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Department of Electrical & Electronics Engineering

Relay & High Voltage Lab Manual

18EEL77

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Department of Electrical & Electronics Engineering

VISION

To be the centre of excellence in teaching and learning to produce the competent & socially responsible professionals in the domain of Electrical & Electronics Engineering.

MISSION

To educate students with core knowledge of Electrical & Electronics Engineering by developing problem solving skills, professional skills and social awareness to excel in their career.

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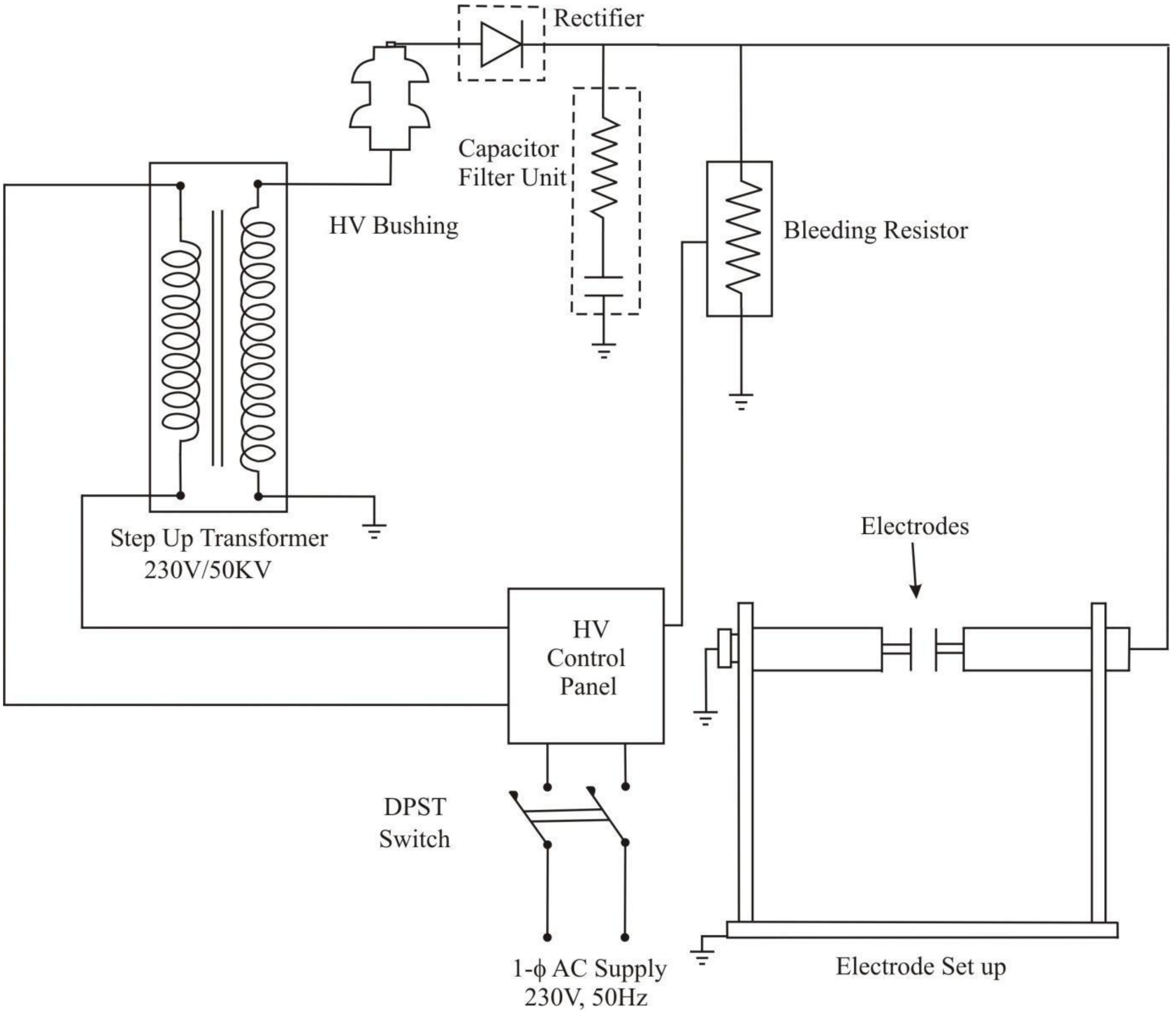
Experiment No.1

