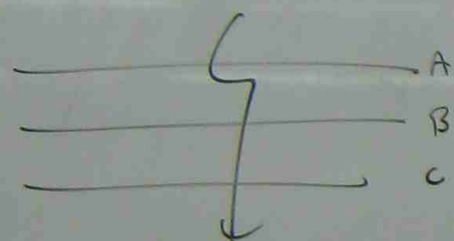
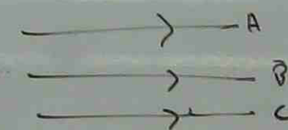
REASON TO DIVIDE POSITIVE, NEGATIVE AND ZERO SEQUENCE COMPONENTS

BALANCED 3ϕ SHORT CIRCUIT



NORMAL



THERE IS ONLY POSITIVE SEQUENCE COMPONENT

$I_{A_1}, I_{B_1}, I_{C_1}$

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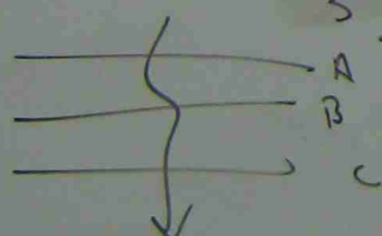
3 LINES TO GROUND



THERE IS ONLY ZERO SEQUENCE COMPONENT

$I_{A_0}, I_{B_0}, I_{C_0}$

Ph → Ph

2L → G

COMPOSE +IVE, −IVE & ZERO

SEQUENCE COMPONENTS

I_{A1}, I_{B1}, I_{C1}, I_{A2}, I_{B2}, I_{C2}, I_{A0}, I_{B0}, I_{C0}

Z_0 = ZERO SEQUENCE IMPEDANCE

Z_1 = +IVE SEQUENCE IMPEDANCE

Z_2 = −IVE SEQUENCE IMPEDANCE

H.V EQUIPMENT

OVER HEAD

STATIC DEVICE

TRANSFORMER
O.H LINE
CABLE
REACTOR

$Z_1 = Z_2$

ROTATING MACHINE

GENERATOR , MOTOR

$Z_1 \neq Z_2$

Z_0 EXISTS WHEN THE DEVICE IS CONNECTED TO EARTH

POSITIVE, NEGATIVE AND ZERO SEQUENCE EQUIVALENT DIAGRAMS

$$I_A = I_A^{+} + I_A^{-} + I_A^{0}$$

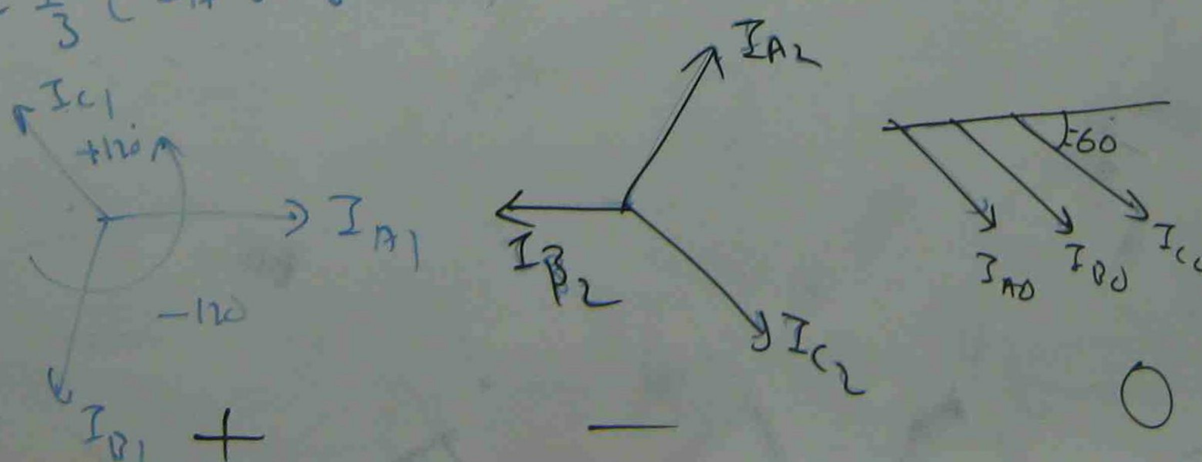
$$I_B = I_B^{+} + I_B^{-} + I_B^{0}$$

$$I_C = I_C^{+} + I_C^{-} + I_C^{0}$$

$$I_{A_1} = \frac{1}{3}\left(I_A + a I_B + a^2 I_C\right) \rightarrow I_{B_1} = \angle \theta_A - 120 \,,\quad I_{C_1} = \angle \theta_A + 120$$

$$I_{A_2} = \frac{1}{3}\left(I_A + a^2 I_B + a I_C\right) \rightarrow I_{B_2} = \angle \theta_A + 120 \quad I_{C_2} = \angle \theta_A - 120$$

