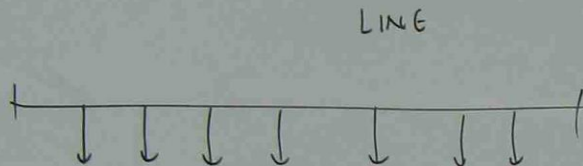


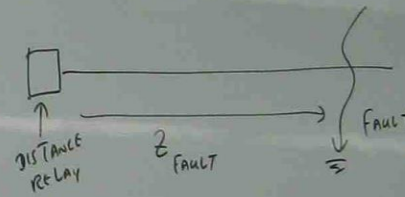
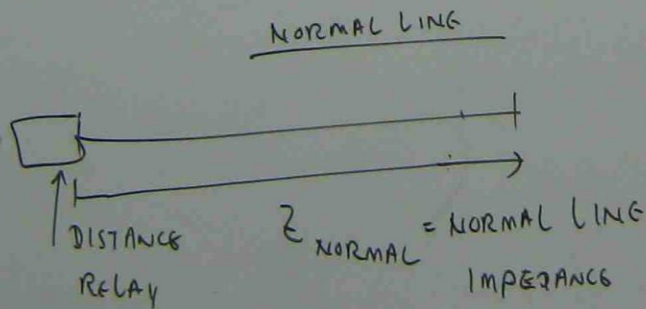
DISTANCE PROTECTION SYSTEM



ELECTRICAL LOADS

TO PROVIDE THE PROTECTION FOR THIS KIND OF LINE, DISTANCE RELAY PROTECTION SYSTEM SHOULD BE USED.

DISTANCE RELAY MEASURES THE LINE IMPEDANCE.



$Z_{FAULT} = \text{LINE IMPEDANCE WHEN FAULT OCCURS}$

$Z_{FAULT} < Z_{NORMAL} \rightarrow \text{RELAY OPERATES.}$

$$\text{LINE IMPEDANCE} = \frac{\text{LINE VOLTAGE}}{\text{LINE CURRENT}}$$

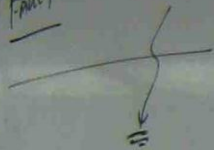
RELAY POTENTIAL COIL points to LINE VOLTAGE
RELAY CURRENT COIL points to LINE CURRENT

PRINCIPLE OF DISTANCE RELAY

$$Z = \frac{\text{LINE VOLTAGE}}{\text{LINE CURRENT}} \rightarrow \frac{\text{LINE VOLTAGE IS HIGH}}{\text{LINE CURRENT IS LOW}} = Z \text{ IS HIGH}$$

RELAY DOES NOT OPERATE

Fault

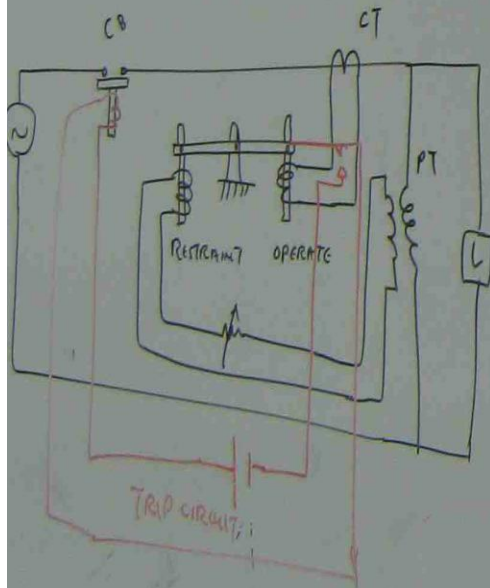


LINE VOLTAGE IS LOWER
LINE CURRENT IS HIGHER

= Z IS LOWER

RELAY WILL OPERATE

CONNECTION OF DISTANCE RELAY



THE DISTANCE RELAY CONSISTS OF BALANCED BEAM RELAY. IT HAS OPERATING COIL AND RESTRAINING COIL.
THE OPERATION COIL SENSES THE LINE CURRENT AND THE RESTRAINING COIL SENSES THE LINE VOLTAGE.

AT NORMAL CONDITION, LINE VOLTAGE IS HIGH AND LINE CURRENT IS LOW.

THE RESTRAINING COIL MAGNETISATION IS GREATER THAN THE OPERATING COIL MAGNETISATION, THE RELAY DOES NOT OPERATE.

