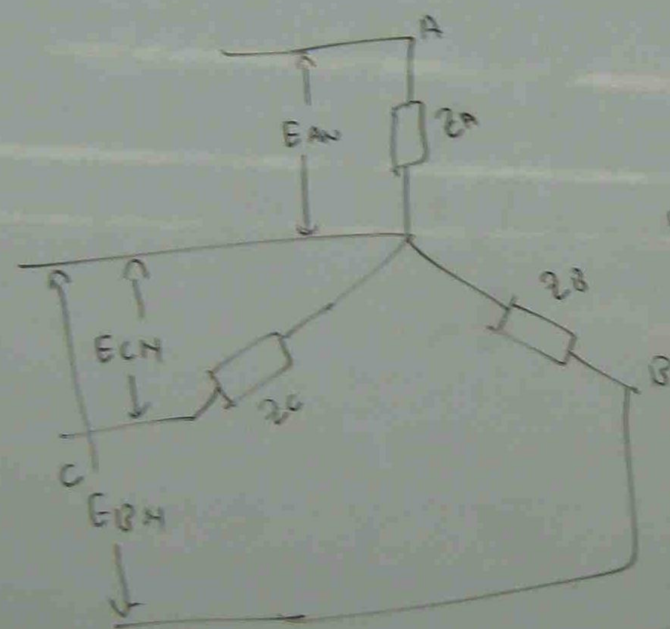
$$= \sqrt{0.878^2 + 0.0012^2}\angle \tan^{-1}\frac{0.0012}{0.878}$$

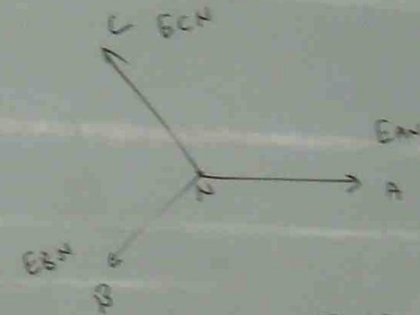
$$I_N = 0.878\angle 0.078 \text{ A}$$

BREAKING OF NEUTRAL WIRE IN 3φ 4WIRE SYSTEM

THE SYSTEM BECOMES 3φ 3WIRE UNBALANCED.

3φ
4WIRE





STAR POINT IS
ALSO NEUTRAL
POINT

(3φ 4WIRE) BALANCE
UNBALANCE

PHASE VOLTAGE
FOLLOWS

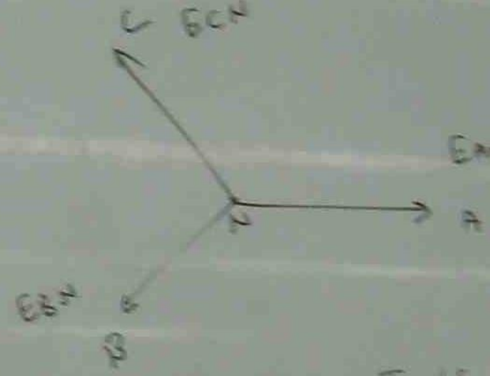
$$E_{AN} = \frac{E\text{-}LINE}{\sqrt{3}}$$

$$E_{BN} = \frac{E\ LINE}{\sqrt{3}}$$

$$E_{CN} = \frac{E\ LINE}{\sqrt{3}}$$

WIRE SYSTEM

LANCES.



STAR POINT IS ALSO NEUTRAL POINT

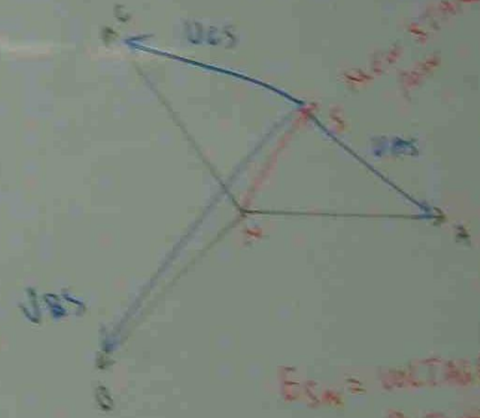
B

(3φ 4WIRE) BALANCE / UNBALANCE

PHASE VOLTAGE FOLLOWS

IF NEUTRAL WIRE BROKEN

STAR POINT POSITION CHANGES



E_{SN} = VOLTAGE BETWEEN NEW STAR POINT & ORIGINAL NEUTRAL POINT

IN NEW DIAGRAM,

$E_{BS} > E_{BN}$

OVER VOLTAGE OCCURS.