$$I_{A_0} = \frac{1}{3}\left(I_A + I_B + I_C\right)$$



POSITIVE, NEGATIVE AND ZERO SEQUENCE EQUIVALENT DIAGRAMS

$$I_A = I_A^{+} + I_A^{-} + I_A^{0}$$

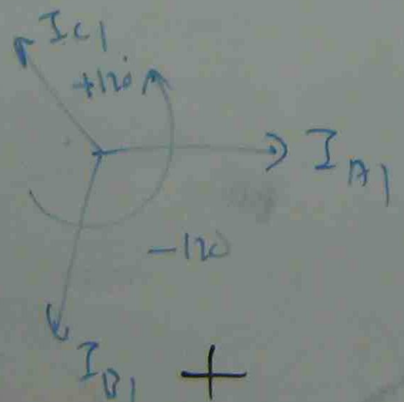
$$I_B = I_B^{+} + I_B^{-} + I_B^{0}$$

$$I_C = I_C^{+} + I_C^{-} + I_C^{0}$$

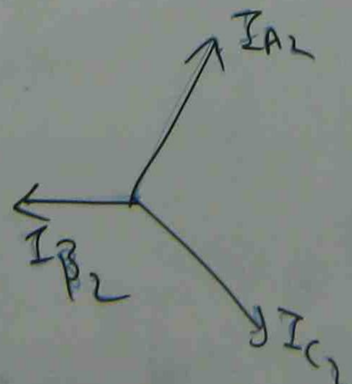
$$I_{A_1} = \frac{1}{3}\left(I_A + a I_B + a^2 I_C\right) \rightarrow I_{B_1} = \angle \theta_A - 120 \quad , \quad I_{C_1} = \angle \theta_A + 120$$

$$I_{A_2} = \frac{1}{3}\left(I_A + a^2 I_B + a I_C\right) \rightarrow I_{B_2} = \angle \theta_A + 120 \quad I_{C_2} = \angle \theta_A - 120$$

$$I_{A_0} = \frac{1}{3}\left(I_A + I_B + I_C\right)$$



+



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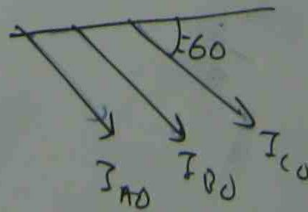
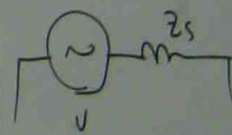


O

NOTE(1)

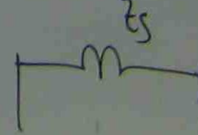
POSITIVE SEQUENCE DIAGRAM

ALL GENERATORS – VOLTAGE SOURCES, THE VOLTAGE AND IMPEDANCES ARE TO BE INCLUDED.

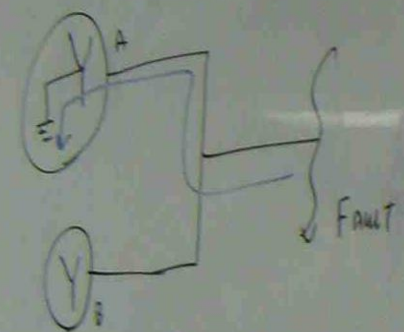


NEGATIVE SEQUENCE DIAGRAM

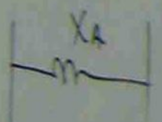
REMOVE THE VOLTAGE. ONLY IMPEDANCE TO BE INCLUDED.



