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Declared to be University u/s of UGC Act 1956
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## DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

# POWER SYSTEM PROTECTION LABORATORY RECORD NOTEBOOK

**DECEMBR-2024**

**Prepared by: M.MAHENDRAN**

**AP-III/DEPT OF EEE**

**NAME** : ____________________

**REG.NO** : ____________________

## SRI CHANDRASEKHARENDRA SARASWATHI

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## BONAFIDE CERTIFICATE

This is to Certify that this is the bonafide record of work done by Mr./Ms.____________________________________________________ __ with Reg. No ____________________ of III Sem ME (PS-Part Time) in the Power System Protection Laboratory during the year 2019- 2020.

**Staff-in-charge** **Head of the Department**

Submitted for the Practical Examination held on _____________.

# ESTIMATION OF SYMMETRICAL FAULT MVA FOR A 3 PHASE SYSTEM

## Aim:

To estimate the symmetrical fault for a given 3 phase 4 bus system.

## Problem:

By conducting short circuit analysis estimate the fault MVA for a given 4 bus system and verify the results using MIpower software tool.

## Single Line Diagram:

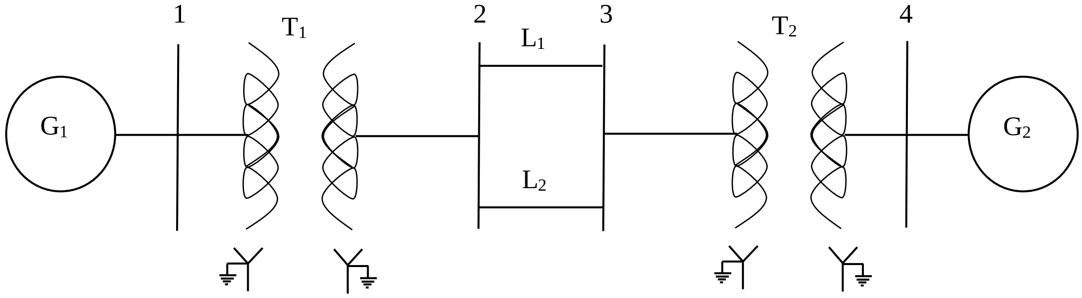


Figure – 1

Given Data:

G1,G2: 100 MVA, 20 KV, X=X=Xd=20%

T1,T2: 100 MVA, 20KV/345, XL=8%

L1, L2; X=X= 15 % and also for a 3 phase to ground (solid) fault at bus 4, determine the fault current and MVA at faulted bus, post fault bus voltage, fault current distribution in different elements of the network.

**Solution:**

**Estimation of Fault MVA (Theoretically)**

The positive sequence network for the given system is shown in figure (2).

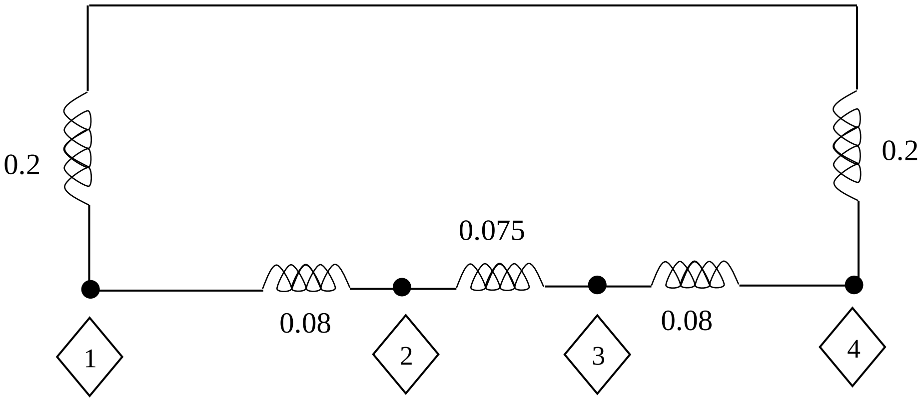


Figure-2

The thevenin equivalent for the 3 phase fault applied at bus no.4 as shown in figure(3).