SPARKOVER CHARACTERISTICS OF AIR SUBJECTED TO HVDC

CIRCUIT DIAGRAM:



Expt.no.1

SPARKOVER CHARACTERISTICS OF AIR SUBJECTED TO HVDC

AIM: To determine the spark over characteristics of following electrode configurations in air subjected to HVDC. The set of electrodes are as below.

i) Point to Point electrodes.
ii) Point to Plane electrodes.
iii) Plane to Plane electrodes.
iv) Sphere-Sphere electrodes

APPARATUS REQUIRED:

S.no	Apparatus	Range	Quantity
1	HV Test Kit	0-50KVAC/70KV DC	01No.
2	Electrodes	Different configurations	01 No.
3	Grounding Rod	--	01 No.
4	Rectifier Unit	70DC	01 No.
5	Resistance Divider	70MΩ	01 No.
6	Filter unit	3100pF	No.

THEORY:

The most efficient method of generating high DC voltages is through the process of rectification employing voltage multiplier circuits.

However, more recent investigations have shown that these rods can be used for dc measurement provided; certain regulations regarding the electrode configurations are observed. The breakdown voltage of a rod gap increases more or less linearly with increasing relative air density over the normal variation in atmospheric pressure, also the breakdown voltage increases with increasing relative humidity.

The earthed electrode must be long enough to initiate positive breakdown streamers. If the high voltage rod is the cathode with this arrangement, the breakdown voltage will always be initiated by positive streamer for both the polarities, thus giving a very small variation and being humidity dependent.

High voltage rectifier is used in this experiment, which is fabricated using high quality and high stability diodes. These diodes are connected in series to withstand the required voltage. The entire assembly is put inside the epoxy fiber glass tubes filled with oil, for cooling. The epoxy fiber glass tubes are painted with anti tracking paints.

TABULAR COLUMN:

Point to Point electrodes.

Sl. No	Gap Length (mm)	Breakdown Voltage in KV
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		

Point to Plane electrodes.

Sl. No	Gap Length (mm)	Breakdown Voltage in KV
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		

Plane to Plane electrodes

Sl. No	Gap Length (mm)	Breakdown Voltage (KV)
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		

Sphere-Sphere electrodes

Sl. No	Gap Length (mm)	Breakdown Voltage (KV)
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		

PRECAUTIONS:

1. Before starting the experiment note down the specifications of the test kit.
2. Completely study the Test equipment on which experiment is conducted.
3. Use the instruction manual provided by the manufacturer to know about the equipment.
4. Check all the earthing connections.
5. Ignore the first two readings as the air between the electrodes may not be ionized.
6. Do not touch the equipment without grounding.
7. Before starting the experiment, make sure that the electrodes are properly aligned and zero reading is adjusted.
8. The electrodes must be cleaned properly before and after use.

PROCEDURE:

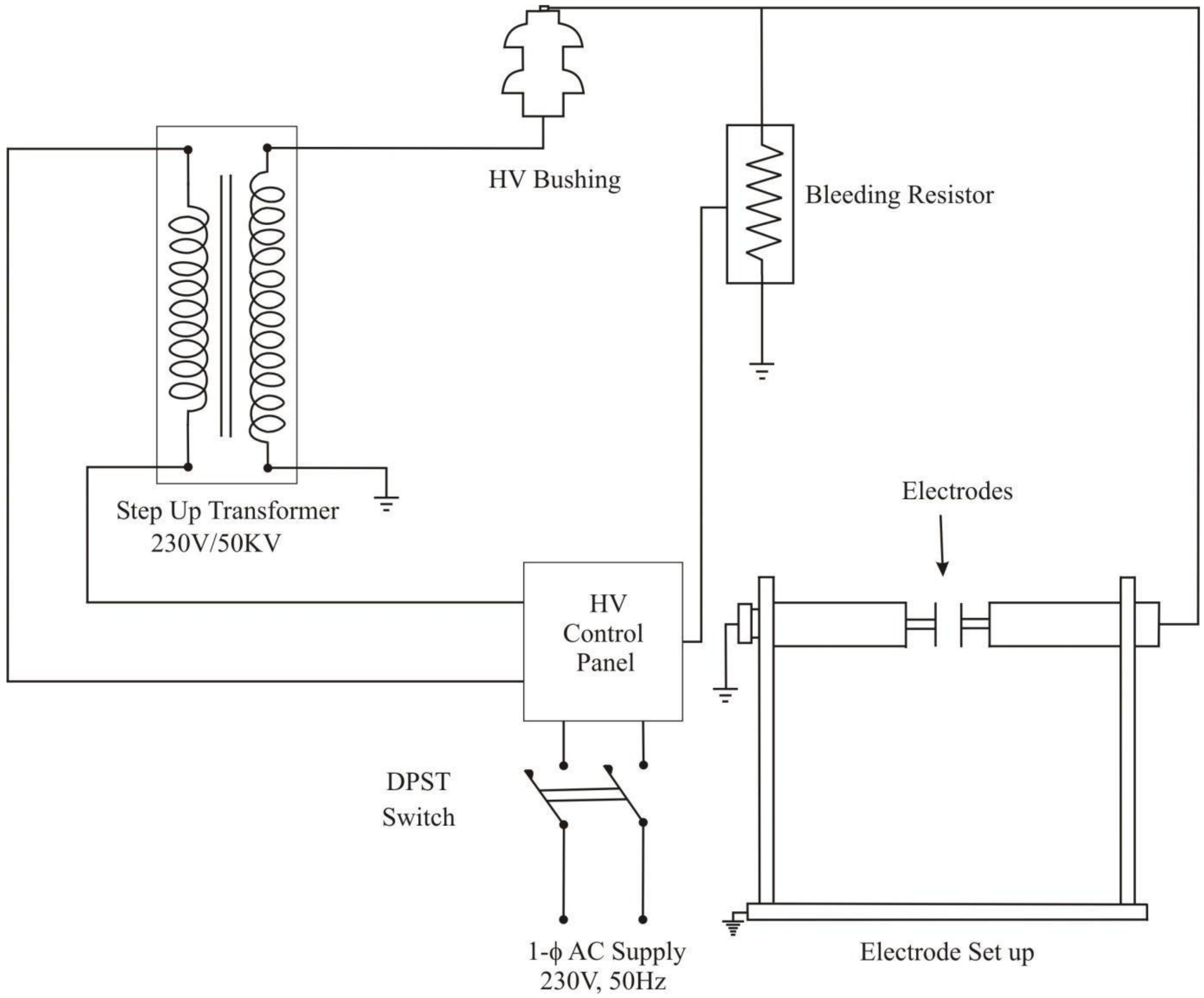
1. Connections are made as per the circuit diagram.
2. Ensure all earth potentials are properly connected to the main earth point.
3. Keep the dimmer at zero position.
4. Place the electrode set, make zero adjustment and keep certain space between the electrodes configuration.
5. Switch 'ON' the power supply to the control panel.
6. Slowly and gradually increase the voltage with the help of dimmer until the flash over occurs between the two electrodes used in the set.
7. Note down the gap length and flash over voltage with the help of meter provided in the control panel.
8. Repeat the above procedure for different gap length between the electrodes and also for the different electrode configuration with both positive and negative polarity.
9. Then plot the graph between flash over Voltage V/s the gap length.

CONCLUSION:

Experiment No.2

SPARKOVER CHARACTERISTICS OF AIR SUBJECTED TO HVAC

CIRCUIT DIAGRAM:



Expt.no.2

SPARKOVER CHARACTERISTICS OF AIR SUBJECTED TO HVAC

AIM: To determine the spark over characteristics of different electrodes configurations in air subjected to HVAC. The set of electrodes are as follows.

i) Point to Point electrodes.
ii) Point to Plane electrodes.
iii) Plane to Plane electrodes
iv) Sphere –Sphere electrodes

APPARATUS REQUIRED:

S.no	Particulars	Range	Quantity
1	HV test kit	0-50KV AC	01No.
2	Electrodes	Different configurations	3 Sets
3	Grounding rod	--	01 No.
4	Resistance divider	70MΩ	01 No.

THEORY:

A gas in its normal state is almost a perfect insulator, however, when a high voltage is applied between the two electrode immersed in a gaseous medium. The gas becomes a conductor and an electrical breakdown occurs.