ZERO SEQUENCE DIAGRAM

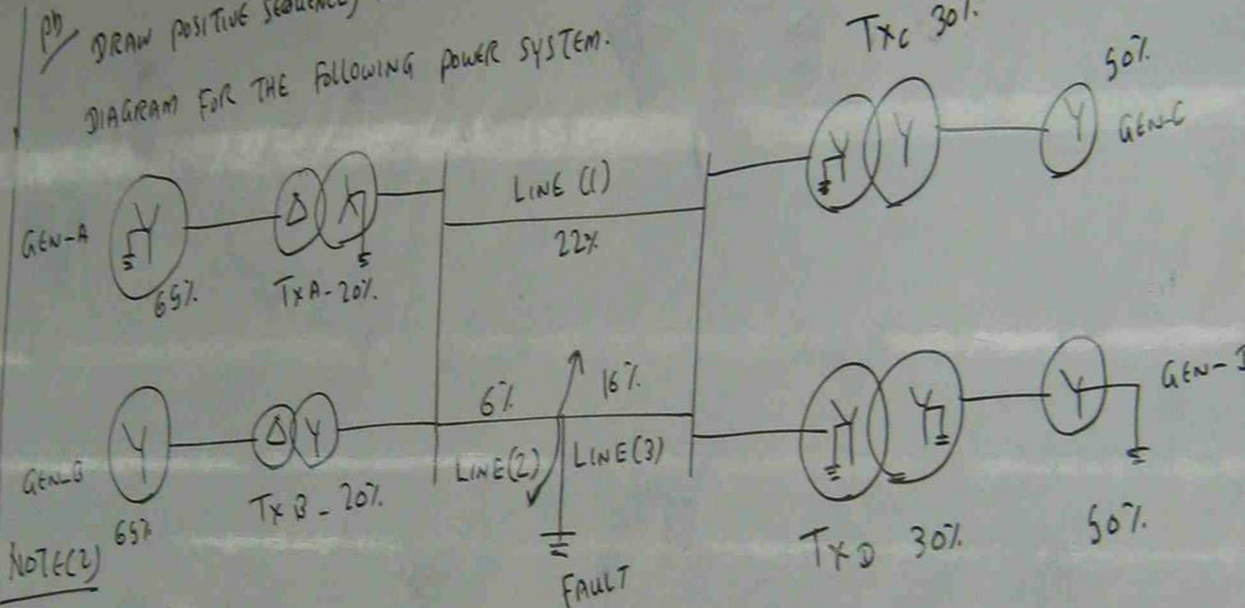


INCLUDE ONLY THE EQUIPMENTS THAT ALLOW THE FAULT CURRENT TO PASS THEM TO THE THE GROUND.



PRACTICAL 12/05/09	PRACTICAL 02/06/09
TEST 2 26/05/09	TEST 3 - 16/06/09

Q1) DRAW POSITIVE SEQUENCE, NEGATIVE SEQUENCE AND ZERO SEQUENCE EQUIVALENT DIAGRAM FOR THE FOLLOWING POWER SYSTEM.

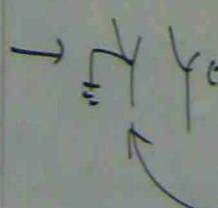


NOTE(2)

INCLUDE BOTH EQUIPMENTS IN ZERO SEQUENCE DIAGRAM

REMOVE
INCLUDE } IN ZERO SEQUENCE DIAGRAM

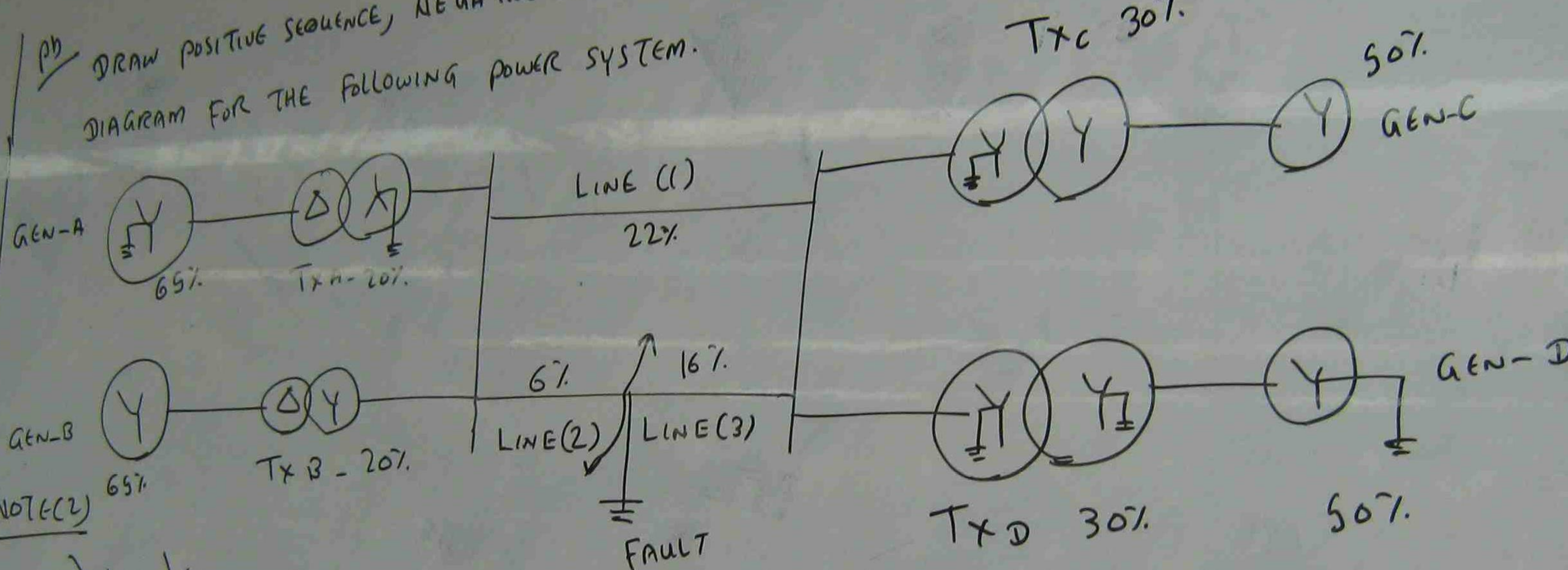
REMOVE BOTH IN ZERO SEQUENCE DIAGRAM



REMOVE

INCLUDE

Pb DRAW POSITIVE SEQUENCE, NEGATIVE SEQUENCE AND ZERO SEQUENCE EQUIVALENT DIAGRAM FOR THE FOLLOWING POWER SYSTEM.