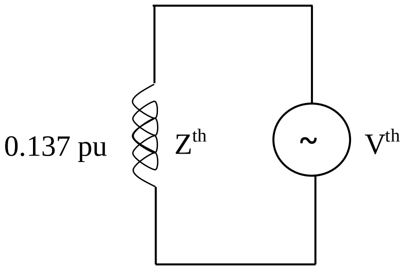


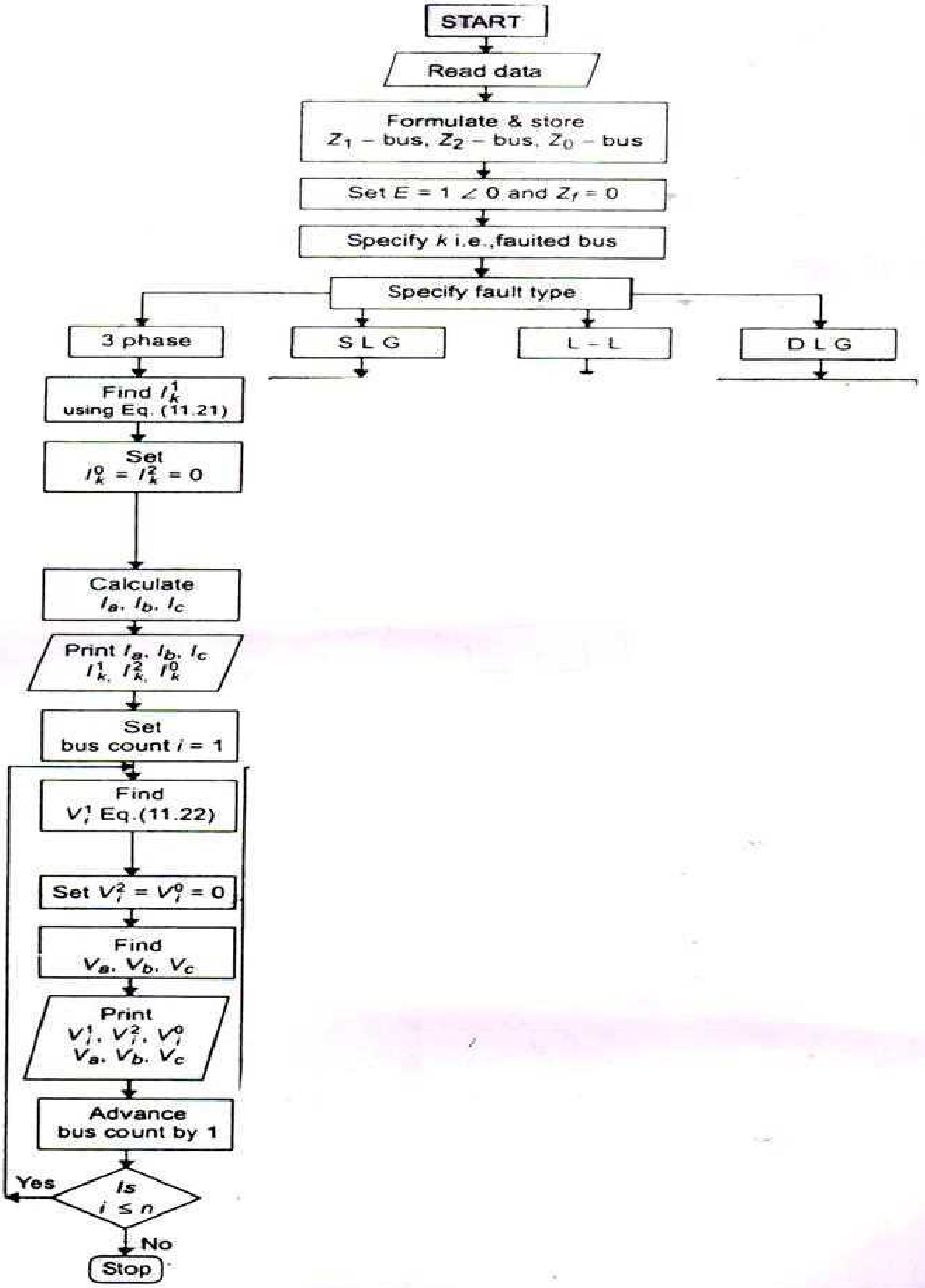
Figure-3

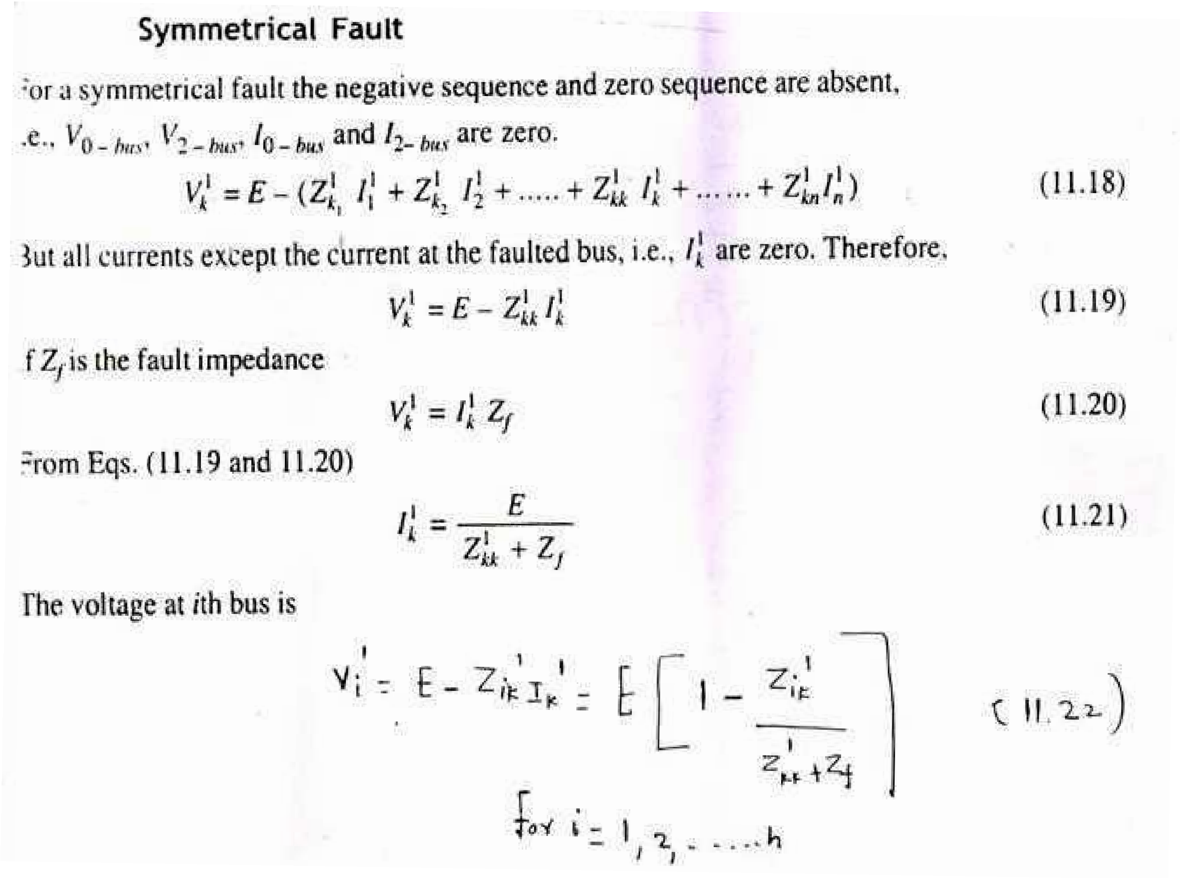
From the above figure

$$\text{Fault MVA} = \frac{\text{Base MVA}}{Z_{PU}}$$

$$= 100/\,0.137 = 730$$

## Flow Chart for Symmetrical Fault





## Symmetrical Fault

For a symmetrical fault the negative sequence and zero sequence are absent,

i.e., $V_{0-bus}$, $V_{2-bus}$, $I_{0-bus}$ and $I_{2-bus}$ are zero.

$$V_k^1 = E - (Z_{k_1}^1\ I_1^1 + Z_{k_2}^1\ I_2^1 + \ldots.. + Z_{kk}^1\ I_k^1 + \ldots\ldots + Z_{kn}^1 I_n^1) \tag{11.18}$$

But all currents except the current at the faulted bus, i.e., $I_k^1$ are zero. Therefore,

$$V_k^1 = E - Z_{kk}^1 I_k^1 \tag{11.19}$$

f $Z_f$ is the fault impedance

$$V_k^1 = I_k^1\ Z_f \tag{11.20}$$

From Eqs. (11.19 and 11.20)

$$I_k^1 = \frac{E}{Z_{kk}^1 + Z_f} \tag{11.21}$$

The voltage at *i*th bus is

$$V_i^1 = E - Z_{ik}^1 I_k^1 = E\left[1 - \frac{Z_{ik}^1}{Z_{kk}^1 + Z_f}\right] \tag{11.22}$$

$$\text{for } i = 1, 2, \ldots n$$

**Output Result:**

**Result:**

For a given 3 phase 4 bus system fault MVA (Symmetrical Fault) estimated and verified using MIpower Software Tool.

## ESTIMATION OF UNSYMMETRICAL FAULT MVA FOR A 3 PHASE SYSTEM

**Aim:**

To estimate the Unsymmetrical fault for a given 3 phase 4 bus system.

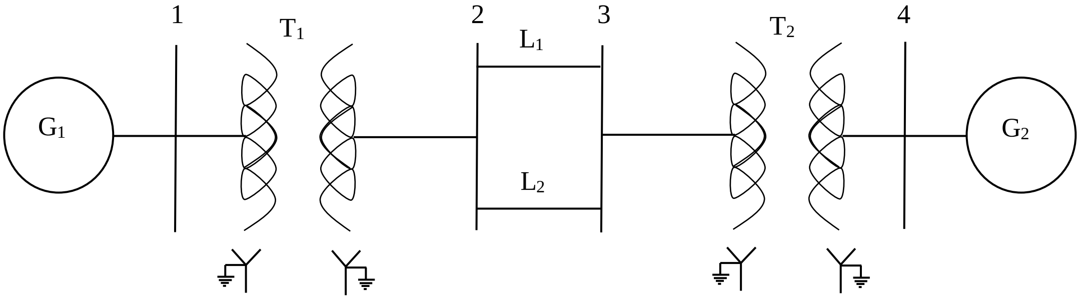
**Problem:**

For a given 3 phase 4 bus system using MIpower software tool, estimate the fault MVA for the following unsymmetrical fault.

1. SLG
2. L – L
3. DLG

at Bus No.4 and also determine the fault current and post fault bus voltage.

**Single Line Diagram:**



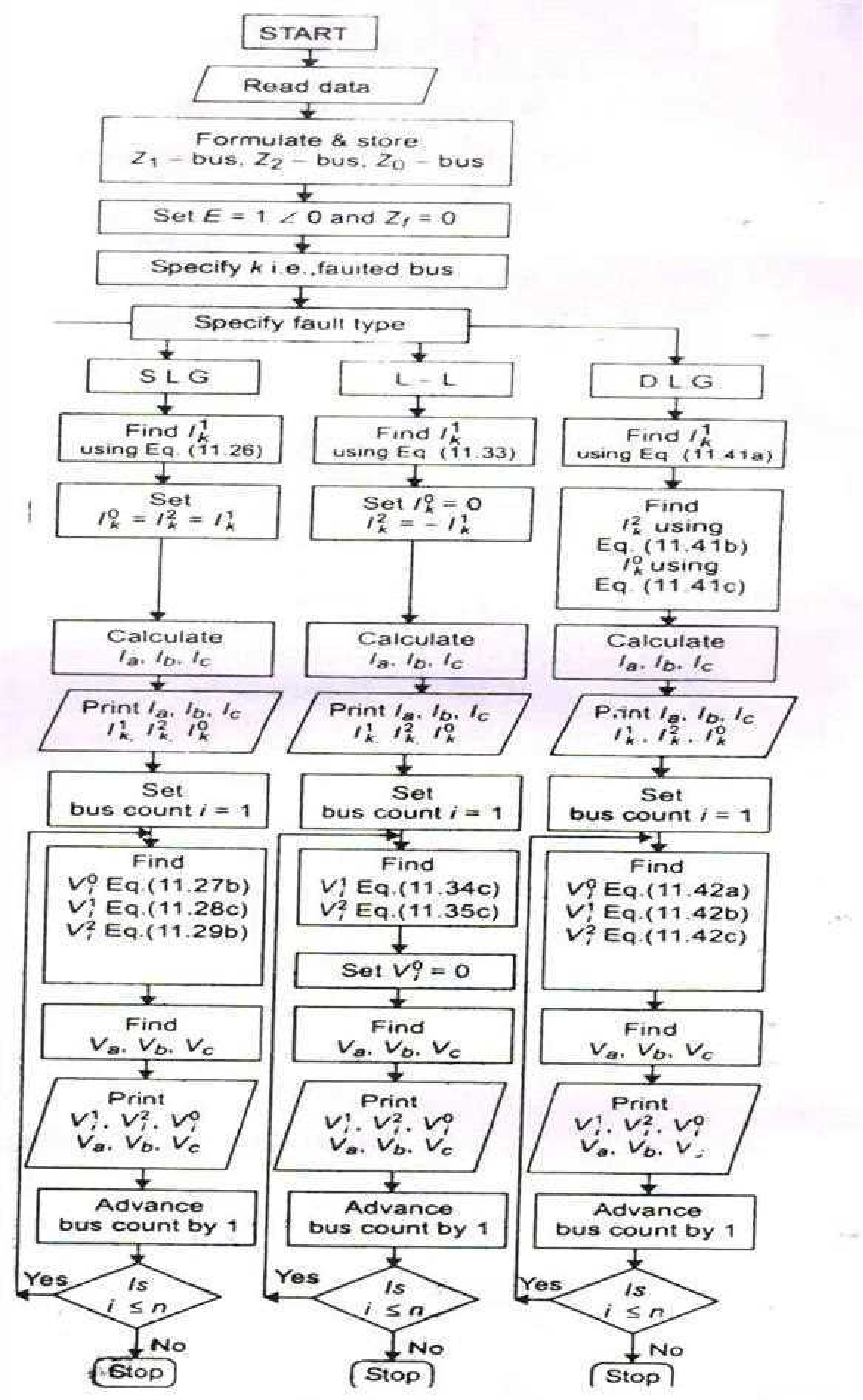
Given Data:

