

Department of
Electrical Engineering

LAB MANUAL

Power System-2 Lab

B.Tech– VI Semester



KCT College OF ENGG AND TECH.

VILLAGE FATEHGARH

DISTT.SANGRUR

INDEX

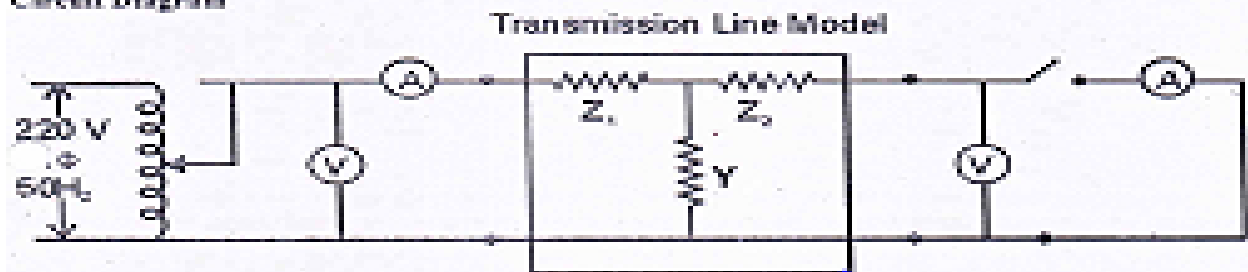
S.no.	Experiment name
1	To study the performance of a transmission line. Also compute its ABCD parameters.
2	To measure the ground resistivity by using spikes .
3	To study the operating characteristics of fuse. (HRC or open type)
4	To study the Characteristics of miniature Circuit breaker.
5	To study the different types of faults in three phase transmission line
6	To find out the dielectric strength of Transformer oil.
7	To study the protection of equipment and system by relays in conjunction with switchgear.
8	To determine the operating characteristic of an induction type Under Voltage Relay.

Experiment 1.

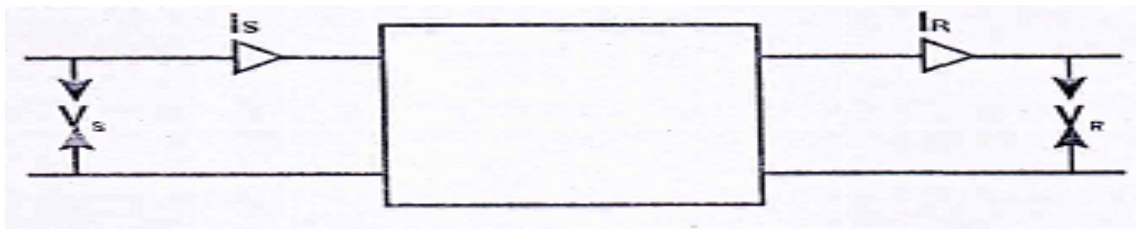
Aim :- To study the performance of a transmission line. Also compute its ABCD parameters.

Apparatus :-Transmission line model consisting of four sections of transmission line (220v ,2A) connected in T network , Voltage variable auto T/F (0-220), digital voltmeter and ampere meter

Circuit Diagram



Theory :-ABCD parameter are widely used in analysis of power transmission engineering where they are termed as generalized circuit parameters ABCD parameters are called as Transmission parameter . it is conventional to designate the input port as sending end and the output port as receiving end while representing ABCD parameters .



ABCD parameters equations are given

$$\begin{aligned} V_S &= AV_R + BI_R \\ I_S &= CV_R + DI_R \end{aligned}$$

Assuming the receiving end open circuited ,i.e.

This gives $A = V_s/V_r$ reverse voltage ratio and is unitless

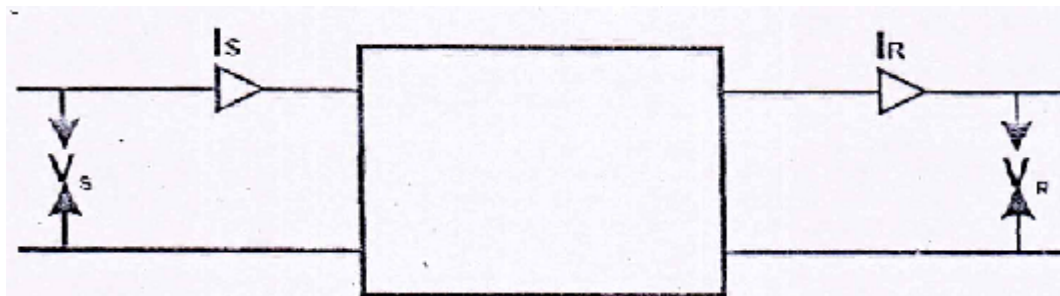
$C = I_s/V_r$ reverse transfer admittance unit is mho .