AT FAULT CONDITION, LINE CURRENT IS HIGHER AND LINE VOLTAGE IS LOWER.

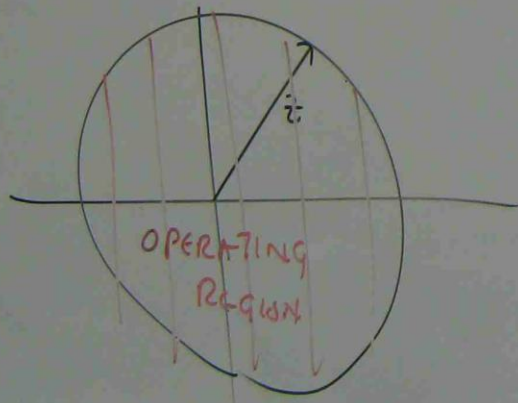
THE OPERATING COIL MAGNETISATION IS GREATER THAN THE RESTRAINING COIL MAGNETISATION,
AS CONSEQUENCE, RELAY OPERATES, TRIP CIRCUIT IS CLOSED AND C.B IS TRIPPED OFF.

THE DISTANCE RELAY CONSISTS OF BALANCED BEAM RELAY. IT HAS OPERATING COIL AND RESTRAINING COIL. THE OPERATION COIL SENSES THE LINE CURRENT AND THE RESTRAINING COIL SENSES THE LINE VOLTAGE.

AT NORMAL CONDITION, LINE VOLTAGE IS HIGH AND LINE CURRENT IS LOW. THE RESTRAINING COIL MAGNETISATION IS GREATER THAN THE OPERATING COIL MAGNETISATION, THE RELAY DOES NOT OPERATE.

AT FAULT CONDITION, LINE CURRENT IS HIGHER AND LINE VOLTAGE IS LOWER. THE OPERATING COIL MAGNETISATION IS GREATER THAN THE RESTRAINING COIL MAGNETISATION, AS CONSEQUENCE, RELAY OPERATES, TRIP CIRCUIT IS CLOSED AND C.B IS TRIPPED OFF.