NOTE(2)

→ CURRENT — INCLUDE BOTH EQUIPMENTS IN ZERO SEQUENCE DIAGRAM

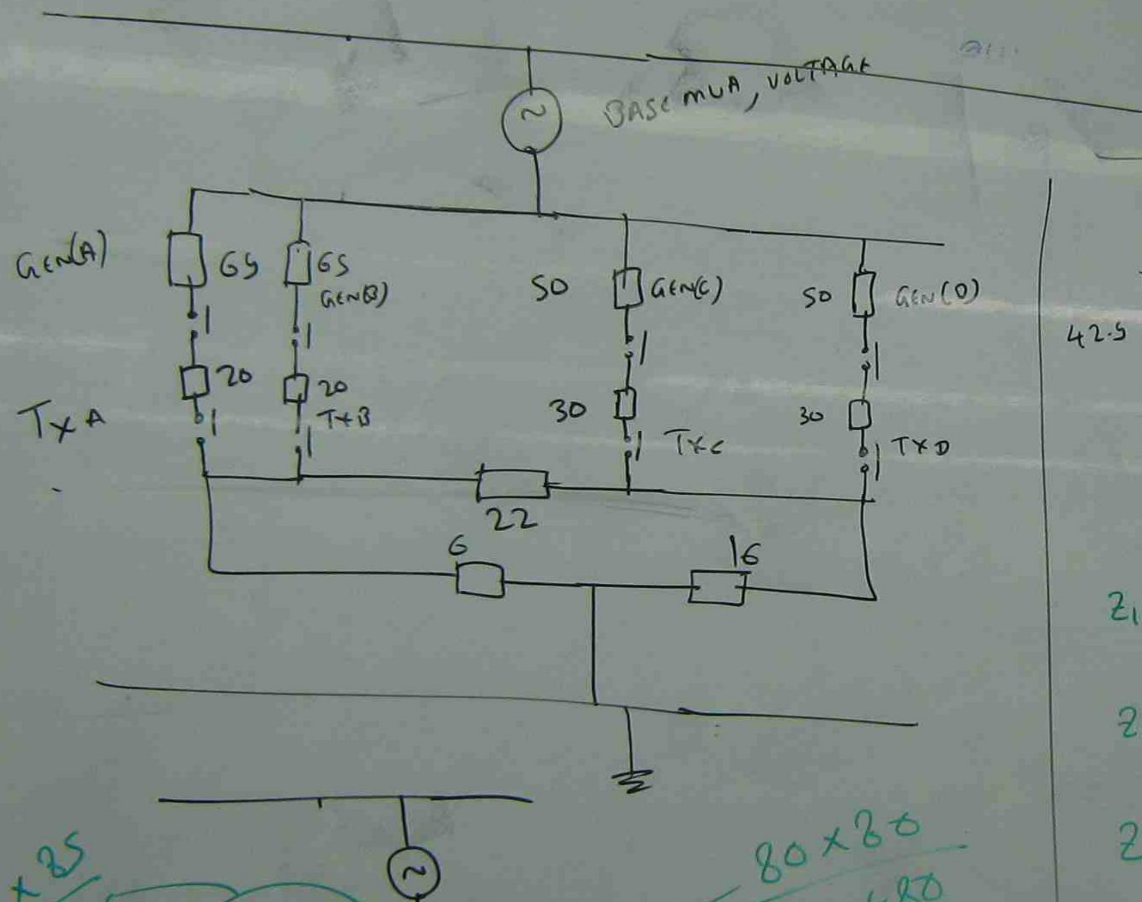
→ CURRENT — REMOVE / INCLUDE } IN ZERO SEQUENCE DIAGRAM

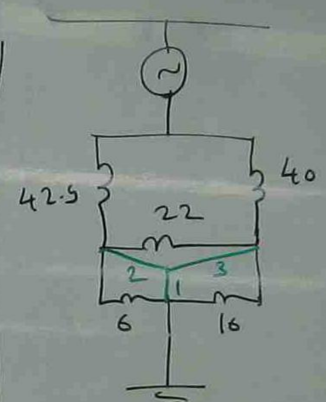
→ REMOVE BOTH IN ZERO SEQUENCE DIAGRAM

→ REMOVE

INCLUDE

POSITIVE SEQUENCE DIAGRAM





$$Z_1 = \frac{6 \times 16}{6+16+22} = 2.2$$

$$Z_2 = \frac{6 \times 22}{6+16+22} = 3$$

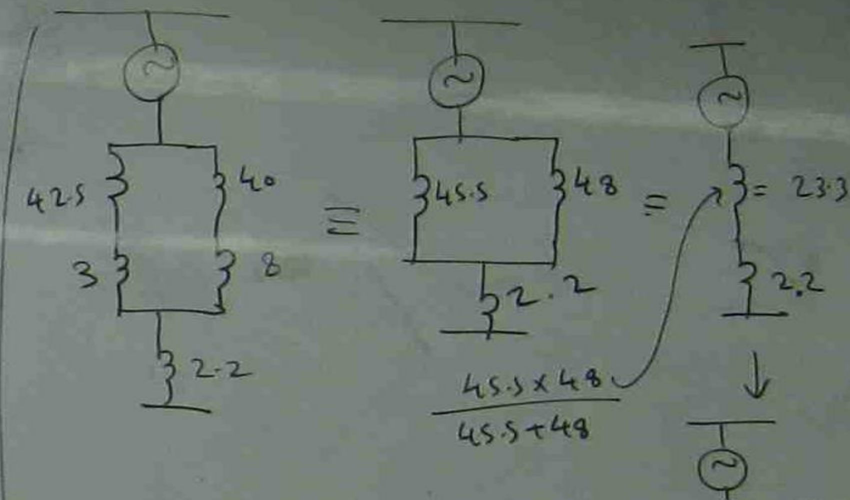