The processes that are primarily responsible for the breakdown of gas are ionized by collision, photo ionization and the secondary ionization processes. The process of liberating an electron from a gas molecule with the simultaneous production of a positive ion is called ionization. If the electric field is uniform, a gradual increase in voltage across a gap produces a breakdown in voltage across the gap on the other hand, if the field is non-uniform an increase in voltage will first cause a discharge in the gas to appear at points with highest electric field intensity, namely at sharp points or where the electrodes are curved or on transmission lines. This form of discharge is called a corona discharge and can be observed as bluish luminance. This phenomenon is always accomplished by hissing noise and the air surrounding the corona region becomes converted into Ozone.

TABULATION:

TABULAR COLUMN:

Point to Point electrodes.

Sl. No	Gap Length (mm)	Breakdown Voltage in KV
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		

Point to Plane electrodes.

Sl. No	Gap Length (mm)	Breakdown Voltage in KV
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		

Plane to Plane electrodes

Sl. No	Gap Length (mm)	Breakdown Voltage (KV)
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		

Sphere-Sphere electrodes

Sl. No	Gap Length (mm)	Breakdown Voltage (KV)
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		

PRECAUTIONS:

1. Before starting the experiment note down the specifications of the test kit.
2. Completely study the test equipment on which experiment is to be conducted.
3. Use the specification book provided by the manufacturer to know about the equipment.
4. Check all the earthing connections, if not make proper connections.
5. Ignore the first two readings as the air between the electrodes may not be ionized.
6. Do not touch the equipment without grounding it with grounding rod.
7. Before starting the experiment, make sure that the electrodes are properly aligned and zero reading is adjusted.
8. The electrodes must be cleaned properly before and after use.

PROCEDURE:

1. Connections are made as per the circuit diagram.
2. Ensure all the earthing potentials are properly connected to the main earth point or not.
3. Keep the dimmer at zero position.
4. Place the electrodes set, make zero adjustment and keep certain space between the electrode configurations.
5. Switch 'ON' the mains supply to the control panel.
6. Slowly and gradually increase the voltage with the help of dimmer until the flash over occurs between the two electrodes used in the set.
7. Then note down the gap length and flash over voltage with the help of meter provided in the control panel.
8. Repeat the above procedure for different gap lengths between the electrodes and also for the different electrode configurations.
9. Then plot the graph between flash over voltage Vs the gap length.