G1,G2: 100 MVA, 20 KV, X=X=Xd=20%

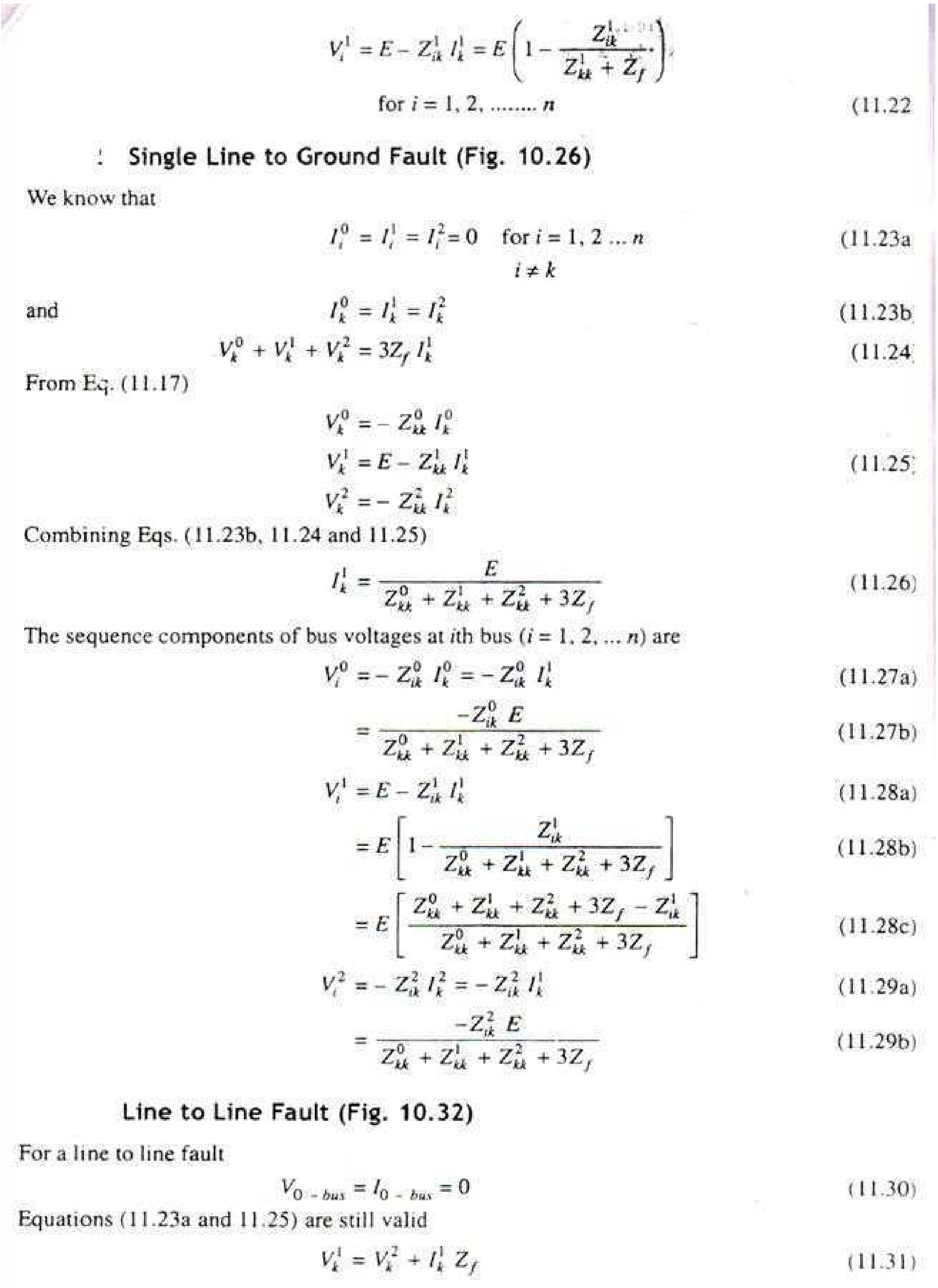
T1,T2: 100 MVA, 20KV/345, XL=8%

L1, L2; X=X= 15 %

## Flow Chart for Unsymmetrical Fault



## Equations



$$V_i^1 = E - Z_{ik}^1 I_k^1 = E\left(1 - \frac{Z_{ik}^1}{Z_{kk}^1 + Z_f}\right)$$

for $i = 1, 2, \ldots\ldots n$ (11.22

### Single Line to Ground Fault (Fig. 10.26)

We know that

$$I_i^0 = I_i^1 = I_i^2 = 0 \quad \text{for } i = 1, 2 \ldots n, \; i \neq k \qquad \text{(11.23a}$$

and

$$I_k^0 = I_k^1 = I_k^2 \qquad \text{(11.23b}$$

$$V_k^0 + V_k^1 + V_k^2 = 3Z_f I_k^1 \qquad \text{(11.24}$$

From Eq. (11.17)

$$\begin{aligned} V_k^0 &= -Z_{kk}^0 I_k^0 \\ V_k^1 &= E - Z_{kk}^1 I_k^1 \\ V_k^2 &= -Z_{kk}^2 I_k^2 \end{aligned} \qquad \text{(11.25}$$

Combining Eqs. (11.23b, 11.24 and 11.25)

$$I_k^1 = \frac{E}{Z_{kk}^0 + Z_{kk}^1 + Z_{kk}^2 + 3Z_f} \qquad \text{(11.26)}$$

The sequence components of bus voltages at *i*th bus ($i = 1, 2, \ldots n$) are

$$V_i^0 = -Z_{ik}^0 I_k^0 = -Z_{ik}^0 I_k^1 \qquad \text{(11.27a)}$$

$$= \frac{-Z_{ik}^0 E}{Z_{kk}^0 + Z_{kk}^1 + Z_{kk}^2 + 3Z_f} \qquad \text{(11.27b)}$$

$$V_i^1 = E - Z_{ik}^1 I_k^1 \qquad \text{(11.28a)}$$

$$= E\left[1 - \frac{Z_{ik}^1}{Z_{kk}^0 + Z_{kk}^1 + Z_{kk}^2 + 3Z_f}\right] \qquad \text{(11.28b)}$$

$$= E\left[\frac{Z_{kk}^0 + Z_{kk}^1 + Z_{kk}^2 + 3Z_f - Z_{ik}^1}{Z_{kk}^0 + Z_{kk}^1 + Z_{kk}^2 + 3Z_f}\right] \qquad \text{(11.28c)}$$

$$V_i^2 = -Z_{ik}^2 I_k^2 = -Z_{ik}^2 I_k^1 \qquad \text{(11.29a)}$$

$$= \frac{-Z_{ik}^2 E}{Z_{kk}^0 + Z_{kk}^1 + Z_{kk}^2 + 3Z_f} \qquad \text{(11.29b)}$$

### Line to Line Fault (Fig. 10.32)

For a line to line fault

$$V_{0\text{-}bus} = I_{0\text{-}bus} = 0 \qquad \text{(11.30)}$$

Equations (11.23a and 11.25) are still valid

$$V_k^1 = V_k^2 + I_k^1 Z_f \qquad \text{(11.31)}$$

ting the values for $V_k^1$ and $V_k^2$ from Eq. (11.25) into Eq. (11.31)

$$E - Z_{kk}^1\, I_k^1 = -\, Z_{kk}^2\, I_k^2 + I_k^1\, Z_f \tag{11.32}$$

e know that for a line to line fault $I_k^2 = -\, I_k^1$. Making this substitution in Eq. (11.32)

$$E - Z_{kk}^1\, I_k^1 = Z_{kk}^2\, I_k^1 + I_k^1\, Z_f$$

or

$$I_k^1 = \frac{E}{Z_{kk}^1 + Z_{kk}^2 + Z_f} \tag{11.33}$$

The positive and negative sequence voltages at *i*th bus ($i = 1, 2 \ldots n$) are

$$V_i^1 = E - Z_{ik}^1\, I_k^1 \tag{11.34a}$$

$$= E - Z_{ik}^1 \frac{E}{Z_{kk}^1 + Z_{kk}^2 + Z_f} \tag{11.34b}$$

$$= E\left[\frac{Z_{kk}^1 + Z_{kk}^2 + Z_f - Z_{ik}^1}{Z_{kk}^1 + Z_{kk}^2 + Z_f}\right] \tag{11.34c}$$

$$V_i^2 = -\, Z_{ik}^2\, I_k^2 \tag{11.35a}$$

$$= +\, Z_{ik}^2\, I_k^1 \tag{11.35b}$$

$$= \frac{Z_{ik}^2\, E}{Z_{kk}^1 + Z_{kk}^2 + Z_f} \tag{11.35c}$$

### Double Line to Ground Fault

From the equivalent circuit shown in Fig. 10.34, it can be inferred that

$$V_k^1 = V_k^2 \tag{11.36a}$$

$$V_k^0 - V_k^1 = 3 I_k^0 Z_f \tag{11.36b}$$

and

$$I_k^0 + I_k^1 + I_k^2 = 0 \tag{11.37}$$

Equations (11.23a and 11.25) are still valid. From Eqs. (11.25, 11.36 and 11.37)

$$I_k^1 = \frac{E - V_k^1}{Z_{kk}^1} \tag{11.38a}$$

$$I_k^2 = -\frac{V_k^2}{Z_{kk}^2} = -\frac{V_k^1}{Z_{kk}^2} \tag{11.38b}$$

$$I_k^0 = -\frac{V_k^0}{Z_{kk}^0} = \frac{-V_k^1}{Z_{kk}^0 + 3Z_f} \tag{11.38c}$$

Substituting Eqs. (11.38) into Eq. (11.37) we have

$$-\frac{V_k^1}{Z_{kk}^0 + 3Z_f} + \frac{E - V_k^1}{Z_{kk}^1} - \frac{V_k^1}{Z_{kk}^2} = 0$$

or

$$V_k^1 = \frac{E\,(Z_{kk}^0 + 3Z_f)\, Z_{kk}^2}{Z_{kk}^1\,(Z_{kk}^2 + Z_{kk}^0 + 3Z_f) + Z_{kk}^2\,(Z_{kk}^0 + 3Z_f)} \tag{11.39}$$

From Eq. (11.38)

$$I_k^1 = \left(Z_{kk}^2 + Z_{kk}^0 + 3Z_f\right) E/\Delta \quad (11.41a)$$

$$I_k^2 = -E\left(Z_{kk}^0 + 3Z_f\right)/\Delta \quad (11.41b)$$

$$I_k^0 = -E\, Z_{kk}^2/\Delta \quad (11.41c)$$

The sequence components of voltages at $i$th bus ($i = 1, 2 \ldots n$) are

$$V_i^0 = -\, Z_{ik}^0\, I_k^0 = E\, Z_{ik}^0\, Z_{kk}^2/\Delta \quad (11.42a)$$

$$V_i^1 = E - Z_{ik}^1\, I_k^1$$

$$= E\,[\Delta - Z_{ik}^1\,(Z_{kk}^2\, Z_{kk}^0 + 3\,Z_f)]/\Delta \quad (11.42b)$$