$$Z_3 = \frac{22 \times 16}{6+16+22} = 8$$

$= 2.2$

$= 3$

$= 8$

Z_2

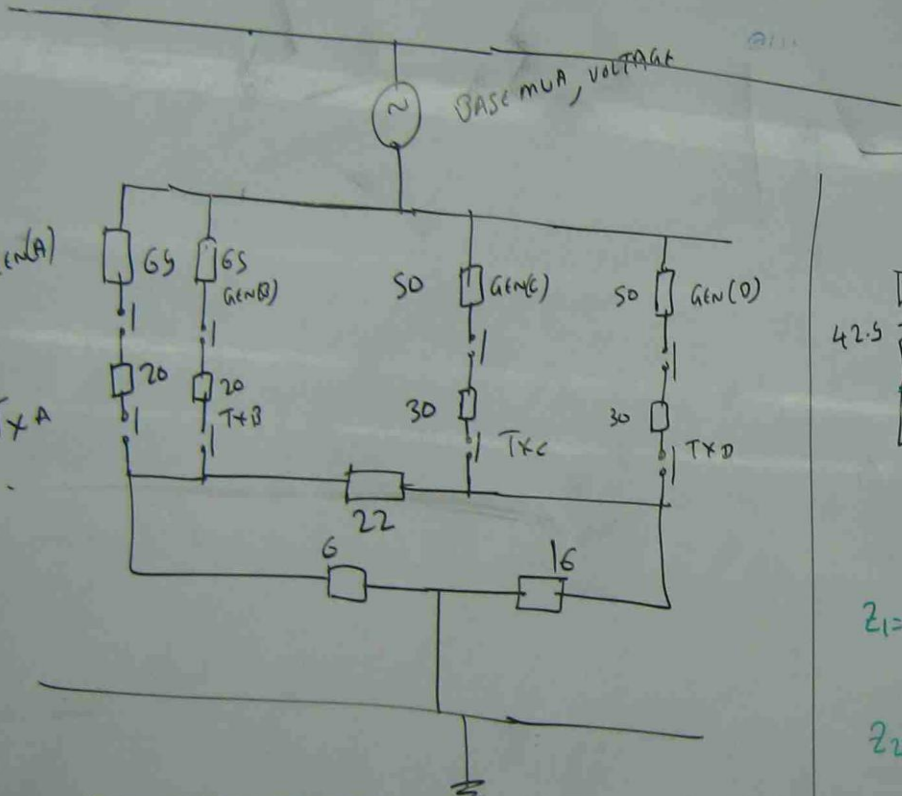


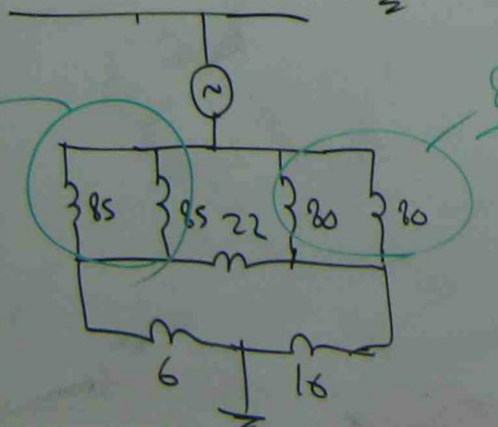
POSITIVE SEQUENCE EQUIVALENT DIAGRAM

IN THIS PROBLEM, THE SAME % IMPEDANCE IS GIVEN FOR BOTH POSITIVE, NEGATIVE AND ZERO SEQUENCE. IF THE DIFFERENT POSITIVE, NEGATIVE AND ZERO SEQUENCE IMPEDANCES ARE GIVEN, USE RESPECTIVE VALUE FOR RESPECTIVE EQUIVALENT CIRCUIT