CHARACTERISTICS DIAGRAM OF DISTANCE RELAY



$$Z = \frac{V}{I}$$

NORMAL

$$\frac{V}{I} = Z$$

RELAY DOES NOT OPERATE

FAULT

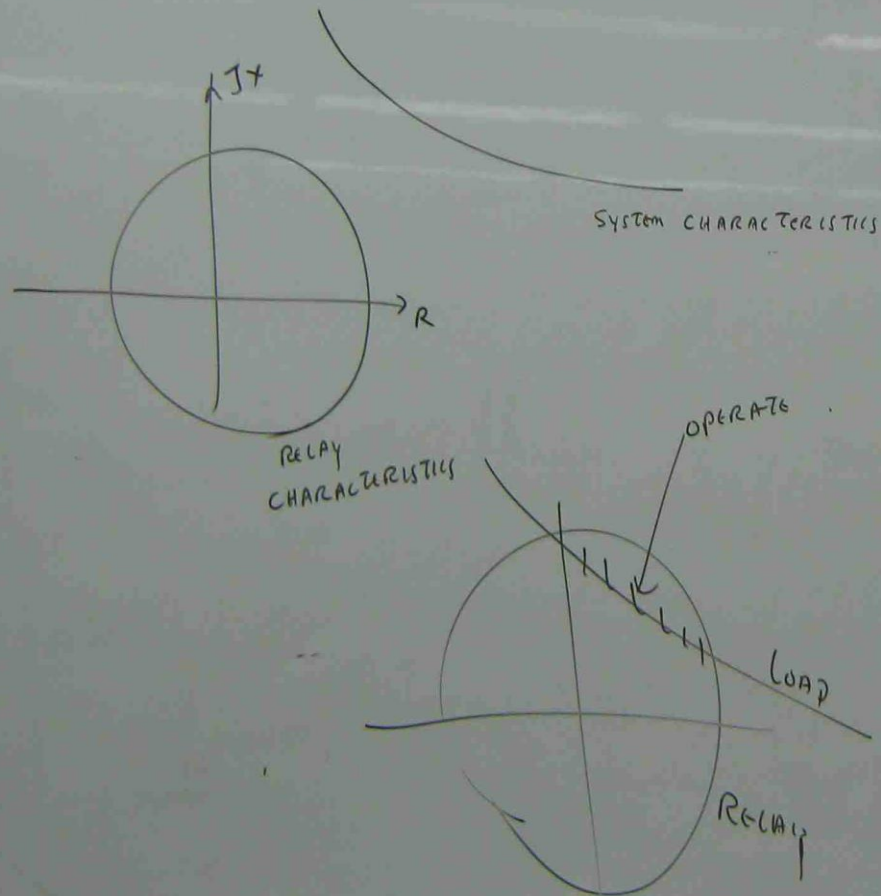
$$\frac{V}{I} = Z$$

RELAY OPERATES.

APPLICATION OF DISTANCE RELAY

SHORT LINE \rightarrow CURRENT IS SIGNIFICANT \rightarrow PROVIDE OVER CURRENT RELAY PROTECTION

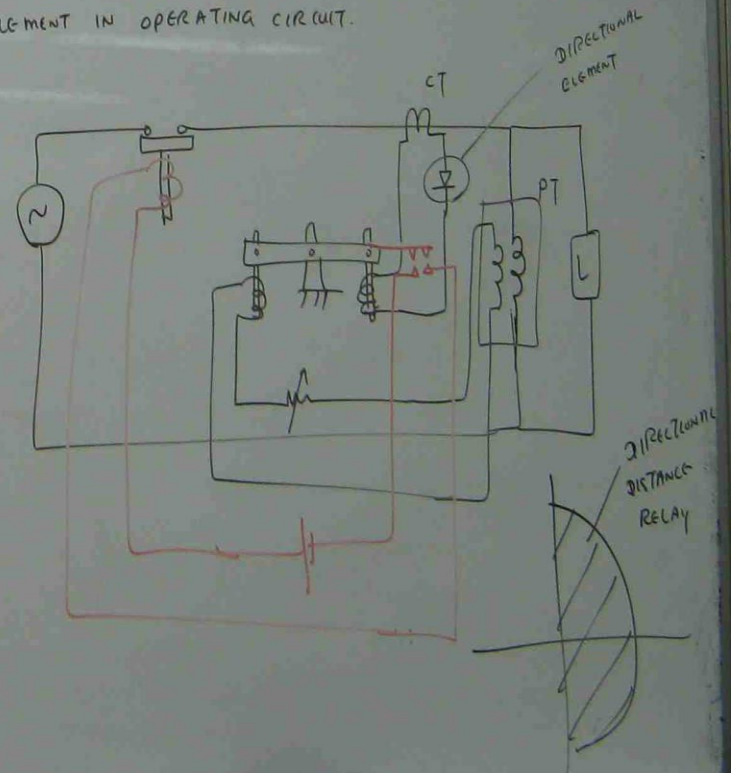
LONG LINE \rightarrow IMPEDANCE IS SIGNIFICANT \rightarrow PROVIDE DISTANCE RELAY PROTECTION



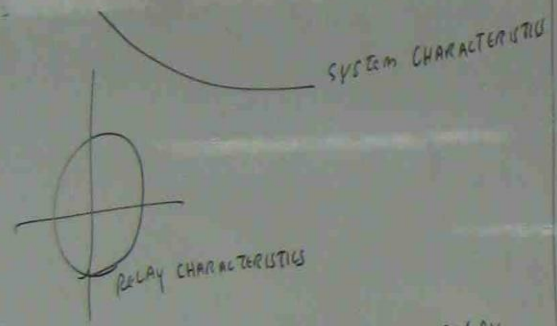
MODIFICATION OF DISTANCE RELAY \rightarrow DIRECTIONAL DISTANCE RELAY

THE ORDINARY DISTANCE RELAY CAN PROVIDE 360° PROTECTION (OR) PROTECTION FOR FLOW OF ANY DIRECTION CURRENT.