$$V_i^2 = -\, Z_{ik}^2\, I_k^2$$

$$= Z_{ik}^2\,[\,Z_{kk}^0 + 3Z_f)]E/\Delta \quad (11.42c)$$

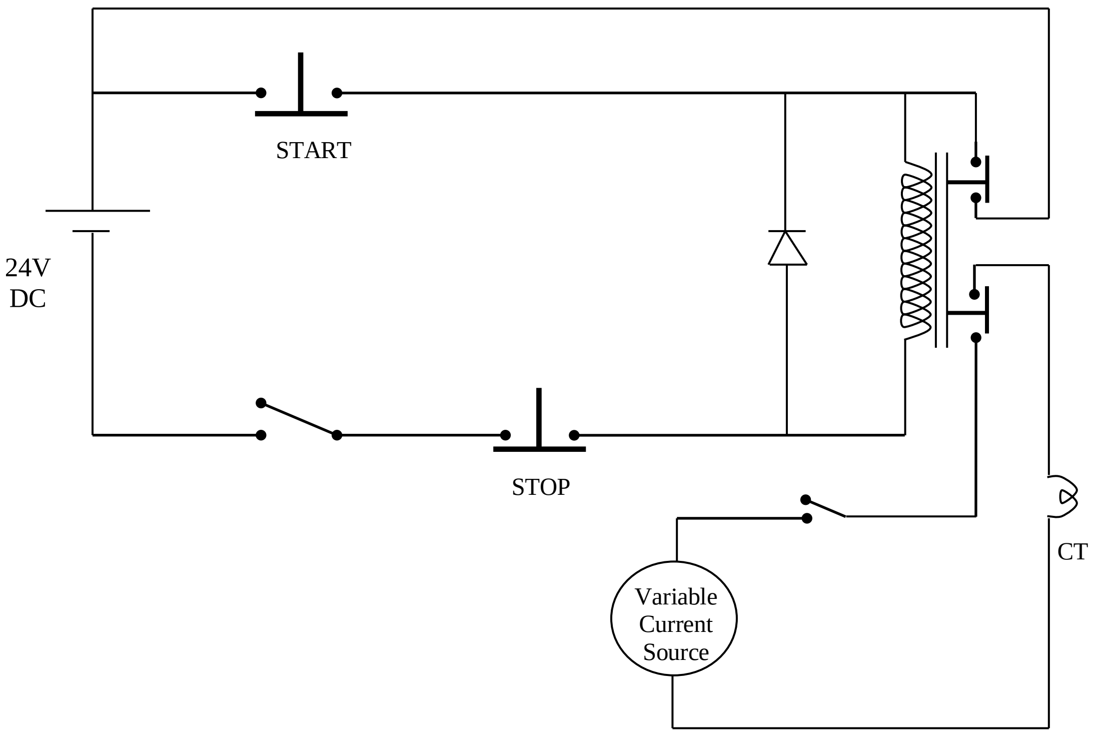
**Tabulation**

| S.No. | Fault Type | Bus No. | Fault MVA |
|---|---|---|---|
| 1. | SLG | 4 | |
| 2. | L-L | 4 | |
| 3. | DLG | 4 | |

**Result:**

For a given 3 phase 4 bus system, at Bus No.4 fault MVA estimated and tabulated for various Unsymmetrical Fault [SLG, L-L, DLG].

# TRIP CIRCUIT FOR OVER CURRENT RELAY (DMT TYPE)



# STUDY OF OVER CURRENT RELAY (DMT TYPE)

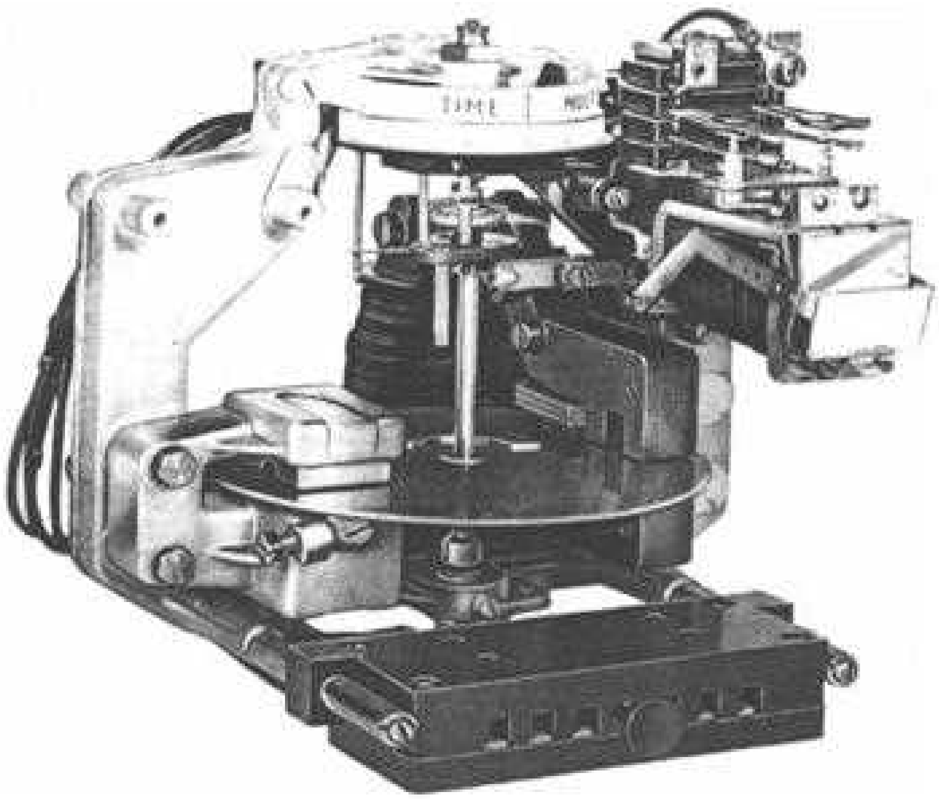
**Aim –** To study and Plot the IDMT characteristics of OC relay

**Apparatus required**

MC Based OC relay trainer

**Theory:**

As the name implies, it is a relay monitoring the current, and has inverse characteristics with respect to the currents being monitored. This (electromechanical) relay is without doubt one of the most popular relays used on medium- and low-voltage systems for many years, and modern digital relays' characteristics are still mainly based on the torque characteristic of this type of relay. Hence, it is worthwhile studying the operation of this relay in detail to understand its characteristics

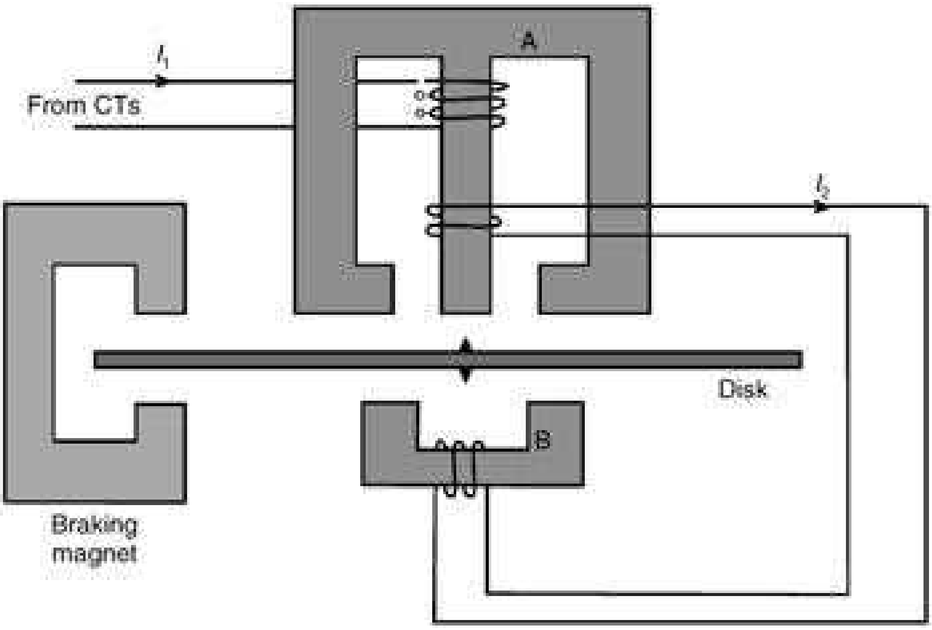


The current $I_1$ from the line CTs, sets up a magnetic flux A and also induces a current $I_2$ in the secondary winding which in turn sets up a flux in B. Fluxes A and B are out of phase thus producing a torque in the disk causing it to rotate. Now, speed is proportional to braking torque, and is proportional to driving torque. Therefore, speed is proportional to $I^2$.

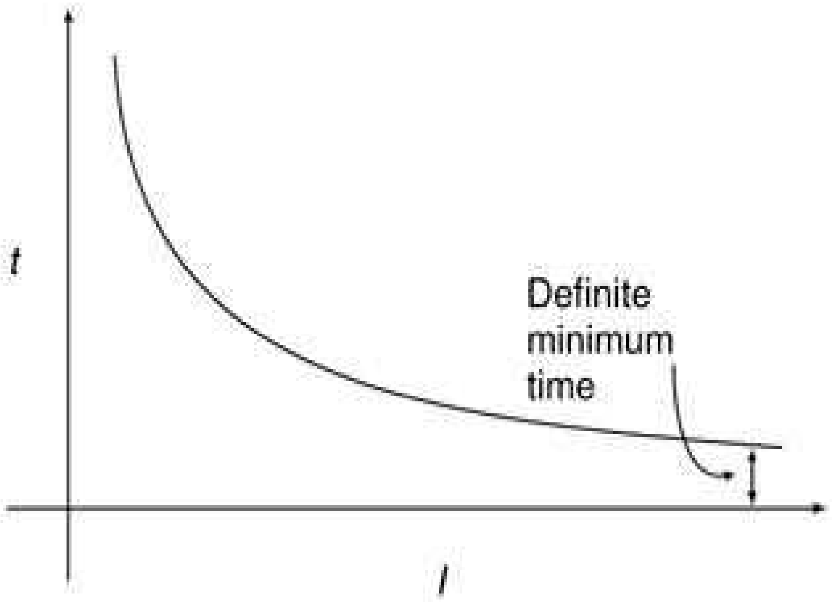
But, $\text{Speed} = \frac{\text{Distance}}{\text{Time}}$

Hence,

$$\text{Speed} = \frac{\text{Distance}}{\text{Time}} = \frac{1}{I^2}$$



This therefore gives an inverse characteristic (see Figure). It can be seen that the operating time of an IDMTL relay is inversely proportional to a function of current, i.e. it has a long operating time at low multiples of setting current and a relatively short operating.



The torque of these relays is proportional to f1f2 Sina, where f1 and f2 are the two fluxes and a is the angle between them. Where both the fluxes are produced by the same quantity (single quantity relays) as in the case of current or voltage operated, the torque T is proportional to I2, or T = K I2, for coil current below saturation. If the core is made to saturate at very early stages such that with increase of I, K decreases so that the time of operation remains the same over the working range. The time -current characteristic obtained is known as definite –time characteristic.

