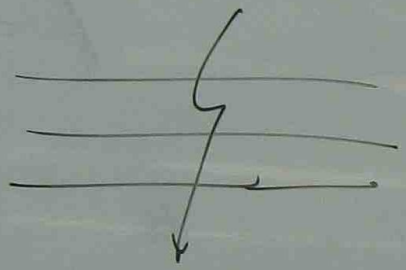
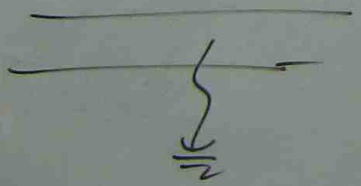
APPLICATION OF POSITIVE, NEGATIVE AND ZERO SEQUENCE IMPEDANCE IN FAULT CALCULATION

BALANCED FAULT

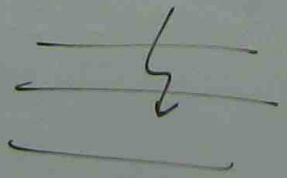


UNBALANCED FAULT

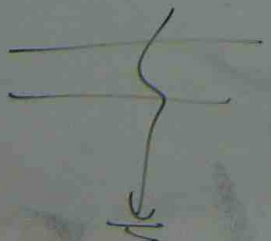
(1) L → G FAULT



(2) L – L FAULT

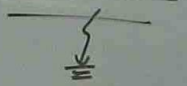


(3) 2L → G FAULT

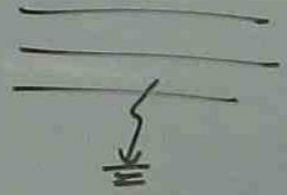
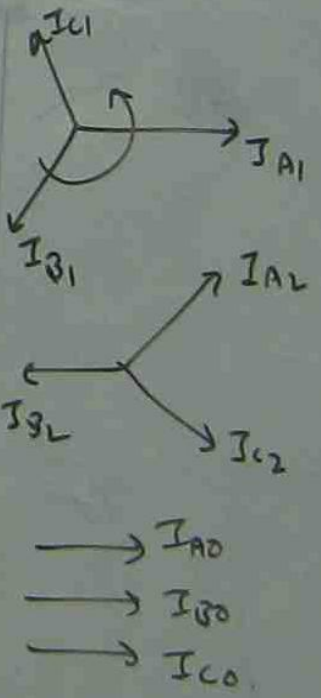
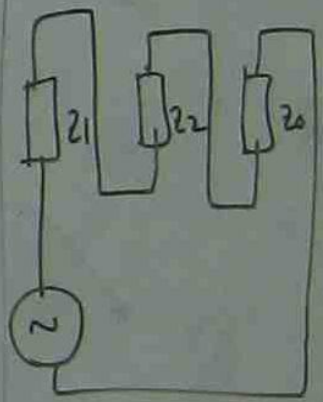
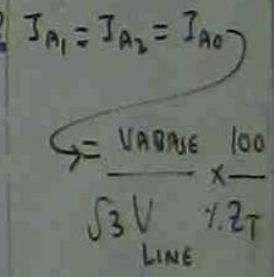


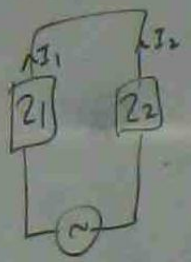
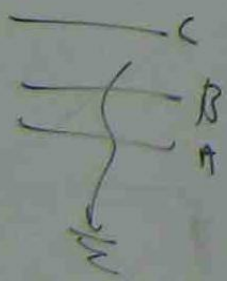
Type of FAULT