$E_{SN} = E_{AN} - E_{AS}$

$E_{SN} = E_{BN} - E_{BS}$

$E_{SN} = E_{CN} - E_{CS}$

$E_{AS} = I_A \times Z_A$

AT UNBALANCED LOAD

$E_{BS} = I_B \times Z_B$

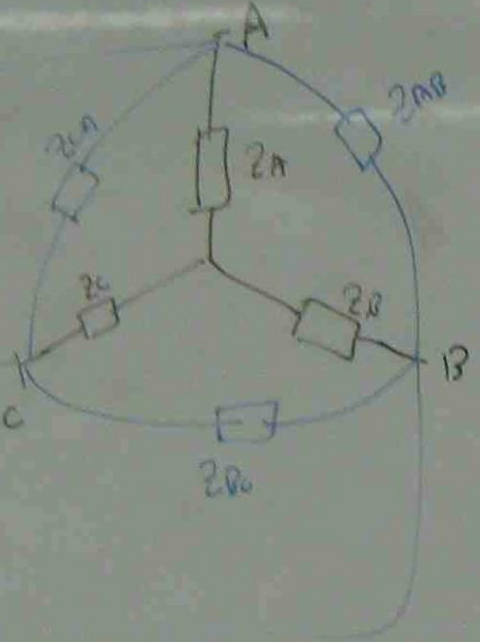
AT UNBALANCED LOAD

$E_{CS} = I_C \times Z_C$

AT UNBALANCED LOAD

TO CALCULATE I_A, I_B, I_C AT 3ϕ 3WIRE UNBALANCED CONDITION, λ LOAD IS TO BE CONVERTED TO Δ.

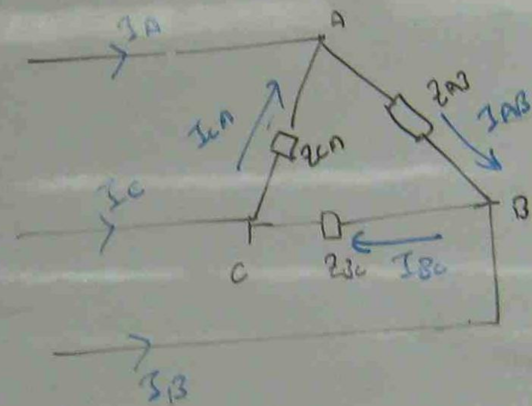
THEN FIND Δ UNBALANCED LINE CURRENTS.



$$Z_{AB} = \frac{Z_A Z_B + Z_B Z_C + Z_C Z_A}{Z_C}$$

$$Z_{BC} = \frac{Z_A Z_B + Z_B Z_C + Z_C Z_A}{Z_A}$$

$$Z_{CA} = \frac{Z_A Z_B + Z_B Z_C + Z_C Z_A}{Z_B}$$



SEQUENCE

A B C

$A \rightarrow B \rightarrow C$

$$I_{AB} = \frac{V_{AB}}{Z_{AB}}$$

$$I_{BC} = \frac{V_{BC}}{Z_{BC}}$$

$$I_{CA} = \frac{V_{CA}}{Z_{CA}}$$

AT (A)

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

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

AT (B)

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

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

AT (C)

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

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

$E_{AS} = I_A Z_A$, $E_{BS} = I_B Z_B$,
$E_{CS} = I_C Z_C$

$$E_{SN} = E_{AN} - E_{AS}$$

(OR)

$$E_{BN} - E_{BS}$$

(OR)

$$E_{CN} - E_{CS}$$

ph

A 3ϕ 200V SYSTEM'S NEUTRAL WIRE IS BROKEN.