Now receiving end is short circuited then $B = V_s/I_r$ forward transfer impedance and expressed in ohm .

$D = I_s/I_r$ reverse current ratio and it is unitless

In hybrid parameter representation both short and open circuit terminal condition are utilized hence this parameter representation is known as hybrid parameter representation .

For the part 2 network allow .



Here

$$\begin{aligned} V_s &= h_{11} I_s + h_{12} V_r \\ I_r &= h_{21} I_s + h_{22} V_r \end{aligned}$$

If receiving end is short circuited $V_r=0$

Then $h_{11} = \frac{V_s}{I_s}$ Input impedance and unit is ohm's

$h_{21} = \frac{I_R}{I_s}$ Forward current gain and it is a unit less quantity.

In a similar way for the sending end open circuited i.e. $I_s = 0$

$h_{12} = \frac{V_s}{V_R}$, Reverse voltage gain and has no unit.

$H_{22} = \frac{I_R}{V_D}$, Output admittance and is expressed in mho.

In a transmission line if the impedance of the sending end with Z_{12} at receiving end be Z_{i1} and simultaneously the impedance looking back from receiving end with Z_{i1} at input port is Z_{i2} then Z_{i1} and Z_{i2} are termed as the image impedance of the network .

We can conveniently express the image impedance in terms of ABCD constant as:-

$$Z_{i1} = \sqrt{\frac{AB}{CD}}$$

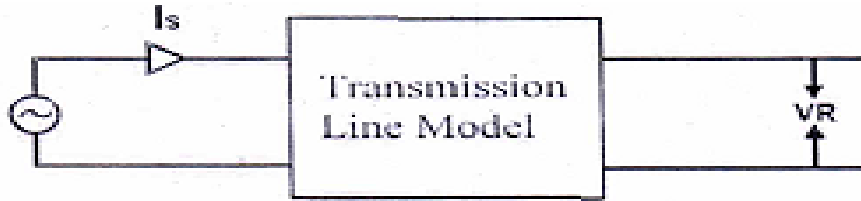
$$Z_{i2} = \sqrt{\frac{BD}{AC}}$$

However image impedance does not completely define a network . We need another parameter which we shall get from the voltage and current ratio as image transfer constant and be calculated

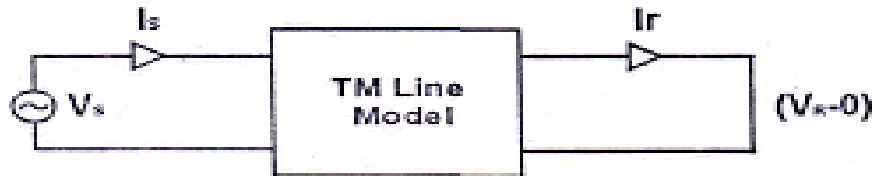
$$\sigma = \frac{1}{2} \ln \frac{V_s I_s}{V_r I_r} = \tanh^{-1} BC/AD$$

Calculation and observation

ABCD Parameters ($I_r=0$)

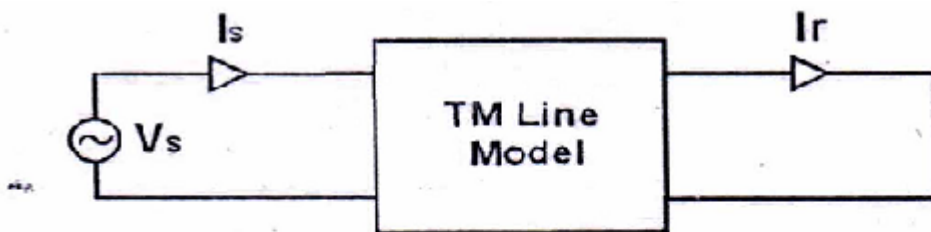


Sr. No	Vs	Is (mA)	VR	$A = \frac{V_S}{V_R}$	$C = \frac{I_S}{V_R}$
1	223	510	229	.9738	2.223×10^{-3}
2	152	350	156	.9744	2.243×10^{-3}
3	106	240	109	.9725	2.202×10^{-3}