1φ → G FAULT

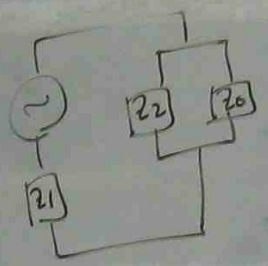


FAULT CURRENT CALCULATION TABLE

Type of Fault	Component	Circuit	Z_T	Fault Current
1φ → G Fault 	+ive, −ive, Zero 		$Z_T = Z_1 + Z_2 + Z_0$	$I_{A1} = I_{A2} = I_{A0}$  $I_A = I_{A1} + I_{A2} + I_{A0}$ $I_A = 3 I_{A1}$

i Type of Fault	Component	Circuit	Z_T	Fault Current
L→L Fault 	+ive, -ive $I_C = 0$ $I_A = -I_B$ $V_A = V_B$	$I_1 = -I_2$ 	$Z_T = Z_1 + Z_2$	$I_1 = \frac{V_{A\,BASE}}{\sqrt{3}\,V_{LINE}} \times \frac{100}{\%\,Z_T}$ $(-I_2) = \frac{V_{A\,BASE}}{\sqrt{3}\,V_{LINE}} \times \frac{100}{\%\,Z_T}$ $I_A = I_B = \sqrt{3}\,I_1$
3φ 	ONLY POSITIVE SEQUENCE $I_A = I_B = I_C = \frac{V_{A\,BASE}}{\sqrt{3}\,V_{LINE}} \times \frac{100}{\%\,Z_T}$ $Z_T = Z_1$			
2L→G Fault 				

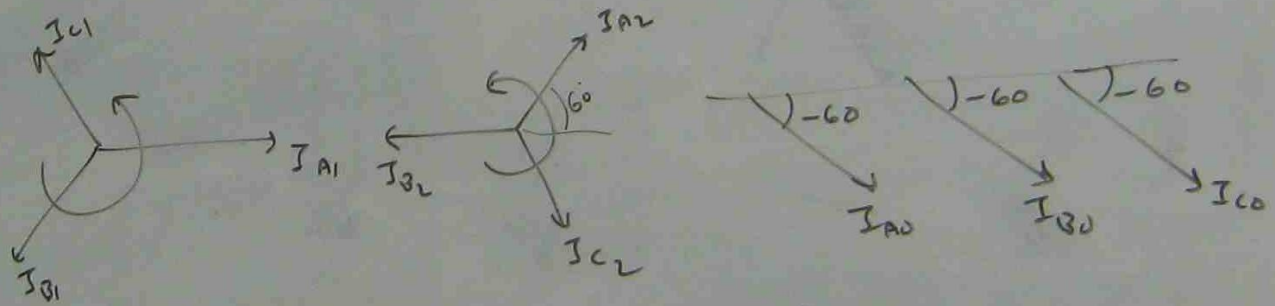
2L → G FAULT



$$Z_T = Z_1 + \frac{Z_2 Z_0}{Z_2 + Z_0}$$

$$I_1 = \frac{V_A \text{ BASE}}{\sqrt{3}\, V_{LINE}} \times \frac{100}{\%.ZT}$$

$$I_2 = \frac{I_1 Z_0}{Z_0 + Z_2} \qquad I_0 = I_1 \frac{Z_2}{Z_0 + Z_2}$$



$$I_A = I_1 \angle 0 + I_2 \angle 60 + I_0 \angle -60$$

$$I_B = I_1 \angle -120 + I_2 \angle 180 + I_0 \angle -60$$

$$I_C = I_1 \angle 120 + I_2 \angle -60 + I_0 \angle -60$$

$$I_{FAULT} = I_A + I_B + I_C$$

Ph

$Z_1 = 10\%$, $Z_2 = 12\%$, 100 MVA BASE, A TO B FAULT AT 66 KV.

FIND FAULT CURRENT.