THE FOLLOWING LINE CURRENTS ARE FLOWING

$Z_A = 50\angle 0^\circ\ \Omega$, $I_A = 1.55\angle -8.5^\circ$ Amp.

$Z_B = 50\angle 0^\circ\ \Omega$ $I_B = 2.47\angle -176.4^\circ$ Amp

$Z_C = 158\angle 71.6^\circ\ \Omega$ $I_C = 1.03\angle 26.88^\circ$ Amp.

(i) WHAT ARE THE NEW PHASE VOLTAGE?

(ii) WHAT IS THE VOLTAGE BETWEEN NEW STAR POINT & ORIGINAL POINT

(iii) WHICH PHASE GOT OVER VOLTAGE?

$$\text{NORMAL PHASE VOLTAGE} = \frac{E\text{-LINE}}{\sqrt{3}} = \frac{200}{1.7321}$$

$$= 115\ V$$

$$E_{AS} = I_A Z_A = 1.55\angle{-8.5} \times 50\angle{0} = 1.55 \times 50\angle{-8.5+0}$$
$$= 77.5\angle{-8.5} \text{ V}$$

$$E_{BS} = I_B Z_B = 2.47\angle{-176.4} \times 50\angle{0}$$
$$= 2.47 \times 50\angle{-176.4+0}$$
$$= 123\angle{-176.4} \text{ V}$$

$$E_{CS} = I_C Z_C = 1.03\angle{26.88} \times 158\angle{71.6}$$
$$= 1.03 \times 158\angle{26.88+71.6}$$
$$= 162.5\angle{98.7} \text{ V}$$

$$E_{SN} = E_{AN} - E_{AS}$$
$$= 115\angle{0} - 77.5\angle{-8.5}$$
$$= 115 - 77.5(\cos 8.5 - j\sin 8.5)$$
$$=$$

A 3ϕ 200V system's neutral wire is broken.

The following line currents are flowing

$Z_A = 50\angle 0°\ \Omega$, $I_A = 1.55\angle -8.5$ Amp.

$Z_B = 50\angle 0°\ \Omega$ $I_B = 2.47\angle -176.4°$ Amp

$Z_C = 158\angle 71.6\ \Omega$ $I_C = 1.03\angle 26.88°$ Amp.

(W)hat are the new phase voltage?

What is the voltage between new star point & original point

) which phase got over voltage?

$$\text{Normal phase voltage} = \frac{E\text{-line}}{\sqrt{3}} = \frac{200}{1.7321}$$

$$= 115\ V$$

$$E_{AS} = I_A Z_A = 1.55\angle -8.5 \times 50\angle 0 = 1.55 \times 50\angle -8.5+0$$

$$= 77.5\angle -8.5\ V$$

$$E_{BS} = I_B Z_B = 2.47\angle -176.4 \times 50\angle 0$$

$$= 2.47 \times 50\angle -176.4+0$$

$$= 123\angle -176.4\ V$$

$$E_{CS} = I_C Z_C = 1.03\angle 26.88 \times 158\angle 71.6$$

$$= 1.03 \times 158\angle 26.88+71.6$$

$$= 162.5\angle 98.7\ V$$

$$E_{SN} = E_{AN} - E_{AS}$$

$$= 115\angle 0 - 77.5\angle -8.5$$

$$= 115 - 77.5(\cos 8.5 - j\sin 8.5)$$

$$=$$

Ph A 3ϕ 200V system's neutral wire is broken.

The following line currents are flowing

$Z_A = 50\angle 0^\circ\ \Omega$, $\quad I_A = 1.55\angle -8.5^\circ$ Amp.

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$Z_C = 158\angle 71.6^\circ\ \Omega$ $\quad I_C = 1.03\angle 26.88^\circ$ Amp.

(i) What are the new phase voltage?