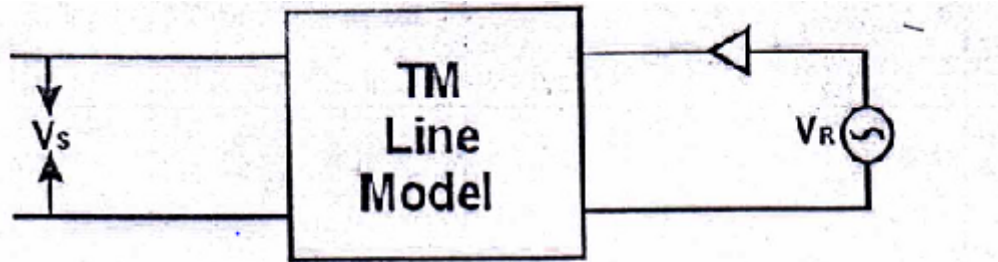


Sr. No	Vs	Is	Ir	$B = \frac{V_S}{I_r}$	$D = \frac{I_S}{I_r}$

Hybrid parameters



Sr. No	Vs	Is	Lr	$h_{11} = \frac{V_S}{I_S}$	$h_{21} = \frac{I_r}{I_S}$



Sr. no	VR	Is	Vs	$h_{12} = \frac{V_s}{V_r}$	$h_{21} = \frac{I_r}{V_r}$

iii) Image Parameter

$$Z_{i1} = \frac{\sqrt{AB}}{\sqrt{CD}} \dots\dots\dots (i)$$

$$\lambda = \frac{\sqrt{BC}}{\sqrt{AC}} \dots\dots\dots (ii)$$

$$\sigma = \tan h^{-1} \frac{\sqrt{BC}}{\sqrt{AD}} \dots\dots\dots (iii)$$

Procedure:-

- i) To find out A and C parameters connect voltage supply of 220v to sending end and open circuit receiving end .
- ii) Observe the value of Vs , Is and Vr with the help of voltmeter and ammeter .
 - i) Observe the value of Vs, Is and Ir .
 - ii) To find out B and D receiving end is short circuited and supply of 220v is giving to sending end

To find out the value of h teach the reading of Vs ,Is and Ir

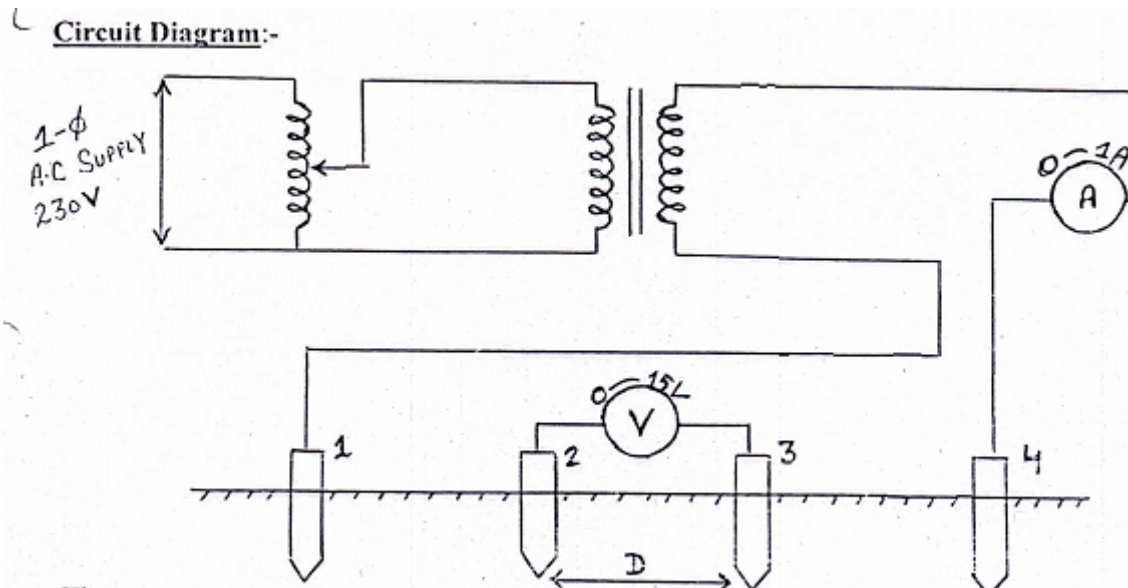
- i) To find out the value of h supply the 220 v at receiving and terminal and open circuit the sending end terminal
- ii) Note down the value of Vs , Vr,Ir

To find out the image parameter takes the value of A,B,C,D, from the equations of i) and ii)

Experiment No. -2

Aim:- To measure the ground resistivity by using spikes .

Apparatus :- Ammeter (0-1A) , Voltmeter (0-15V) earth electrode , connecting wires ,variance etc.