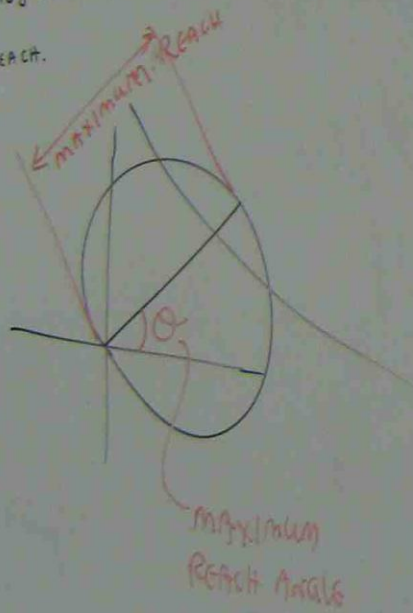
IF SPECIFIC DIRECTIONAL PROTECTION IS REQUIRED, THE DISTANCE RELAY CAN BE MODIFIED TO DIRECTIONAL DISTANCE RELAY BY COMBINING THE DIRECTIONAL ELEMENT IN OPERATING CIRCUIT.



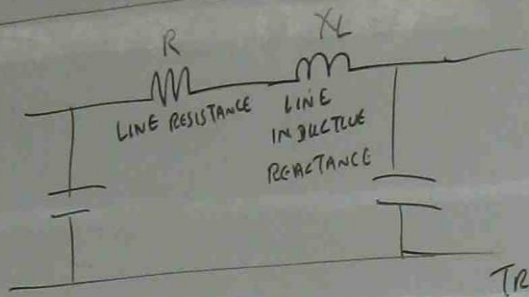
INCREASING THE MAXIMUM REACH OF DISTANCE RELAY



ADJUST R_1 & R_2 TO INCREASE THE RELAY REACH.



RELATION BETWEEN RELAY MAXIMUM REACH & SYSTEM CHARACTERISTICS

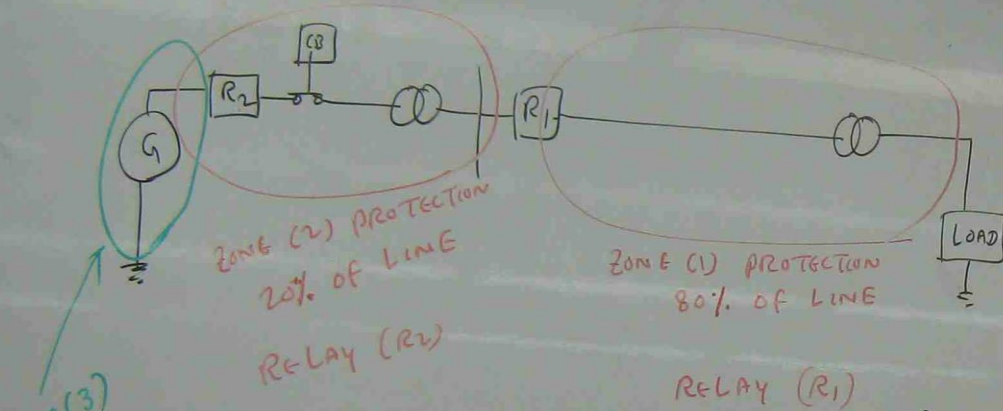


$$\tan \theta = \frac{X_L}{R}$$

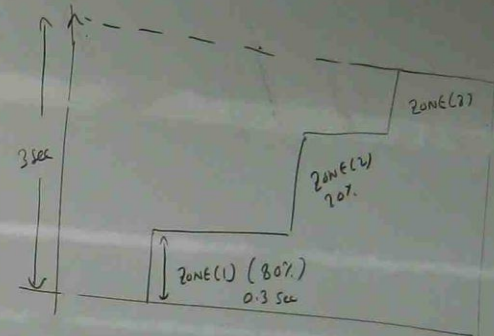
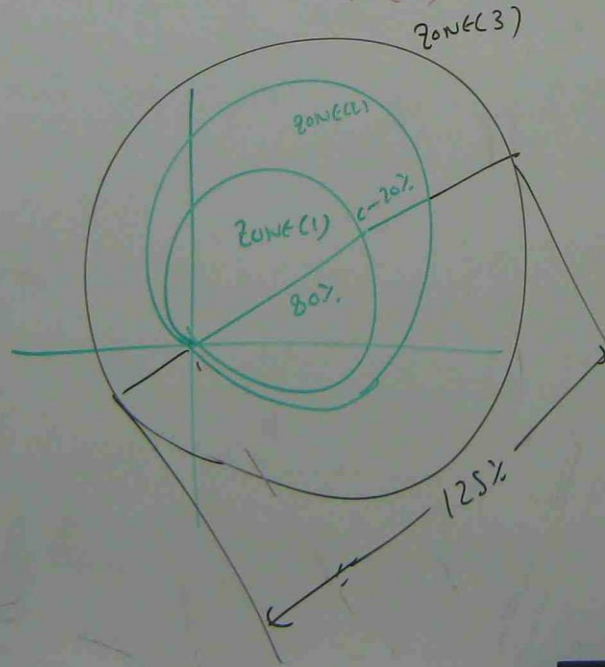
$$\theta = \tan^{-1} \frac{X_L}{R}$$