(ii) What is the voltage between new star point & original point

(iii) Which phase got over voltage?

$$\text{Normal phase voltage} = \frac{E_{LINE}}{\sqrt{3}} = \frac{200}{1.7321}$$

$$= 115\ V$$

$$E_{AS} = I_A Z_A = 1.55\angle -8.5 \times 50\angle 0 = 1.55 \times 50^\circ \angle -8.5 + 0$$

$$= 77.5\angle -8.5\ V$$

$$E_{BS} = I_B Z_B = 2.47\angle -176.4 \times 50\angle 0$$

$$= 2.47 \times 50\angle -176.4 + 0$$

$$= 123\angle -176.4\ V$$

$$E_{CS} = I_C Z_C = 1.03\angle 26.88 \times 158\angle 71.6$$

$$= 1.03 \times 158\angle 26.88 + 71.6$$

$$= 162.5\angle 98.7\ V$$

$$E_{SN} = E_{AN} - E_{AS}$$

$$= 115\angle 0 - 77.5\angle -8.5$$

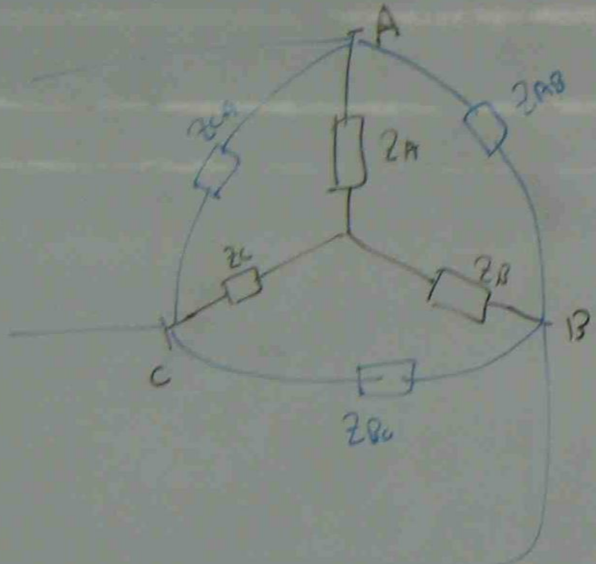
$$= 115 - 77.5(\cos 8.5 - j\sin 8.5)$$

$$=$$

25.6)

TO CALCULATE I_A, I_B, I_C AT 3ϕ 3WIRE UNBALANCED CONDITION, λ LOAD IS TO BE CONVERTED TO Δ.

THEN FIND Δ UNBALANCED LINE CURRENTS.



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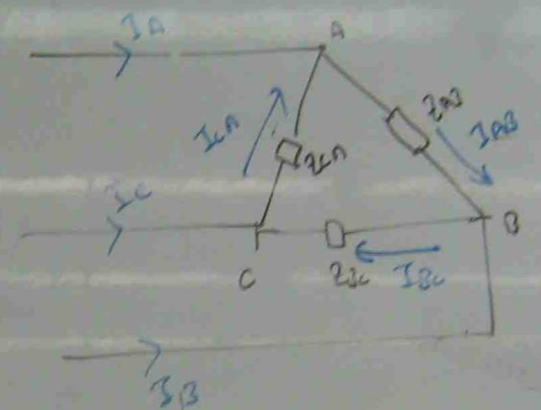
$$Z_{BC} = \frac{Z_A Z_B + Z_B Z_C + Z_C Z_A}{Z_A}$$

$$Z_{CA} = \frac{Z_A Z_B + Z_B Z_C + Z_C Z_A}{Z_B}$$



SEQUENCE

ABC

$A \longrightarrow B \longrightarrow C$

AT (A) $I_A + I_{CA} = I_{AB}$

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

AT (B) $I_B + I_{AB} = I_{BC}$

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

AT (C) $I_C + I_{BC} = I_{CA}$

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

$$I_{AB} = \frac{V_{AB}}{Z_{AB}}$$

$$I_{BC} = \frac{V_{BC}}{Z_{BC}}$$

$$I_{CA} = \frac{V_{CA}}{Z_{CA}}$$

$E_{AS} = I_A Z_A$ $E_{BS} = I_B Z_B$

$E_{CS} = I_C Z_C$

$E_{SN} = E_{AN} - E_{AS}$

(OR)

$E_{BN} - E_{BS}$

(OR)

$E_{CN} - E_{CS}$