Theory:_ Ground resistivity is measured by four electrode methods suggested by F,Weener . test set up four metal rods whose diameter is small as compared to length are driven into earth at equal distance. A known current I is measured between 2nd & 3rd

The current I produced an electric field proportional to current density & soil resistivity . the voltage V is proportional to the ratio V/I is given by

$$\rho = \frac{4 \pi D V / I}{1 + \frac{2D}{\sqrt{(b^2 + 4D^2)}} - \frac{2D}{\sqrt{4D^2 + 4b^2}}}$$

Where ρ = soil resistivity in ohm-meter
 D = horizontal distance between two successive electrodes in meters .
 B = depth of buried in meters.
 If $B \ll D$ equation 1 simplified to

If ratio $B/D < 0.1$ from equation 2 gives sufficient accuracy

For measurement in field earth tester based on above principle are available . They are calibrated ti indicate the ratio V/I directly . if measurements are to be made using main

supply an isolating transformer should be connected between the main supply & test setup so that residual earth currents do not effect the results .

The average value of ρ obtained from these measurements should be used in diagram

Procedure:-

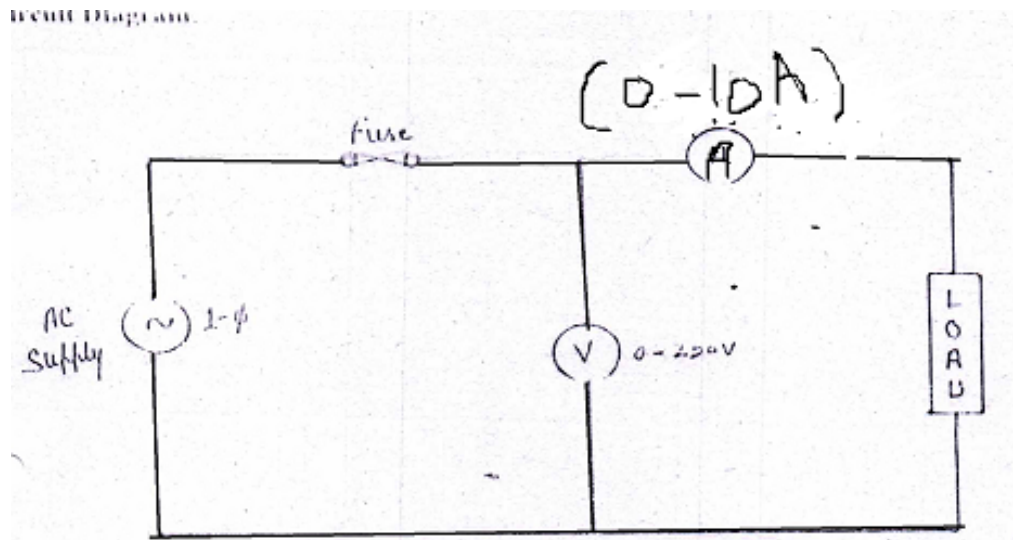
- 1) Make the connection as shown in diagram
- 2) Use actual four rods .
- 3) Make the connections tight .
- 4) Use voltmeter and ammeter and make connections tight .

Experiment No. -3

Aim:- To study the operating characteristics of a fuse .

Apparatus :- A kit of connecting wires ,power supply , fuse .