If the core is made to saturate at a later stage, the characteristic obtained is known as IDMT. The time-current characteristic is inverse over some range and then after saturation assumes the definite time form. In order to ensure selectivity, it is essential that the time of operation of the relays should be dependent on the severity of the fault in such a way that more severe the fault, the less is the time to operate, this being called the inverse-time characteristic.

This will also ensure that a relay shall not operate under normal overload conditions of short duration. It is essential also that there shall be a definite minimum time of operation, which can be adjusted to suit the requirements of the particular installation. At low values of operating current the shape of the curve is determined by the effect of the restraining force of the control spring, while at high values the effect of saturation predominates. Different time settings can be obtained by moving a knurled clamping screw along a calibrated scale graduated from 0.1 to 1.0 in steps of 0.05. This arrangement is called Time Multiplier Setting and will vary the travel of the disc required to close the contacts. This will shift the time-current characteristic of the relay parallel to itself. By delaying the saturation to a further point, the Very Inverse and Extremely Very Inverse time current characteristics can be obtained.

**Precautions:**

- Keep the MCB is in off condition
- Keep the Autotransformer is in Minimum Position
- Keep the Power ON/OFF switch is in off position .

**Connection Procedure:**

- Connect Current source output terminals C1A ( IN Front panel) to C1 ( Relay CT Input terminal)
- Connect Current source output terminals C2A ( IN Front panel) to C2 ( Relay CT Input terminal)

**Experimental Procedure:**

1. Switch ON the Power using Power ON/OFF Switch (IRS SWITCH)
2. SET THE RELAY Parameters –IDMT Mode (using procedure ( Mentioned in last page)
3. In Relay – set the set current value is 1A ( For example)
4. Switch ON the MCB
5. Press the START Button

➢ Apply current of 2A (Indicate the front panel ammeter) by Adjusting the Front panel Autotransformer.

➢ Now the fault current of 2A is set – while adjusting the autotransformer the relay may trip –don't consider this condition.

➢ Press Manual STOP Button.

- Now the set up is ready for applying Fault current of 2A – If relay is tripped press reset switch & again select IDMT Mode in relay – [set current value & time value will not change – it is maintaining previous set value.]

6. Press the START Button
7. Now the relay tripped after some time
8. Once the RELAY is tripped and the STOP CLOCK is automatically stopped and indicate the relay trip time , note down this trip time in table
9. Repeat the above procedure ( Procedure 1 to 5 ) with different Current setting
10. Draw graph Applied fault current Vs Measured tripping time- It gives IDMT Characteristics
11. Repeat the same with different VALUES of current setting

TABLE I

| **S.N** | **Applied Fault Current in Amp** | **Calculated tripping Time in ms** | **Measured Tripping Time in ms** | **Set Current** |
|---|---|---|---|---|
| 01 | 1.5A | | | **1A** |
| 02 | 3A | | | |
| 03 | 5A | | | |
| 06 | 10A | | | |

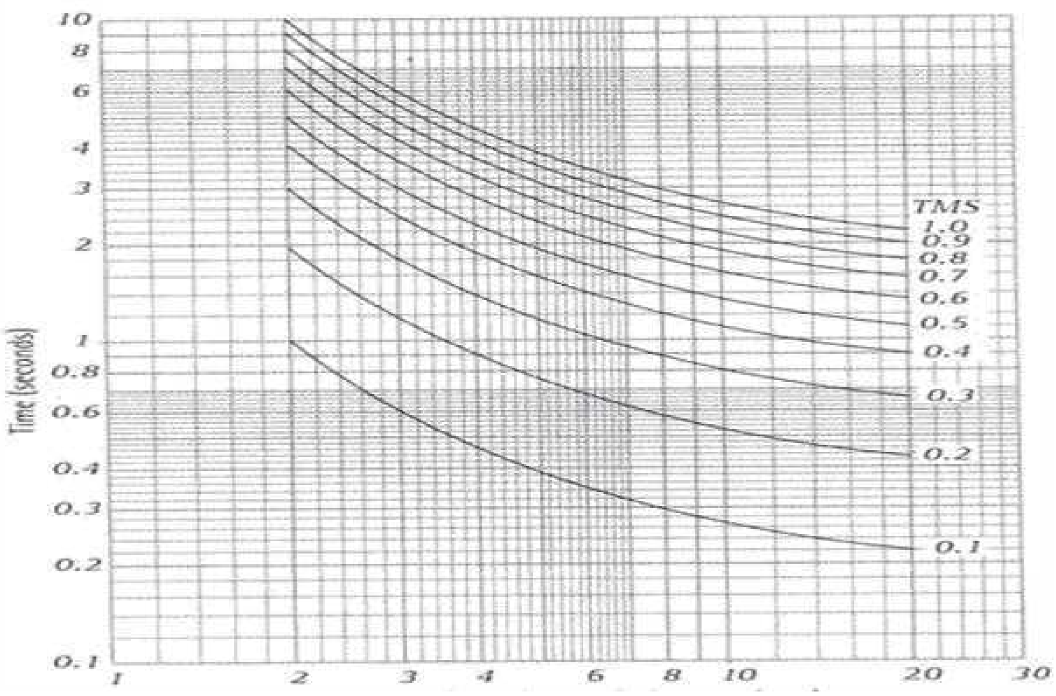
TABLE II

| **S.N** | **Applied Fault Current in Amp** | **Calculated tripping Time in ms** | **Measured Tripping Time in ms** | **Set Current** |
|---|---|---|---|---|
| 01 | 1.5A | | | **1.5 A** |
| 02 | 3A | | | |
| 03 | 5A | | | |
| 06 | 10A | | | |

TABLE III

| **S.N** | **Applied Fault Current in Amp** | **Calculated tripping Time in ms** | **Measured Tripping Time in ms** | **Set Current** |
|---|---|---|---|---|
| 01 | 1.5A | | | **2 A** |
| 02 | 3A | | | |
| 03 | 5A | | | |
| 06 | 10A | | | |

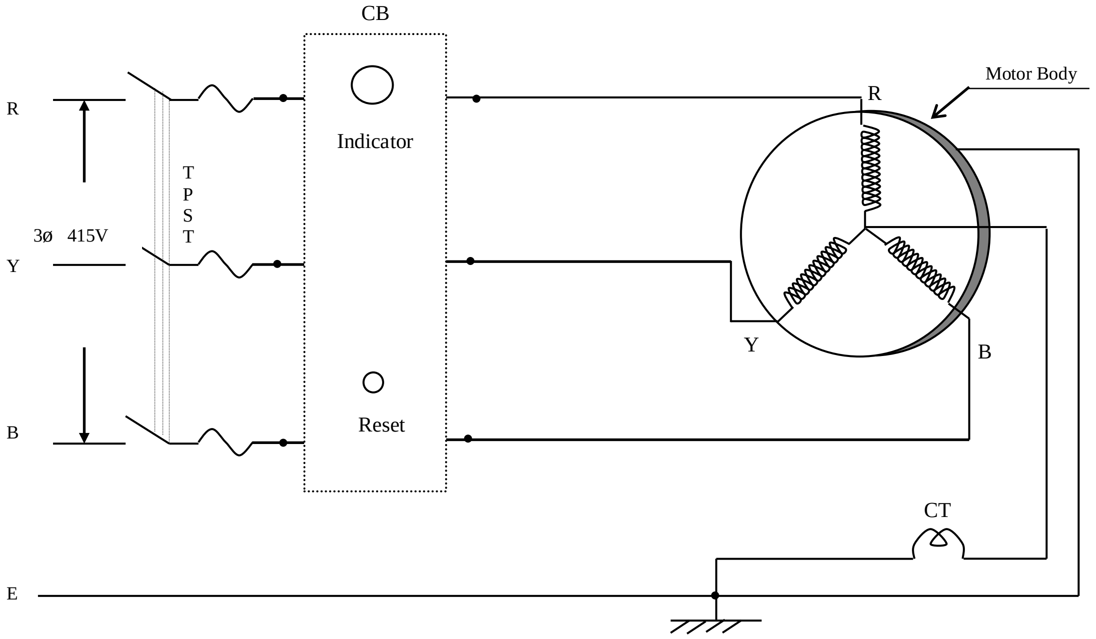
**Model Graph:**



**Result:**

The concept of Over current relay were studied using microcontroller based DMT relay test kit and values are tabulated.

# STUDY OF EARTH FAULT RELAY



# STUDY OF EARTH FAULT RELAY

**Aim –** To study and test the various types of Earth Faulty Relay.

**Apparatus required**

Earth Fault simulator and hardware set up (Motor set up)

**Theory:**

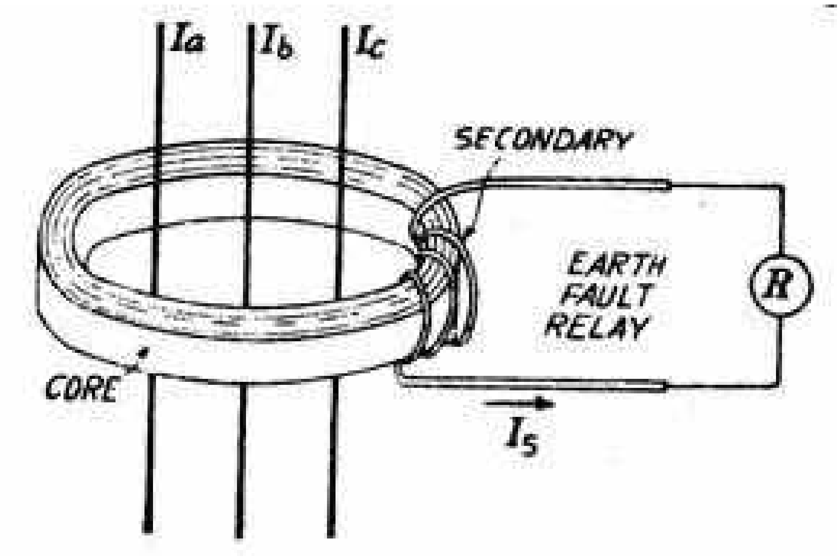
## 1. Earth-fault Relay connected in Neutral to Earth Circuit

One of the method of connecting an earth-fault relay is illustrated . The relay is connected to secondary of a CT whose primary is connected in neutral to earth connection. Such protection can be provided at various voltage levels by connecting earth-fault relay in the neutral-to-earth connection of that voltage level. The fault current finds the return path through the earth and then flows through the neutral-to-earth connected. The magnitude of earth fault current is dependent on type of earthing (resistance, reactance or solid) and location of fault. In this type of protection, The zone of protection cannot be accurately defined. The protected area is not restricted to the transformer/generator winding alone. The relay senses the earth faults beyond the transformer/generator winding hence such protection is called unrestricted earth-fault protection. The earth-fault protection by relay in neutral to earth circuit depends upon the type of neutral Earthing. In case of large generators, voltage transformer is connected between neutral and earth Earth-fault protection by earth-fault-relay connected in neutral-to-earth circuit.