MUST BE EQUAL TO MAXIMUM REACH ANGLE OF RELAY

ZONES FOR DISTANCE PROTECTION



FOR PROVIDING THE PROTECTION ON 3 ϕ FAULT AT GENERATOR BUS BAR



TRANSMISSION LINE IS DIVIDED INTO THE ZONES AND RELAYS ARE ALLOCATED TO PROVIDE THE PROTECTION.

ZONE (1) RELAY PROVIDES THE PROTECTION FOR 80% OF THE LINE.

ZONE (2) RELAY PROVIDES THE PROTECTION FOR 20% OF THE LINE INCLUDING THE STEP UP TRANSFORMER.

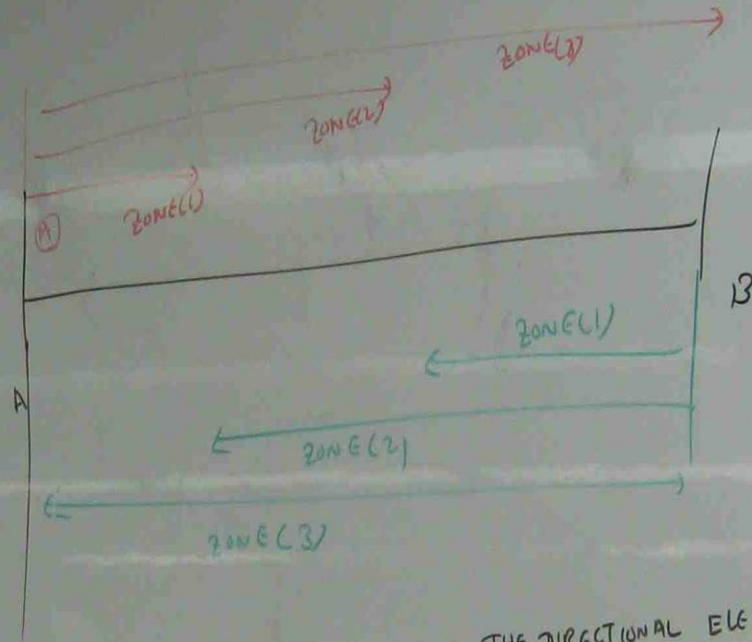
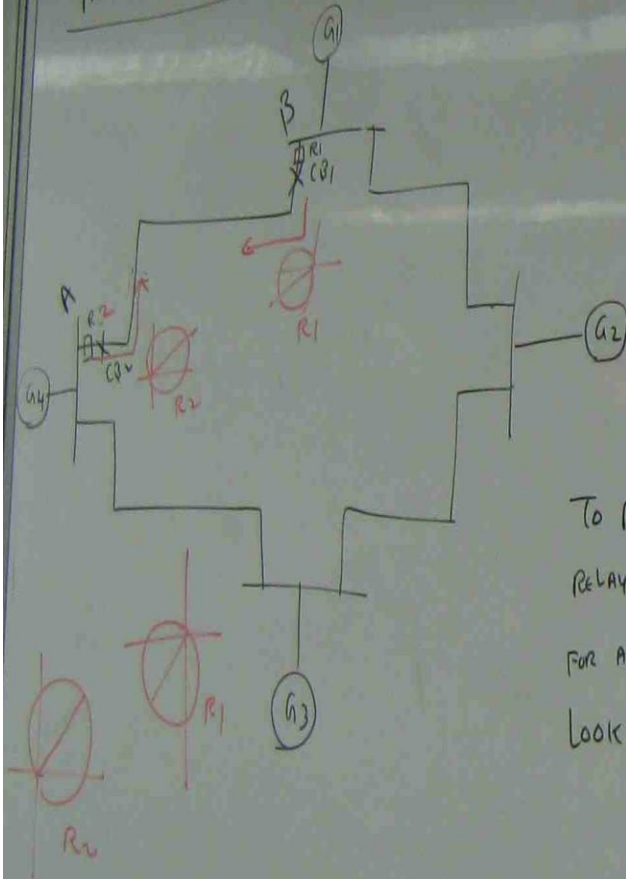
ZONE (3) RELAY PROVIDES THE PROTECTION FOR GENERATOR BUSBAR. IT IS DESIGNED TO REACH 125% & BACKWARD PROTECTION.