Circuit Diagram :-

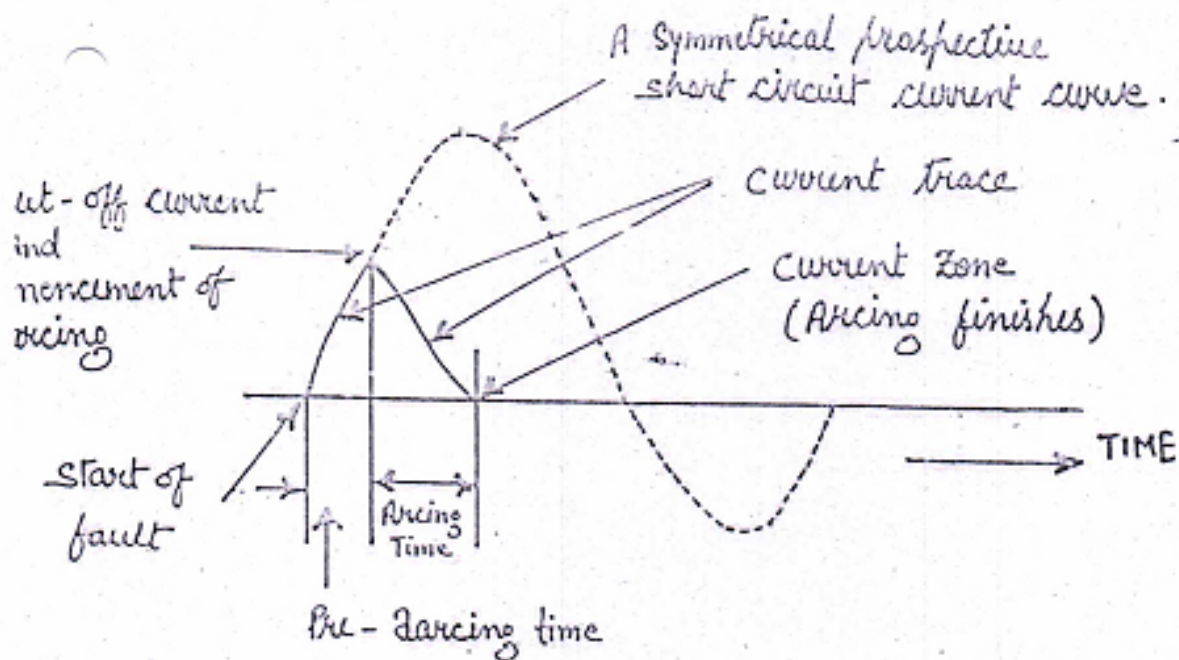


Technical Data :-

Voltage rating	415 V
Current rating	6A
Specification	CM/L-1375654

Theory :-

A current limiting protective device cuts off a short circuit in less than one half cycle and that too before it reaches its total prospective highly destructive value. Fuses are current limiting devices. By maintaining a minimum ratio of fuse – ampere rating between upstream and downstream fuse selective coordination is assured which prevents the power failure caused over current conditions.



Procedure :-

- 1) Make the connections as shown in circuit diagram
- 2) Now vary the load gradually till the rated current of fuse flows in the circuit. The reading of ammeter & voltmeter and note the time at which fuse blows
- 3) Now increase the load in small steps. Record the reading of voltmeter and ammeter
- 4) Repeat the above step.
- 5) Plot the graph between time and current

Observation table :-

S.no.	Voltage	Current	Time (in sec.)

Conclusion :-

As the fault current increases the operating time of fuse reduces

Experiment No:-4

Aim:- To study the Characteristics of miniature Circuit breaker.

Apparatus :-

S.no.	Name of apparatus	Range	Quantity
1	Ammeter	0.5-10 A	1
2	Voltmeter	250-500 V	1
3	Mini circuit Breaker	240-415V	1
4	Variable load		1

Technical Data :-

Voltage rating - 240-415V

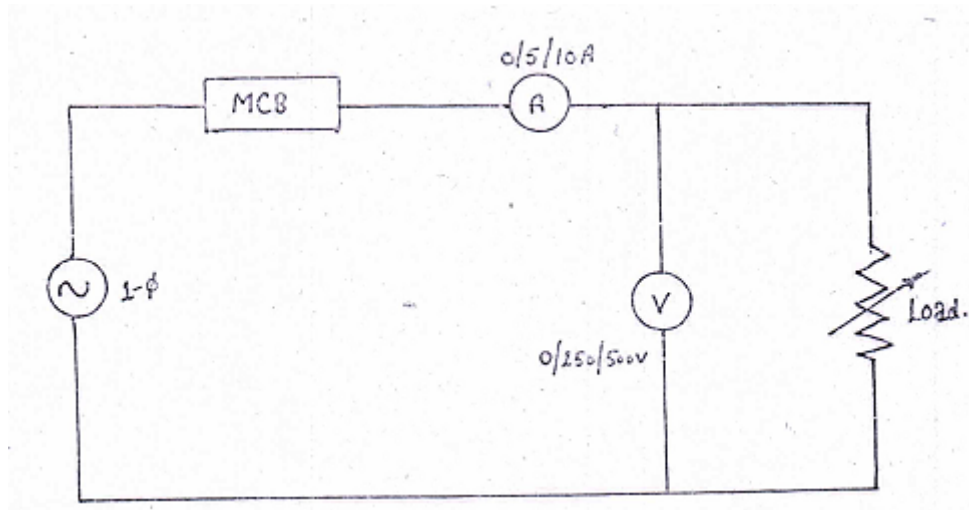
Current rating - 6A

No of poles - 1

Specifications - SIGMA

Capacity

Rated frequency – 50 Hz



Theory:-

MCB is high fault capacity, thermal /magnetic current limiting trip free automatic switching device with fast magnetic tripping

Thermal operation with inverse time current characteristics for overload protection . Hammer trip assisted magnetic operation for short circuit protection

Thermal operation is achieved with a bimetallic strip which deflected when heated by any over current flowing through it . in doing so releases the latch mechanism and causes the contact to open . inverse time current characteristic result greater the overload current short the time required to operate the MCB. When short circuit Fault occurs the rising current energizes the solenoid opening the plunger to strike the trip level causing immediate release of the latch mechanism . Rapidity of the magnetic solenoid operation causes instantaneous opening of contacts

Observational table:-

Rated current of MCB =

Current at which MCB trips =

S.no.	Voltage	Current	Time (in sec.)