## 2. Combined Earth-fault and Phase-fault Protection

It is convenient to incorporate phase-fault relays and earth-fault relay in a combined phase-fault and earth-fault protection. (Fig. 4) The increase in current of phase causes corresponding increase in respective secondary currents. The secondary current flows through respective relay-units Very often only two-phase relays are provided instead of three, because in case of phase faults current in any at least two phases must increase. Hence two relay-units are enough.

## 3. Earth-fault Protection with Core Balance Current Transformers. (Zero Sequence CT)



In this type of protection (Fig. 6) a single ring shaped core of magnetic material, encircles the conductors of all the three phases. A secondary coil is connected to a relay unit.

## 4. Principle of core-balance CT for earth fault protection

Ample, so that saturation is not a problem. During no-earth-fault condition, the components of fluxes due to the fields of three conductors are balanced and the secondary current is negligible. During earth faults, such a balance is disturbed and current is induced in the secondary. Core-balance protection can be conveniently used for protection of low-voltage and medium voltage systems. The burden of relays and exciting current are deciding factors. Very large cross-section of core is necessary for sensitivity less than 10 A. This form of protection is likely to be more popular with static relays due to the fewer burdens of the latter. Instantaneous relay unit is generally used with core balance schemes.

Let $I_a$, $I_b$ and $I_c$, be the three line currents and $\Phi_a$, $\Phi_b$ and $\Phi_c$ be corresponding components of magnetic flux in the core. Assuming linearity, we get resultant flux $\Phi$ as, $\Phi = k\,(I_a + I_b + I_c)$

where k is a constant $\Phi = K * I_a$. Referring to theory of symmetrical components

$(I_a + I_b + I_c) = 3\,I_c = I_n$

Where, $I_o$ is zero sequence current and In, is current in neutral to ground circuit. During normal condition, when earth fault is absent,

$(I_a + I_b + Ic) = 0$

Hence $\Phi r = 0$ and relay does not operate

During earth fault the earth fault current flows through return neutral path.

For example for single line ground fault,

$I_f = 3I_{ao} = I_n$

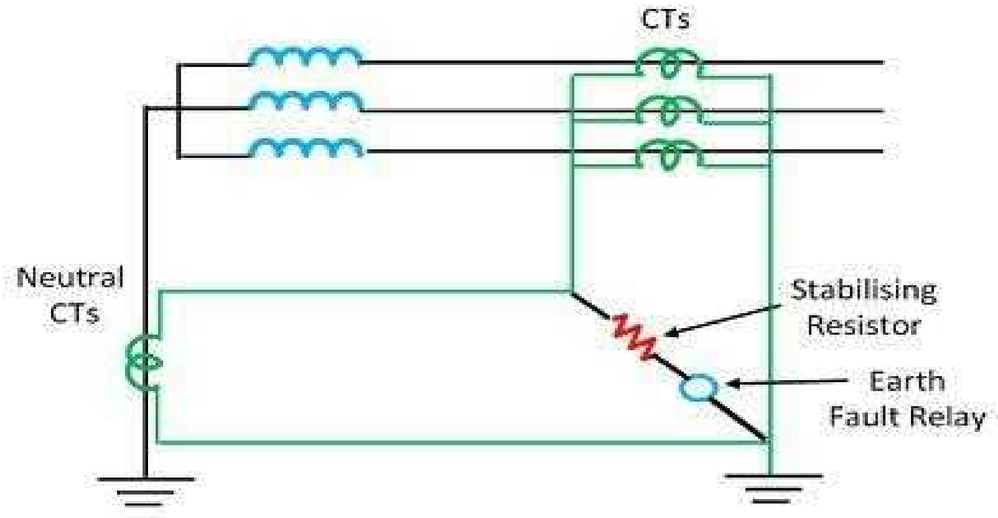
Hence the zero-sequence component of $I_o$ produces the resultant flux $\Phi r$ in the core. Hence core balance current transformer is also called as zero sequence current transformers (ZSCT).

## 5.Restricted Earth Fault Protection:

Earth fault is the unintended fault between the live conductor and the earth. It also occurs, because of the insulation breakdown. When the fault occurs the short-circuit currents flow through the system, and this current is returned through the earth or through any electrical equipment. This fault current damaged the equipment of the power system and also interrupted the continuity of the supply.

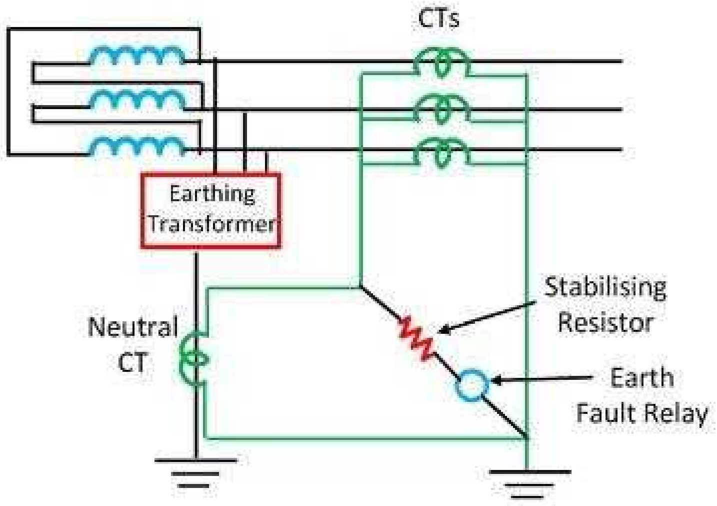
The earth fault can be dispersed by using the restricted earth fault protection scheme. The earth fault protection scheme consists the earth fault relay, which gives the tripping command to the circuit breaker and hence restricted the fault current.

Earth fault relay connected in the residual part of the line CTs (current transformer) provides protection against earth fault on the delta or unearthed star-connected windings of the power transformer. The connection with restricted earth fault protection for star-connected and delta connected windings are shown in the figure below



Neutral Earthed within the Protected Zone of the Star Winding of the Transformer

Circuit Globe



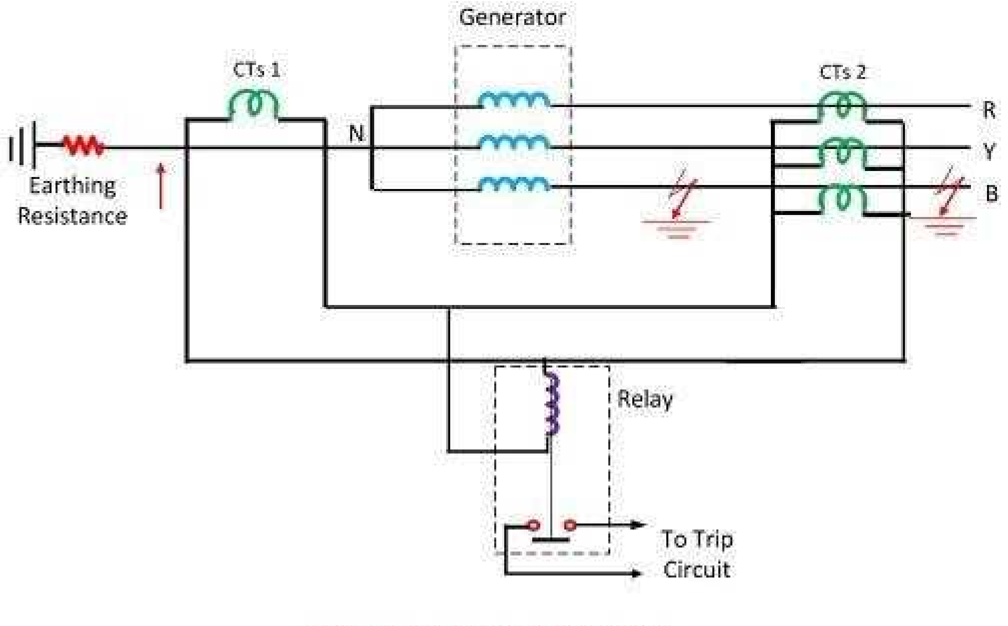
Neutral Earthed within the Protected Zone of the Delta Winding of the Transformer

Circuit Globe

The current transformer is fitted in each connection which is to be protected and secondary of the CTs are connected in parallel to a relay. When the system is in the protected zone, the output of the current transformers is equal to the zero sequence current in the line. When the short circuit current flow through the system the external fault zero system current is absent and the internal fault zero sequence current is twice the total fault current.

## 6.Connection of Balanced Earth Fault Protection Scheme:

In this scheme, the current transformers are mounted on each phase. Their secondary is connected in parallel with that of CT mounted on a conductor joining the star point of the generator to earth. A relay is connected across the secondaries of the CTs.



Balanced Earth Fault Protection

Circuit Globe

The balanced protection schemes provide protection against earth fault in the limited region between the neutral and line CTs (current transformers). It provides protection against the stator winding of the earth fault in the stator and does not operate in case of an external earth fault. This scheme is also called restricted earth fault protection scheme. Such type of protection is provided in the large generator as an additional protection scheme.

### Working of Balanced Earth Fault Protection Scheme

When the generator is in a normal operating condition the sum of the currents flow in the secondary of the current transformers is zero and the current flow into secondary to neutral is also zero. Thus the relay remains de-energized. When the fault occurs in the protected zone (left of the line) the fault current flow through the primary of current transformers and the corresponding secondary current flow through the relay which trips the circuit breaker.