L → L FAULT

$$Z_T = Z_1 + Z_2 = 10 + 12 = 22\%$$

$$I_1 = -I_2 = \frac{\text{VA BASE}}{\sqrt{3}\, V_{LINE}} \times \frac{100}{\%Z_T}$$

$$= \frac{100 \times 10^6}{\sqrt{3} \times 66 \times 10^3} \times \frac{100}{22}$$

$$= 3976 \text{ Amp}$$

$$I_A = I_3 = \sqrt{3}\, I_1 = 1.732 \times 3976$$

$$= 6886 \text{ Amp}$$

pb

$Z_1 = 6\%$, $Z_2 = 7\%$, $Z_0 = 10\%$ 100 MVA. 132 KV

LINE TO GROUND FAULT. FIND FAULT CURRENT.

$$Z_T = Z_1 + Z_2 + Z_0 = 6 + 7 + 10 = 23\%$$

$$I_{A_1} = I_{A_2} = I_{A_0} = \frac{\text{VA BASE}}{\sqrt{3}\, V_{LINE}} \times \frac{100}{\%.ZT}$$

$$= \frac{100 \times 10^6}{1.7321 \times 132 \times 10^3} \times \frac{100}{23} = 1902 \text{ AMP}$$

$$I_A = 3 I_{A_1} = 3 \times 1902 = 5706 \text{ AMP}$$

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pb

$Z_1 = 69\%$, $Z_2 = 69\%$, $Z_0 = 40\%$

BASE MVA = 100 MVA. $E = 132$ KV

ph – ph – E FAULT

CALCULATE FAULT CURRENT.

$$Z_T = Z_1 + \frac{Z_2 Z_0}{Z_2 + Z_0} = 65 + \frac{69 \times 40}{69 + 40} = 90\%$$

$$I_1 = \frac{VA_{BASE}}{\sqrt{3}\, V_{LINE}} \times \frac{100}{\%Z_T} = \frac{100 \times 10^6}{1.7321 \times 132 \times 10^3} \times \frac{100}{90} = 4.86 \text{ Amp}$$

$$I_2 = \frac{I_1 Z_0}{Z_0 + Z_2} = \frac{4.86 \times 40}{40 + 69} = 178.3 \text{ Amp}$$

$$I_0 = \frac{I_1 Z_2}{Z_0 + Z_2} = \frac{4.86 \times 69}{40 + 69} = 307.6 \text{ Amp}$$

$$I_A = I_{A1} \angle 0 + I_{A2} \angle 60 + I_{A0} \angle -60$$

$$= I_1 \angle 0 + I_2 \angle 60 + I_0 \angle -60$$

$$= 4.86 \angle 0 + 178.3 \angle 60 + 307.6 \angle -60$$

$$= 4.86(\cos 0 + j \sin 0) + 178.3(\cos 60 + j \sin 60) + 307.6(\cos(-60) + j \sin(-60))$$

$$= 728.95 - j111.98$$

$$= \sqrt{728.95^2 + 111.98^2} \angle -\tan^{-1} \frac{111.98}{728.95}$$

$$= 737.4 \angle -8.7 \text{ Amp.}$$

$$I_B = I_{B1}\angle -120 + I_{B2}\angle 180 + I_{B0}\angle -60$$
$$= I_1\angle -120 + I_2\angle 180 + I_0\angle -60$$
$$= 486\angle -120 + 178.3\angle 180 + 307.6\angle -60$$

$$I_B = 740.7\angle -111.9 \text{ Amp}$$

$$I_C = I_{C1}\angle 120 + I_{C2}\angle -60 + I_{C0}\angle -60$$
$$= I_1\angle 120 + I_2\angle -60 + I_0\angle -60$$
$$= 486\angle 120 + 178.3\angle -60 + 307.6\angle -60$$
$$= 0$$

$$I_{FAULT} = I_A + I_B + I_C = 737.4\angle -8.7 + 740.7\angle -111.9 + 0$$

$$= 737.4\left(\cos(-8.7) + j\sin(-8.7)\right) + 740.7$$
$$\left(\cos(-111.9) + j\sin(-111.9)\right)$$

$$= 918.3\angle -60.5 \text{ Amp}$$