Procedure:-

- 1) Make the connections as shown in circuit diagram
- 2) Now vary the load gradually till the rated current of MCB flows in the circuit . The rating of ammeter & voltmeter and note the time at which MCB blows
- 3) Now increase the load in small steps . Record the reading of voltmeter and ammeter
- 4) Repeat the above step .
- 5) Plot the graph between time and current

Conclusion :-

The tripping time of CB reduces with the increase in fault current

Experiment no. -5

Aim:-To study the different types of faults in three phase transmission line

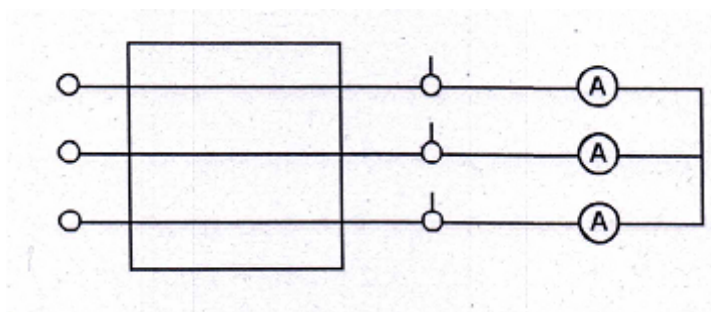
Theory:-

Transmission line is the medium through which electric energy is sent from one place to another .this energy for may be lighting, heating ,doing work .A transmission line is a two port device .Energy is fed at one part and receive at other end port .The high voltage transmission lines carry electrical energy from generating plants to the towns and cities.

Panel board consists of model of three phase transmission line in two sections . components of line parameters i.e. resistance, inductance, capacitances are shown on panel board with terminal brought out and transmission lines can be represented as II section and T section considering shunt capacitance of line or in case of short and medium transmission line the the shunt capacitance is ignored being very small and line is represented by series resistance and inductance only . Three voltmeter are provided to measures the voltage in all three phases and three ammeter for measuring current .Following faults can be created and studied on the panel

1. Single line to earth fault on any of the three phases
2. Line to Line fault Between any two phases .
3. Line to Line fault between to earth and phase .
4. Three phase fault without ground.
5. Three phase fault with ground.

Ckt. Daigram:-



Procedure:-

- 1) Connect three phase supply at the input terminal.
- 2) Make the transmission line configuration as desired as detailed in theory part.
- 3) Connect the three voltmeter across all the phases and neutral at the receiving end.
- 4) Connect ammeter in series at receiving end .
- 5) Create different types of fault as discussed in theory .

Experiment No:-6

Aim:-To find out the dielectric strength of Transformer oil.

Theory:-

High voltage distribution & power transformer are mostly filled with oil . The functions of the oil are to provide additional cooling to the core & winding and to improve insulation between Winding and earth ,similarly ,insulating oil is also used in low & medium voltage switch gear since it is mostly used in transformer ,it is commonly known as transformer oil .the transformer oil is obtained by refining suitably selected natural petroleum crude .

The electric strength of transformer oil as per IS:335 ,1983 should be given below :-

- (a) New unfiltered oil 30 Kv (rms)
- (b) After filtration 60 Kv (rms)

The indian standard specifies that the sample vessels containing the test oil shall be gently agitated & turned over several times in such a way as to insure as far as possible a homogeneous distribution of the impurities contained in the oil without causing the formation of air bubbles . Immediately after this the sample should be poured down into the test cell .slowly in avoid formation of air bubbles. The temperature at the time of the test shall be between 15 degree to 35 degree c & should be noted .

Observation table :-

S.no.	Break down voltage	Mean
1		
2		
3		
4		
5		
6		
7		
8		

Procedure :-

- 1) Read the instructions manual supplied by the manufacturer of the set . Keep set ready as per instructions given in the manual
- 2) Clean the test cell by rinsing with the test oil .
- 3) Fill the cell by sample oil upto the mark & place the cell in proper in the test set . close the lid & switch on the ac mains .
- 4) Check whether the voltmeter is reading zero at this stage
- 5) Record the voltage reading & reset the knob & the voltmeter for next observation .
- 6) Calculate arithmetic mean of the six results . Which is the electric strength of the given sample .

Experiment no. -7

OVERCURRENT & EARTH FAULT RELAYS

Objective:

To study the protection of equipment and system by relays in conjunction with switchgear.