IF C.B CONTACT IS EARTHED, IT IS BEYOND THE REACH OF RELAY R₁ & R₂. THE RELAYS WILL NOT PROTECT.

ZONE (3) RELAY PROVIDES THE PROTECTION FOR SUCH SITUATION.

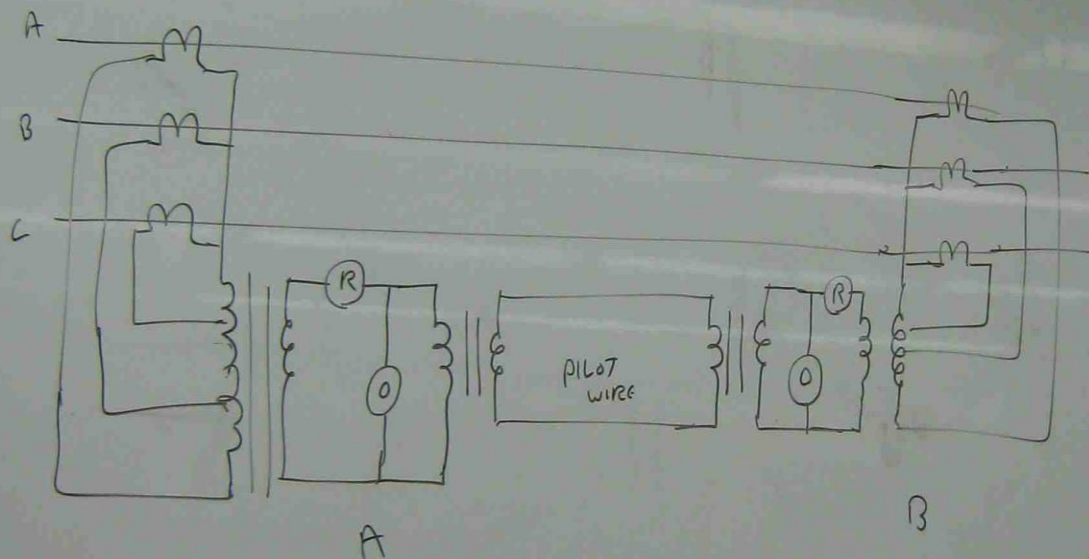
ZONE (3) RELAY POSSESSES 150 CYCLE (PR) 3 SEC TO CORRECTLY OPERATE & CLEAR THE FAULT.

PROTECTION FOR INTER CONNECTOR



TO PROVIDE THE PROTECTION FOR RING CONNECTOR, THE DIRECTIONAL ELEMENTS OF THE RELAYS ARE ADJUSTED TO DIRECT EACH OTHER.
 FOR A LONG CONNECTORS, THE PROTECTION ZONES ARE ALSO PROVIDED AND THE RELAYS LOOK EACH OTHER. THE PROTECTION ZONES ARE ARRANGED AS ABOVE.