GEN A	GEN B	
$Z_1 = 3$	$Z_1 = 4$	POSITIVE SEQUENCE CIRCUIT
$Z_2 = 6$	$Z_2 = 7$	NEGATIVE SEQUENCE CIRCUIT
$Z_0 = 9$	$Z_0 = 8$	ZERO SEQUENCE CIRCUIT

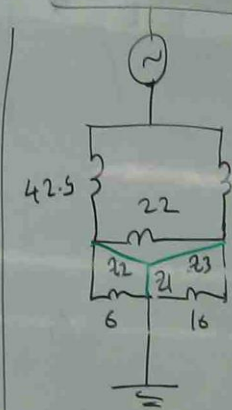
POSITIVE SEQUENCE DIAGRAM





$$\frac{85\times 85}{85+85} = 42.5$$

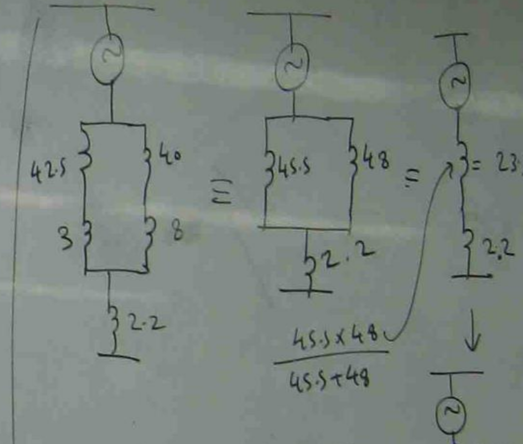
$$\frac{80\times 80}{80+80} = 40$$



$$Z_1 = \frac{6\times 16}{6+16+22} = 2.2$$

$$Z_2 = \frac{6\times 22}{6+16+22} = 3$$

$$Z_3 = \frac{22\times 16}{6+16+22} = 8$$



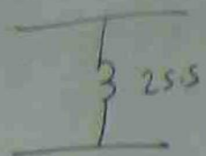
POSITIVE SEQUENCE EQUIVALENT DIAGRAM

IN THIS PROBLEM, THE SAME % IMPEDANCE IS GIVEN FOR BOTH POSITIVE, NEGATIVE AND ZERO SEQUENCE. IF THE DIFFERENT POSITIVE, NEGATIVE AND ZERO SEQUENCE IMPEDANCE ARE GIVEN, USE RESPECTIVE IMPEDANCE FOR RESPECTIVE EQUIVALENT CIRCUIT VALUE FOR RESPECTIVE EQUIVALENT CIRCUIT

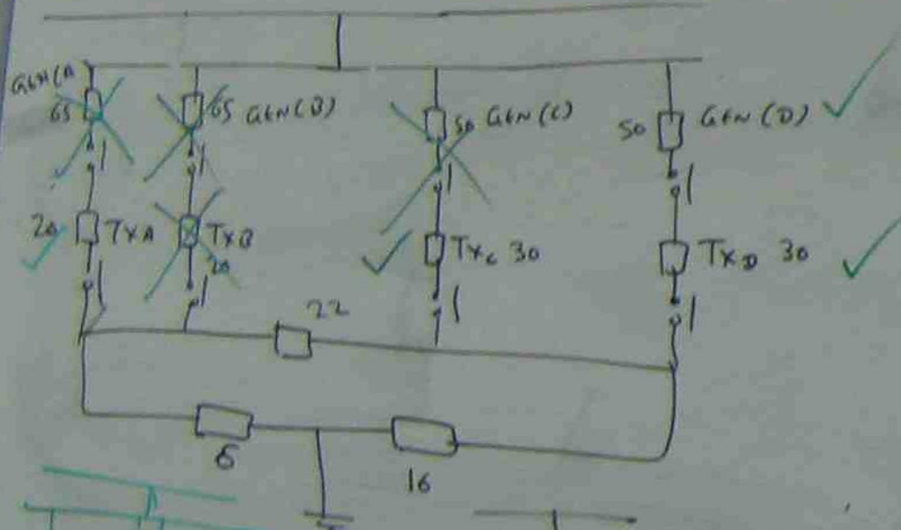
GEN(A)	GEN(B)	
$Z_1 = 3$	$Z_1 = 4$	POSITIVE SEQUENCE CIRCUIT
$Z_2 = 6$	$Z_2 = 7$	NEGATIVE SEQUENCE CIRCUIT
$Z_0 = 9$	$Z_0 = 8$	ZERO SEQUENCE CIRCUIT