Theory:

The function of a relay is to detect abnormal conditions in the system and to initiate through appropriate circuit breakers the disconnection of faulty circuits so that interference with the general supply is minimized. Relays are of many types. Some depend on the operation of an armature by some form of electromagnet. A very large number of relays operate on the induction principle. When a relay operates it closes contacts in the trip circuit which is normally connected across 110 V D.C. supply from a battery. The passage of current in the coil of the trip circuit actuates the plunger, which causes operation of the circuit breaker, disconnecting the faulty system.

In the laboratory, a 3-phase contactor simulates the operation of the circuit breaker. The closure of the relay contacts short-circuits the 'no-volt' coil of the contactor, which, in turn, disconnects the faulty system.

The protective relaying which responds to a rise in current flowing through the protected element over a pre-determined value is called 'over current protection' and the relays used for this purpose are known as over current relays. Earth fault protection can be provided with normal over current relays, if the minimum earth fault current is sufficient in magnitude. The design of a comprehensive protection scheme in a power system requires the detailed study of time-current characteristics of the various relays used in the scheme. Thus it is necessary to obtain the time current characteristics of these relays.

The over current relay works on the induction principle. The moving system consists of an aluminum disc fixed on a vertical shaft and rotating on two jeweled bearings between the poles of an electromagnet and a damping magnet. The winding of the electromagnet is provided with seven taps (generally 0, which are brought on the front panel, and the required tap is selected by a push-in -type plug. The pick-up current setting can thus be varied by the use of such plug multiplier setting. The pick-up current values of earth fault relays are normally quite low.

The operating time of all over current relays tends to become asymptotic to a definite minimum value with increase in the value of current. This is an inherent property of the electromagnetic relays due to saturation of the magnetic circuit. By varying the point of saturation, different characteristics can be obtained and these are

1. Definite time
2. Inverse Definite Minimum Time (IDMT)
3. Very Inverse
4. Extremely Inverse

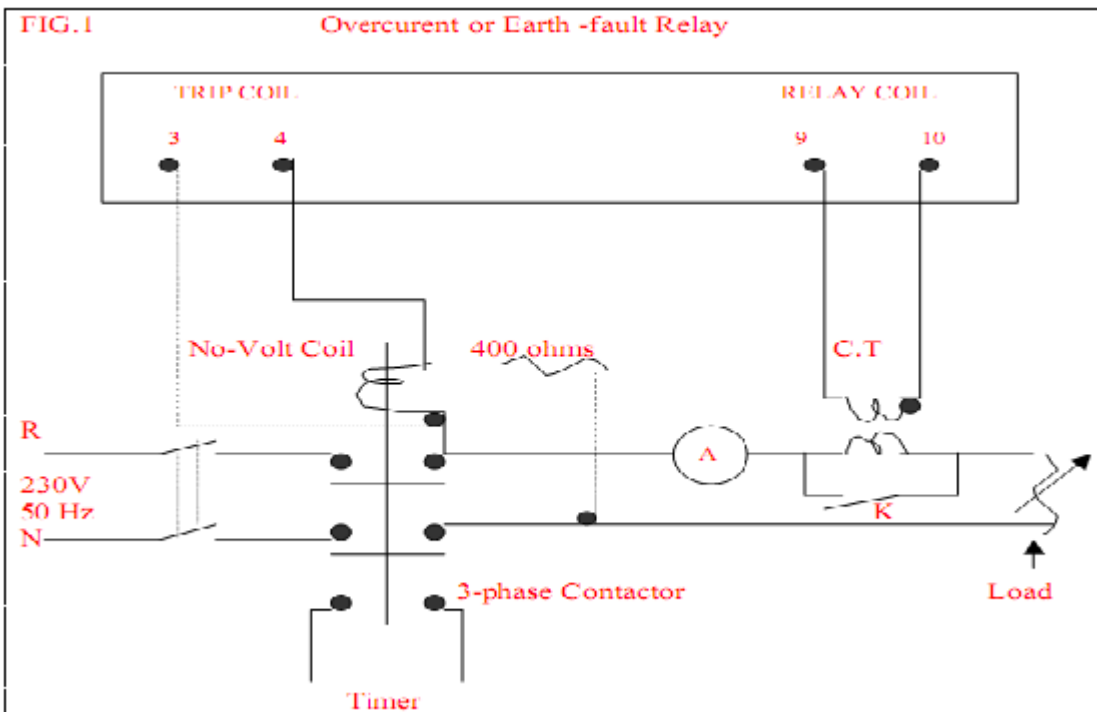
The torque of these relays is proportional to $\phi_1 \phi_2 \sin \alpha$, where ϕ_1 and ϕ_2 are the two fluxes and α is the angle between them. Where both the fluxes are produced by the same quantity (single quantity relays) as in the case of current or voltage operated, the torque T is proportional to I^2 , or $T = K I^2$, 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.