When the fault develops external of the protective zone (right of the current transformer) the sum of the currents at the terminal of the generator is exactly equal to the current in the neutral connection. Hence, no current flows through the relay operating coil.

### Drawback of Balanced Earth Protection Scheme

If the fault occurs near the neutral terminal or when grounding of the neutral is connected through a resistance or a distributing transformer then the magnitude of the fault current flow through the secondary of current transformer becomes small. This current is less than the pick-up current of the relay. Thus, the relay remains inoperative, and the fault current continues to persist in the generator winding which is highly undesirable.

## **Hardware details :**

This set up is designed to study the working principle and IDMT characteristics of Earth Fault relay (Micro controller type). This set up consists of

1. Micro controller based –Earth Fault Relay –IDMT Type
2. Earth Fault simulator set up (Motor set up)

## Micro controller based –Earth Fault Relay –IDMT Type

## Earth Fault simulator set up (Motor set up)

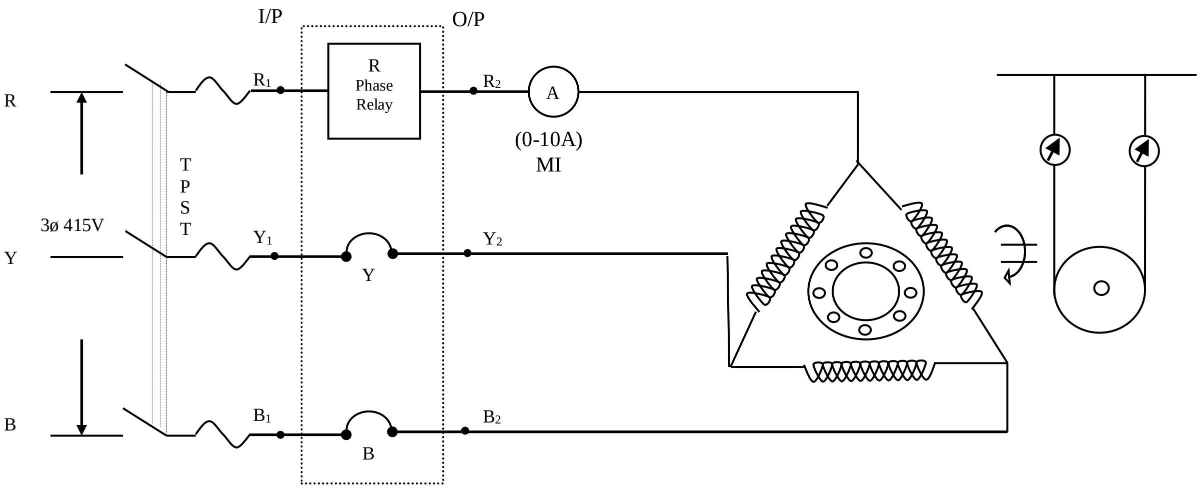
This simulator is designed to test the earth fault relay with IDMT characteristics. It consists of

- One number of 3 phase ac induction motor/0.5hp/3 phase/1440rpm-siemens Make is provided For short circuit /earth fault creation
- One number of short circuit resistor is provided to limit short circuit /Earth current

**Result:**

The concept of earth fault relay were studied using microcontroller based IDMT relay test kit.

# OVER CURRENT PROTECTION OF 3 PHASE INDUCTION MOTOR



IDMT Over Current Relay
Test Kit

# OVER CURRENT PROTECTION OF 3 PHASE INDUCTION MOTOR

## Aim:

To study the over current protection of 3 phase induction motor using IDMT Over current electromagnetic relay.

## Apparatus Required:

| Sl.No. | Name of the apparatus | Type | Range | Quantity |
|---|---|---|---|---|
| 1. | IDMT Over current Relay Test Kit | Electro Magnetic | - | 1 |
| 2. | Induction motor | Squirrel cage | - | 1 |
| 3. | Ammeter | MI | (0-10)A | 1 |

## Name plate details:

1. Power – 5.5 Kw
2. Voltage – 415 V
3. Current – 7A
4. Frequency – 50 Hz.
5. Speed –149 rpm.

## Fuse Rating:

125 % of rated current

## Precautions:

1. TPST should be in open condition.
2. There should not be any load initially.

**Procedure:**

1. The connections are made as pert her circuit diagram.
2. With no mechanical load on the motor, it is started by direct on line starter.
3. The belt is tightened against the break drum. The applied to the motor is varied. It is verified with kit ammeter and the external connected ammeter.
4. For the settled fault current and time the theoretical and practical operating time is verified.
5. For various fault current the same procedure is repeats.

**Tabular Column:**

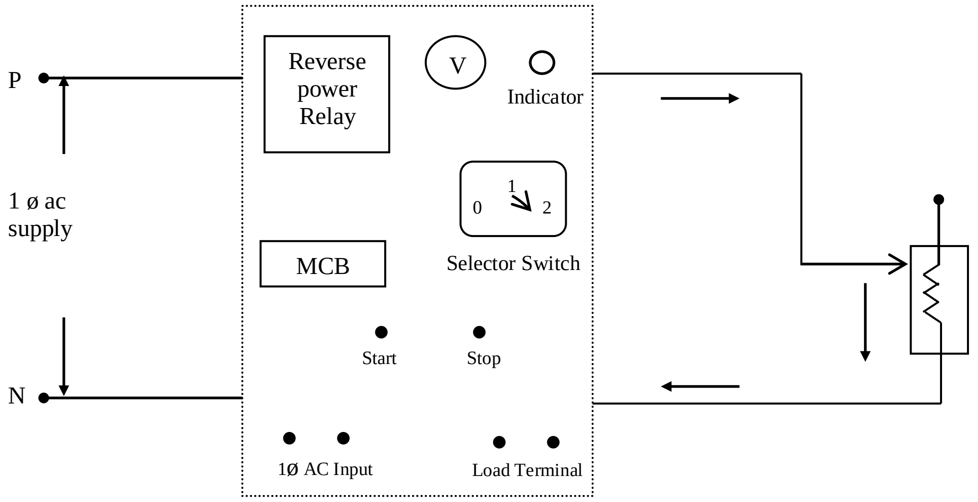
| Sl.No. | Flux Set in Relay | Fault Current | Relay Tripping Time in sec. | |
|---|---|---|---|---|
| | | | Theoretical | Practical |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |

**Result:**

The concept of over current protection were studied using IDMT over Current Relay Test Kit.

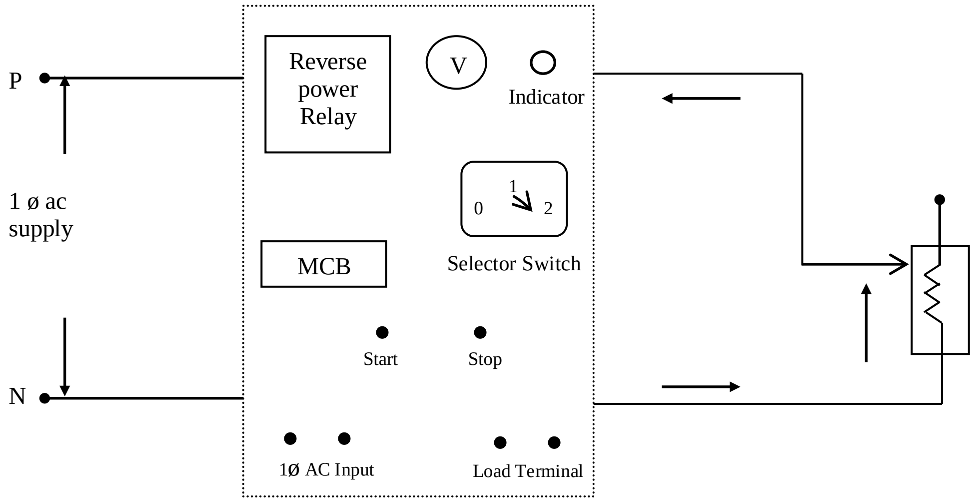
# STUDY AND TESTING OF REVERSE POWER RELAY

## Test set up (normal condition)



Microprocessor based
Reverse power Relay
Test Kit

## Test set up (abnormal condition)



Microprocessor based
Reverse power Relay
Test Kit

# STUDY AND TESTING OF REVERSE POWER RELAY

## Aim:

To study and testing of reverse power relay using reverse power relay test kit.

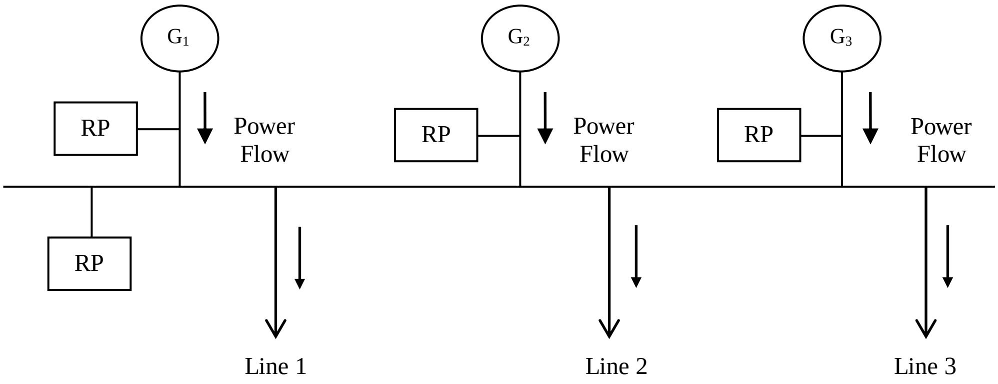
## Apparatus Required:

| Sl.No. | Name of the apparatus | Type | Range | Quantity |
|---|---|---|---|---|
| 1. | Reverse Power Relay Test Kit | Microprocessor Based | - | 1 |
| 2. | Rheostat | Wire wound | - | 1 |

## Theory:

Reverse power relay is a directional protective relay that prevents/protects the generator from motoring effect (going to reverse direction) it is used where generators run in parallel with other utility or generator. The relay monitors the power supply from the generator and in case the generator output faults below a preset value, it quickly activate the trip and disconnect the generator.