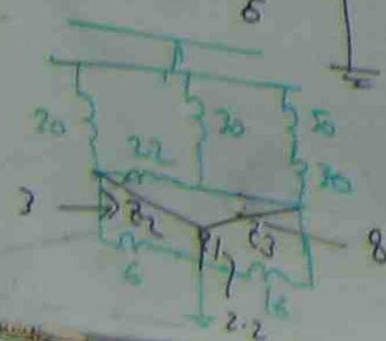
NEGATIVE SEQUENCE EQUIVALENT CIRCUIT

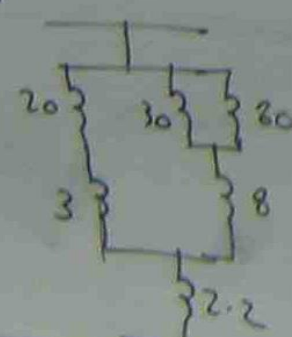
Remove voltage source, include impedance

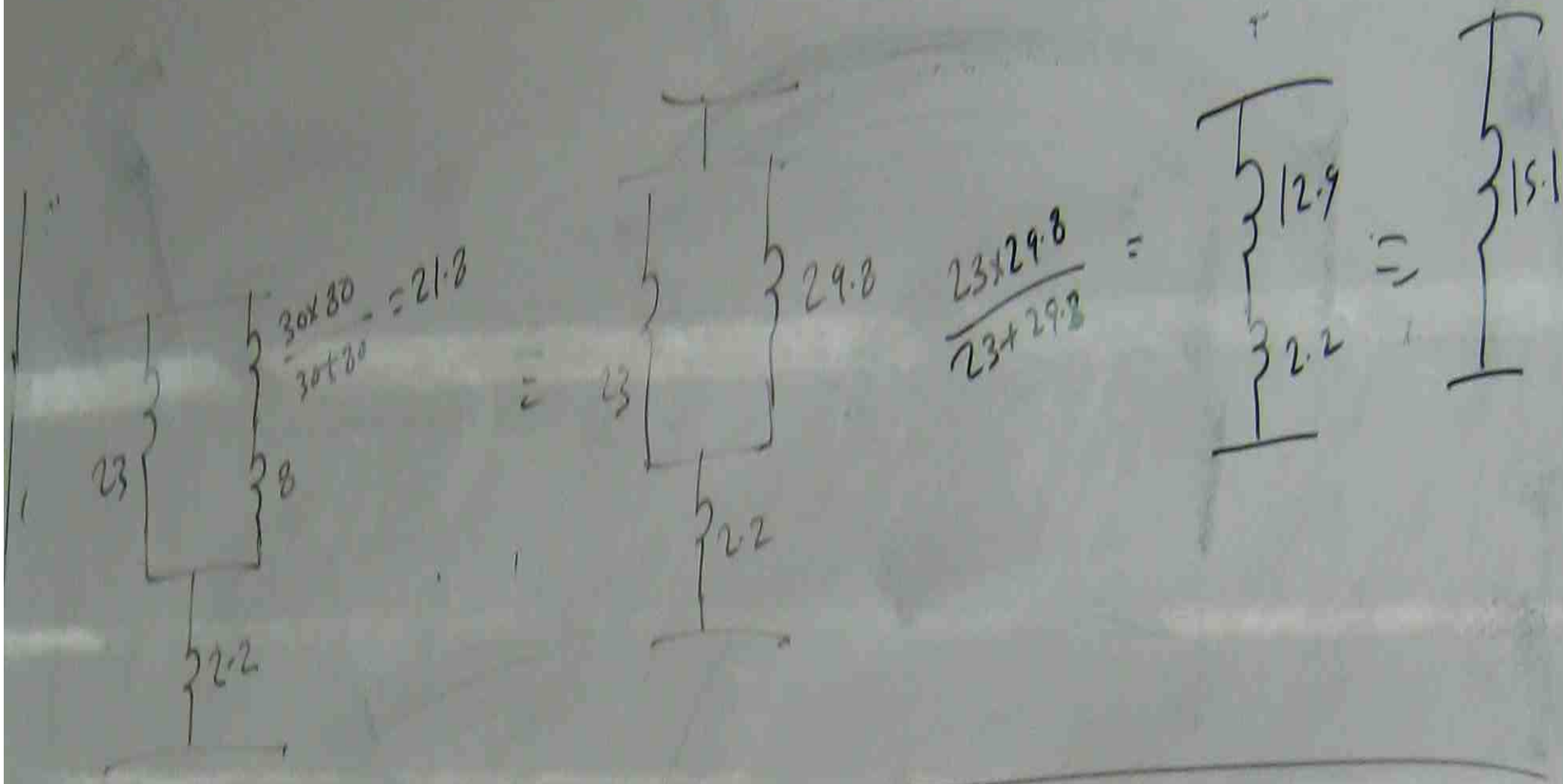


ZERO SEQUENCE EQUIVALENT DIAGRAM









23
8
30x80 / 30+80 = 21.8
2.2
=
23
29.8
2.2
23x29.8 / 23+29.8 =
12.9
2.2
=
15.1

POSITIVE SEQUENCE DIAGRAM

SELECT BASE MVA = 100 MVA

$$Z_{NEW} = \frac{\text{BASE MVA}}{\text{MVA OLD}} \times Z_{OLD}$$

GEN (A)

$$Z_1 = \frac{100}{50} \times 32.5 = 65\%$$

$$Z_2 = \frac{100}{50} \times 45 = 90\%$$

$$Z_0 = \frac{100}{50} \times 60 = 120\%$$

GEN (B)

$$Z_1 = \frac{100}{50} \times 32.5 = 65$$

$$Z_2 = \frac{100}{50} \times 45 = 90$$

$$Z_0 = \frac{100}{50} \times 60 = 120$$

6 16

OLD

Tx (A) $Z_1 = Z_2 = Z_0 = \frac{100}{50} \times 10 = 20$