Material & equipment

Over current relay, Earth fault relay, Current transformer, 3-phase contactor, 1-phase load, Ammeter, Digital timer.

Procedure:**Over current Relay:**

1. Study the construction of the relay and identify the various parts.
2. Connect as in FIG.1

FIG.1 Overcurrent or Earth -fault Relay

No-Volt Coil 400 ohms C.T

R

230V

50 Hz K

N

3-phase Contactor Load

Timer

TRIP COIL RELAY COIL

3 4 9 10

A

3. Set the pick-up value of the current marked 1 A(100 % f. l current) by inserting the plug in the groove.
4. Set the Time Multiplier Setting (TMS) initially at 1.0.
5. Adjust the load current to about 1.3 times the f.l current by shorting the switch K. Open the switch K to permit this adjusted current to flow through the relay and record the time taken for this overload condition.
6. Vary the value of the load current in steps and record the time taken for the operation of the relay in each case with the help of the timer.
7. Repeat steps 5 and 6 for TMS values of 0.2, 0.4,0.6 and 0.8.
8. Repeat the above experiment with different pick up current values using the plug setting bridge.

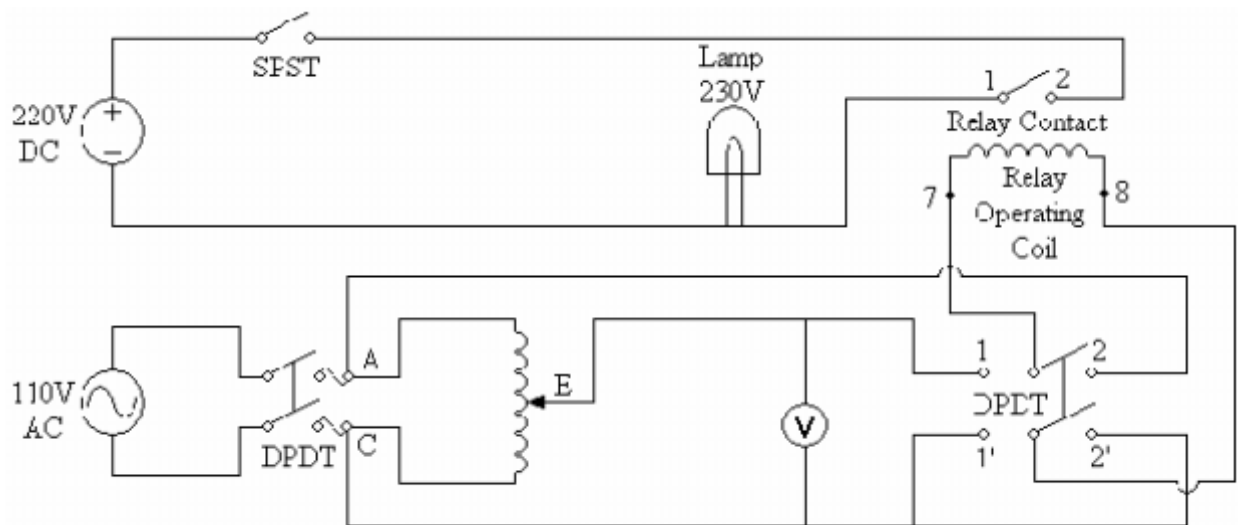
EXPERIMENT NO: 8**UNDERVOLTAGE RELAY**

To determine the operating characteristic of an induction type Under Voltage Relay

Theory:

The operating torque is provided by the spring and restraining torque is proportional to the voltage.

$$K_1 - K_2 V^2 > 0$$

**Procedure:**

1. Chose the required relay setting (% of 110V) and TSM
2. By the Autotransformer set the circuit to a particular PSM with DPDT at 1
3. Put the DPDT to 2 to reset the Relay (disc should return to its original position)
4. Switch over to 1 (DPDT), record the time of operation of the Relay, till the contactor trips.
5. Repeat 1-4 for at least two TSMs and two relay settings.

Precaution:

1. Slowly increase the Voltage to the required value.

Report:

1. Plot PSM-time curve.
2. Compare the curve with reference curve of the manufacturer
3. Discussion on curve in 2
4. Mention an application of such an Under Voltage Relay

Discussion:

1. Why time feature is important in Under Voltage Relay?
2. What are the situations, when the power system voltage is below the rated values?