**Generating Station**

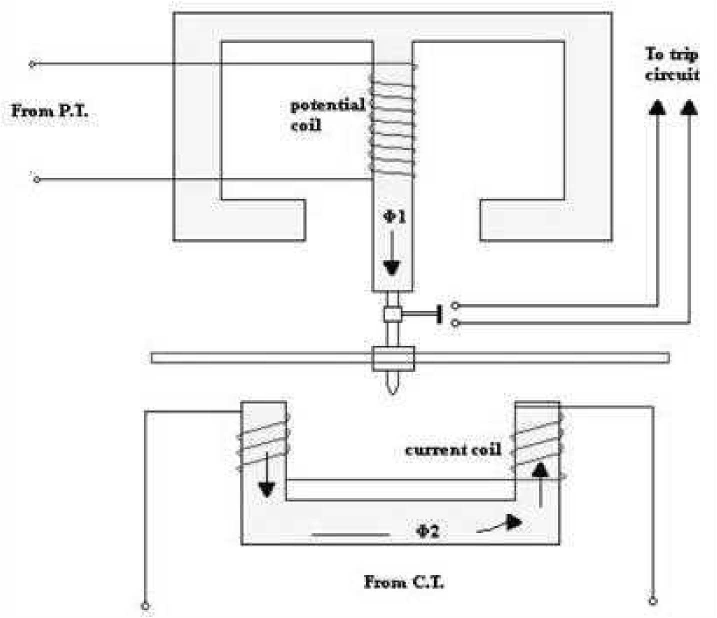


**Procedure:**

The concept of reverse power relay studied using reverse power relay it. In that kit single phase ac supply act as source (Generator) and rheostat act as a load (Busbar line).

1. The single phase ac supply is given to the kit through MCB.
2. During the condition the selector switch is positioned to 1 (normal).
3. For that load condition using voltmeter and relay electrical parameters are noted (V, I, F, P). During that period wealthy LED will glow that indicates normal power flow.
4. To realize the operation of the relay under reverse power flow (abnormal condition), the selector switch is positioned to 2.
5. At this condition the current reverse in direction form load to source ( single phase ac supply) which is treated as abnormality.
6. To prevent this the relay gets energized and contact action is realized.

**Construction of Reverse Power Relay:**



**Result:**

The concept of reverse power relay were studied using microcontroller based reverse power Relay Test Kit.

Exp. No.:7 Date:

## STUDY AND TESTING OF IMPEDENCE RELAY

**Aim:**

To study and testing of impedance relay using micro controller based distance relay kit.

**Apparatus Required:**

| Sl No. | Name of the apparatus | Type | Range | Quantity |
|---|---|---|---|---|
| 1. | Impedance Relay Test Kit | Microcontroller Based | 5A | 1 |
| 2. | Rheostat | Wire wound | 300ohm/1.8 A | 1 |
| 3. | Ammeter | MI | (0-5) Amps | 1 |

**Theory:**

In such type of relay, the torque is induced by the electromagnetic action on the voltage and current. These torques are compared. Consider the circuit of the electromagnetic type induction relay. The solenoid B is excited by the voltage supplied of the PT. This voltage develops the torque in the clockwise direction, and it pulls the plunger $P_2$ in the downward direction. The spring connects to the plunger $P_2$ apply the restraining force on it. This spring generates the mechanical torque in the clockwise direction.

The solenoid A generates the other torque in the clockwise direction and thus moves the plunger $P_1$ downwards. The solenoid one is excited by the CT of the lines. This torque is called the deflecting or pick up torque.

When the system is free from fault, the contacts of the relay become open. When the fault occurs in the protective zone, the current of the system rises because of which the current across the relay also increases. The more torque developed on the solenoid A. The restoring torque because of the voltage decreases. The balance arms of the relay start rotating in the opposite direction, thus closed their contacts.

**Procedure:**

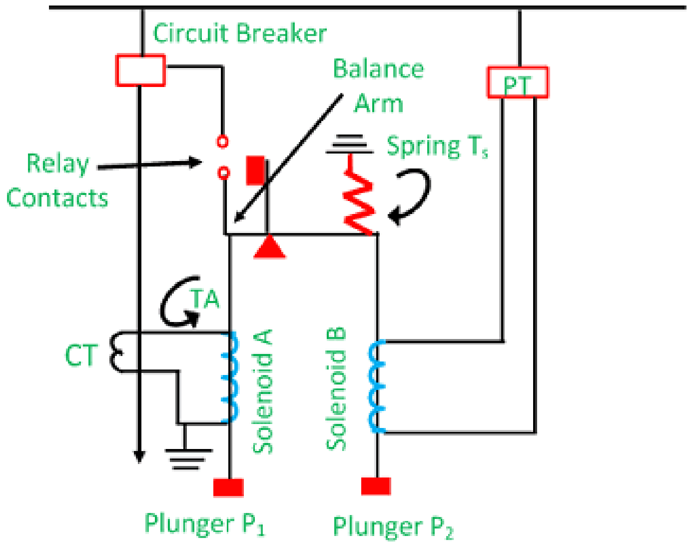
The concept of impedance relay studied using distance relay kit it. In that kit single phase ac supply act as a source (Generating station or substation bus bar) and rheostat act as a load (Transmission line).

The connections are made as per the circuit diagram.The single phase ac supply is given to the kit by varying single phase auto transformer

1. For the setted value , current and resistance set the value of impedance of the Transmission lion calculated and value setted in the relay.
2. For the normal condition for setted value of impedance, the relay will not operated.
3. To realize the operation of faulted condition the setted value resistance is changed manually.
4. Due to the changing resistance, the impedance value falls below the already setted value.

The Micro controller relay detects the changing impedance value and it operates trips circuits after the setted time delay.

**Construction of Distance Relay (Electromagnetic Type):-**



Electromagnetic Type Impedance Relay

**Tabular Column:**

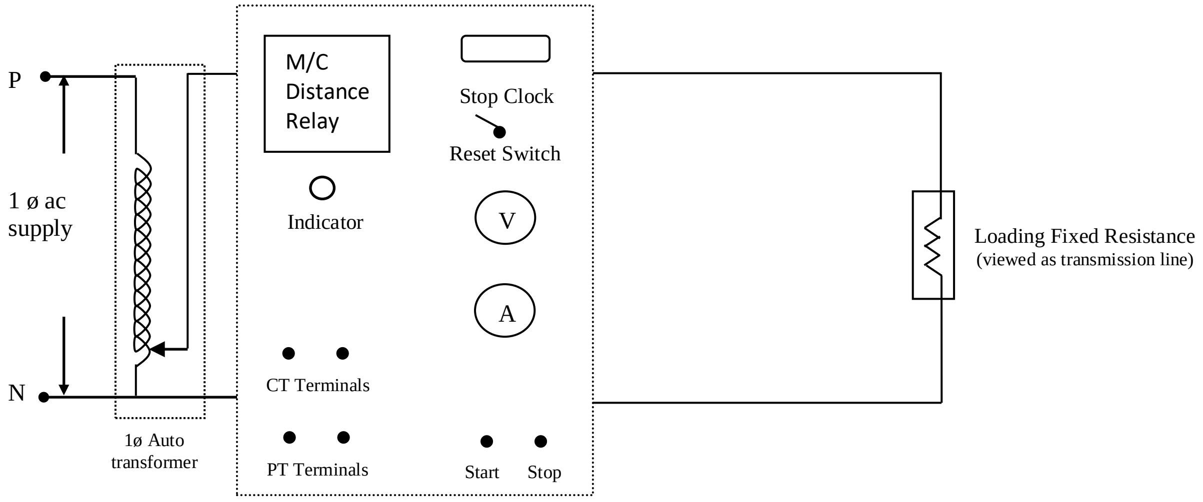
| Sl.No. | Voltage | Current | Impedance | Set time | Circuit Condition | |
|---|---|---|---|---|---|---|
| | | | | | Normal | Fault |
| 1. | | | | | Not Tripped | - |
| 2. | | | | | - | Tripped |

**Result:**

The concept of impedance relay were studied using microcontroller based distance relay test kit

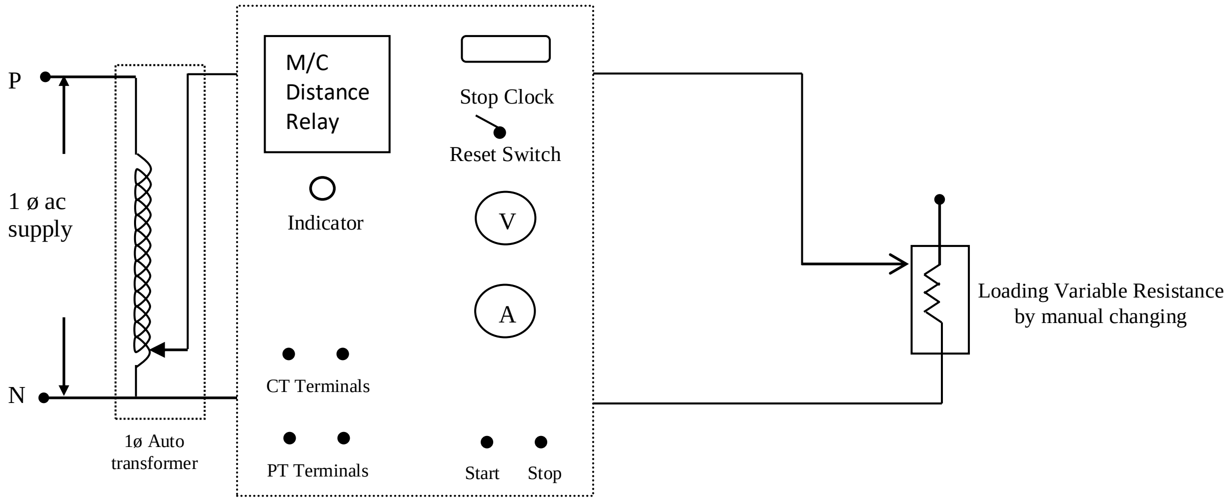
# STUDY AND TESTING OF IMPEDANCE RELAY

## Test set up (normal condition)



Microcontroller based Impedance Relay test kit

## Test set up (Fault condition)



Microcontroller based Impedance Relay test kit