Tx (B) $Z_1 = Z_2 = Z_0 = \frac{100}{50} \times 10 = 20$

Tx (C) $Z_1 = Z_2 = \frac{100}{40} \times 12 = 30$

$Z_0 = \frac{100}{40} \times 6 = 15$

Tx (D)

$Z_1 = Z_2 = \frac{100}{40} \times 12 = 30$

$Z_0 = \frac{100}{40} \times 6 = 15$

GEN (C) $Z_1 = 50, \; Z_2 = 30, \; Z_0 = 25$

GEN (D) $Z_1 = 50 \quad Z_2 = 30 \quad Z_0 = 25$

LINE (21)

$$\%Z = \frac{Z(\Omega) \times \text{BASE MVA}}{(kV)^2} \times 100$$

LINE (1)

$Z_1 = Z_2 = \frac{36.8 \times 100}{(132)^2} \times 100 = 22\%$

$Z_0 = \frac{134 \times 100}{(132)^2} \times 100 = 77\%$

SIMILARLY

LINE (2)

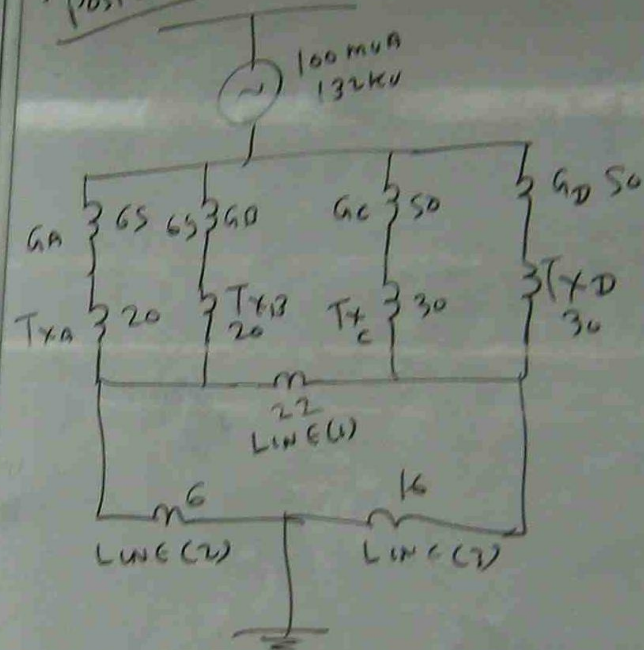
$Z_1 = Z_2 = 6\%$

$Z_0 = 21\%$

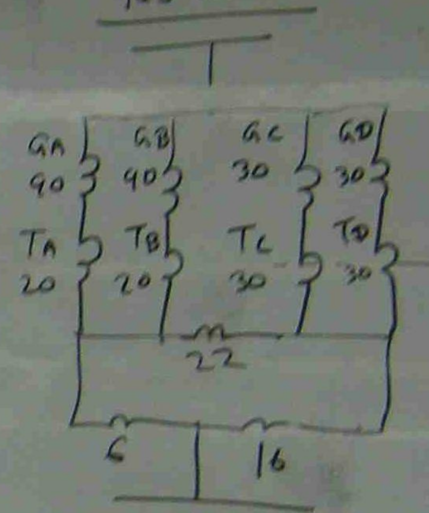
LINE (3) $Z_1 = Z_2 = 16$

$Z_0 = 56$

POSITIVE



NEGATIVE



ZERO