3φ DISTANCE RELAY



LINE TO LINE FAULT

A → B FAULT → $I_A - I_B$
OPERATING
CURRENT

V_{AB}
RESTRAINING
VOLTAGE

B → C FAULT → $I_B - I_C$
OPERATE

V_{BC}
RESTRAINT

C → A FAULT → $I_C - I_A$
OPERATE

V_{CA}
RESTRAINT

GROUND FAULT

A → G FAULT

$I_{A \rightarrow G}$
OPERATE

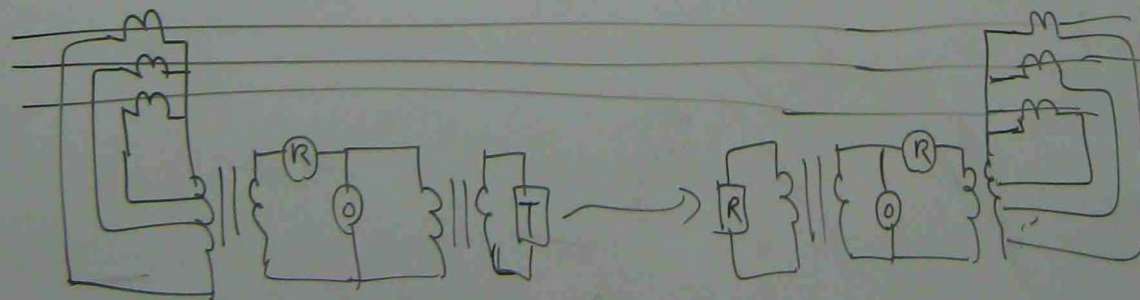
$V_{A \rightarrow G}$
RESTRAINT

B → G FAULT → $I_{B \rightarrow G}$
OPERATE

$V_{B \rightarrow G}$
RESTRAINT

C → G FAULT → $I_{C \rightarrow G}$
OPERATE

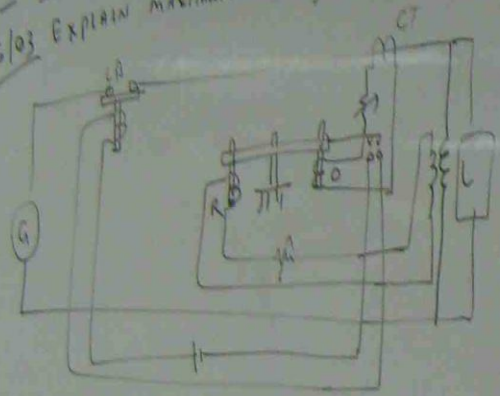
$V_{C \rightarrow G}$
RESTRAINT



T - TRANSMITTER
R - RECEIVER

TUTORIAL

Sketch the distance relay and explain the operation
T6/03 Explain maximum reach, maximum reach angle



DISTANCE RELAY OPERATING COIL SENSES LINE CURRENT
RESTRAINING COIL SENSES LINE VOLTAGE.

AT NORMAL CONDITION, LINE VOLTAGE IS HIGH AND
LINE CURRENT IS LOW

ACCORDING TO $Z = \frac{\text{RESTRAINING COIL VOLTAGE}}{\text{OPERATING COIL CURRENT}}$

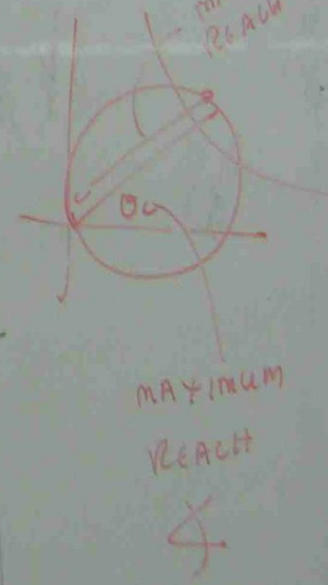
Z IS HIGH. RELAY DOES NOT OPERATE.

WHEN THE FAULT OCCURS, RESTRAINING COIL VOLTAGE IS LOWER AND OPERATING COIL
CURRENT IS HIGHER. Z BECOMES LOWER AND RELAY OPERATES.

THE RELAY MAXIMUM REACH CAN BE ADJUSTED BY ADJUSTING THE SETTINGS FOR
RESTRAINING COIL VOLTAGE AND OPERATING COIL CURRENT. IT SHOULD BE
SET AT MAXIMUM REACH ANGLE = $\tan^{-1} \frac{\text{LINE INDUCTIVE REACTANCE}}{\text{LINE RESISTANCE}}$

FOR 3Φ PROTECTION

	OPERATING	RESTRAINING
A → B FAULT	$I_A - I_B$	V_{AB}
B → C FAULT	$I_B - I_C$	V_{BC}
C → A FAULT	$I_C - I_A$	V_{CA}
A → G FAULT	I_{AG}	V_{AG}
B → G FAULT	I_{BG}	V_{BG}
C → G FAULT	I_{CG}	V_{CG}



T6/04

DESCRIBE ZONE 1, 2, 3 PROTECTION PROVIDED BY
IMPEDANCE RELAY IN POWER LINE