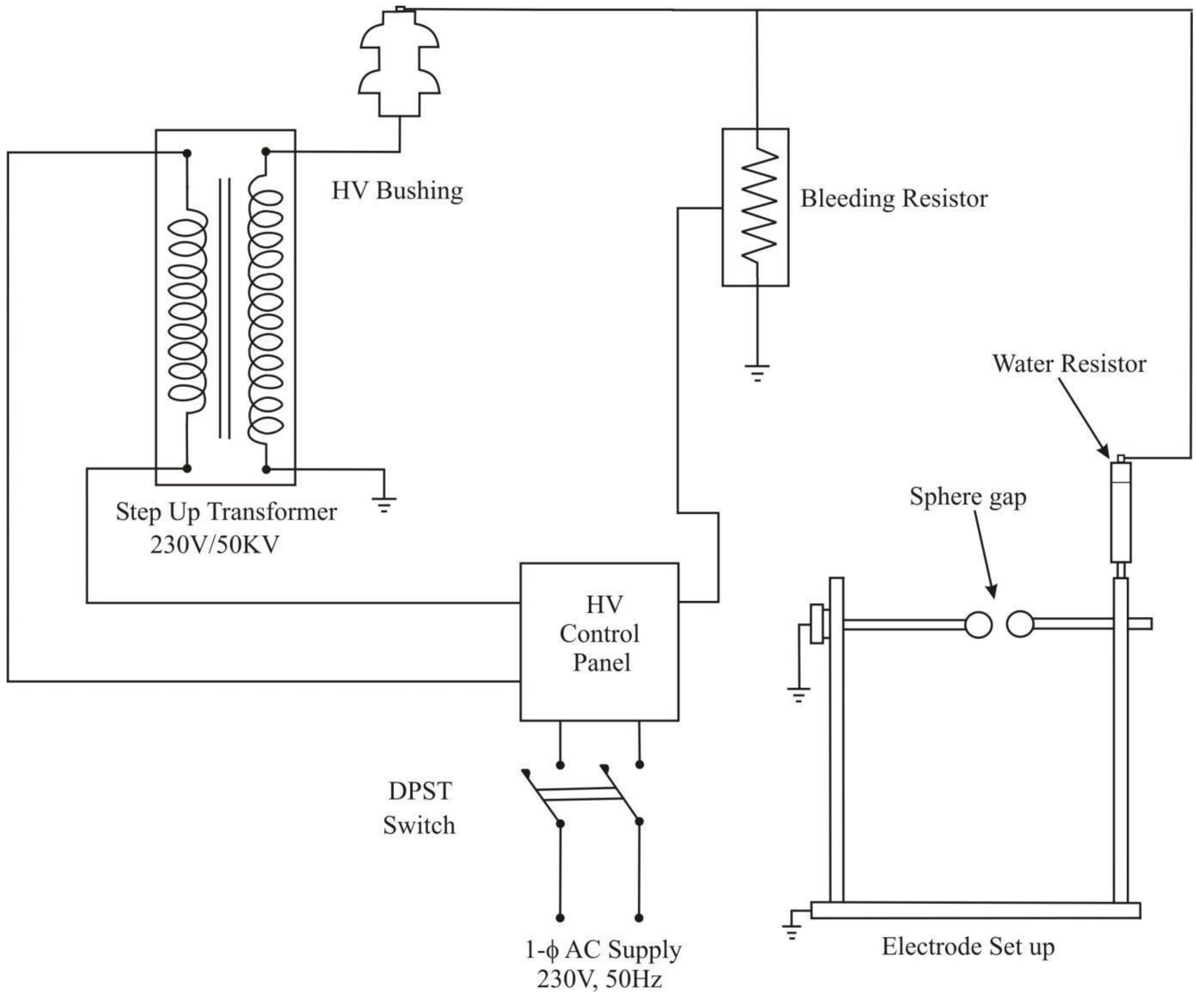
CONCLUSION:

Experiment No.3

MEASUREMENT OF HVAC AND HVDC USING STANDARD SPHERES

CIRCUIT DIAGRAM:

MEASUREMENT OF HVAC USING STANDARD SPHERES



Expt.no.3

MEASUREMENT OF HVAC AND HVDC USING STANDRAD SPHERES

AIM: Measurement of HVAC and HVDC using spheres gap with spark over voltage corrected to STP.

APPARATUS REQUIRED:

S.no	Apparatus	Range	Quantity
1	HV Test Kit	0-50KVAC/70KV DC	01No.
2	Electrodes	Standard Spheres	01 Set.
3	Grounding Rod	--	01 No.
4	Rectifier Unit	70DC	01 No.
5	Resistance Divider	70MΩ	01 No.
6	Filter unit	3100pF	No.

THEORY:

Sphere gap is an absolute method of measurement of the peak value of high voltage for alternate, direct and 1150µsec impulse voltage for spacing up to 0.5D (Where D= Sphere diameter). It can be measured accurately within ±3%. For direct voltage measurement in the absence of excessive dust the results are considered accurate within ±5% for spacing not greater than 0.4D.

There are two types of sphere gaps, namely, i) Vertical sphere gap ii) Horizontal sphere gap.

In vertical sphere gap two identical spheres are arranged vertically such that lower sphere is grounded permanently.

In horizontal sphere gap assembly both spheres are connected to the source. One of the sphere is grounded. In horizontal configuration it is generally arranged that both spheres are symmetrically charged at high voltage above the ground.

The sphere may be made up of aluminium, brass, copper or light alloys and the surface should be free from burs. The radius of curvatures should be uniform. The radius of curvature measured with sphere meter at various points over and over by a circle 0.3D around. Sparking point should not differ by exceeding ±2% of the nominal values. The surface should be free from dust, grease or any other coating.

A uniform field spark gap will always have specific over voltage within a known tolerance under constant atmospheric conditions. Hence a spark gap can be used for measurement of the peak value of voltage if gap distance is known. The voltage to be measured is applied between the two spheres and the distance between them gives a measure of spark over voltage. A series resistance is usually connected for the following reasons,

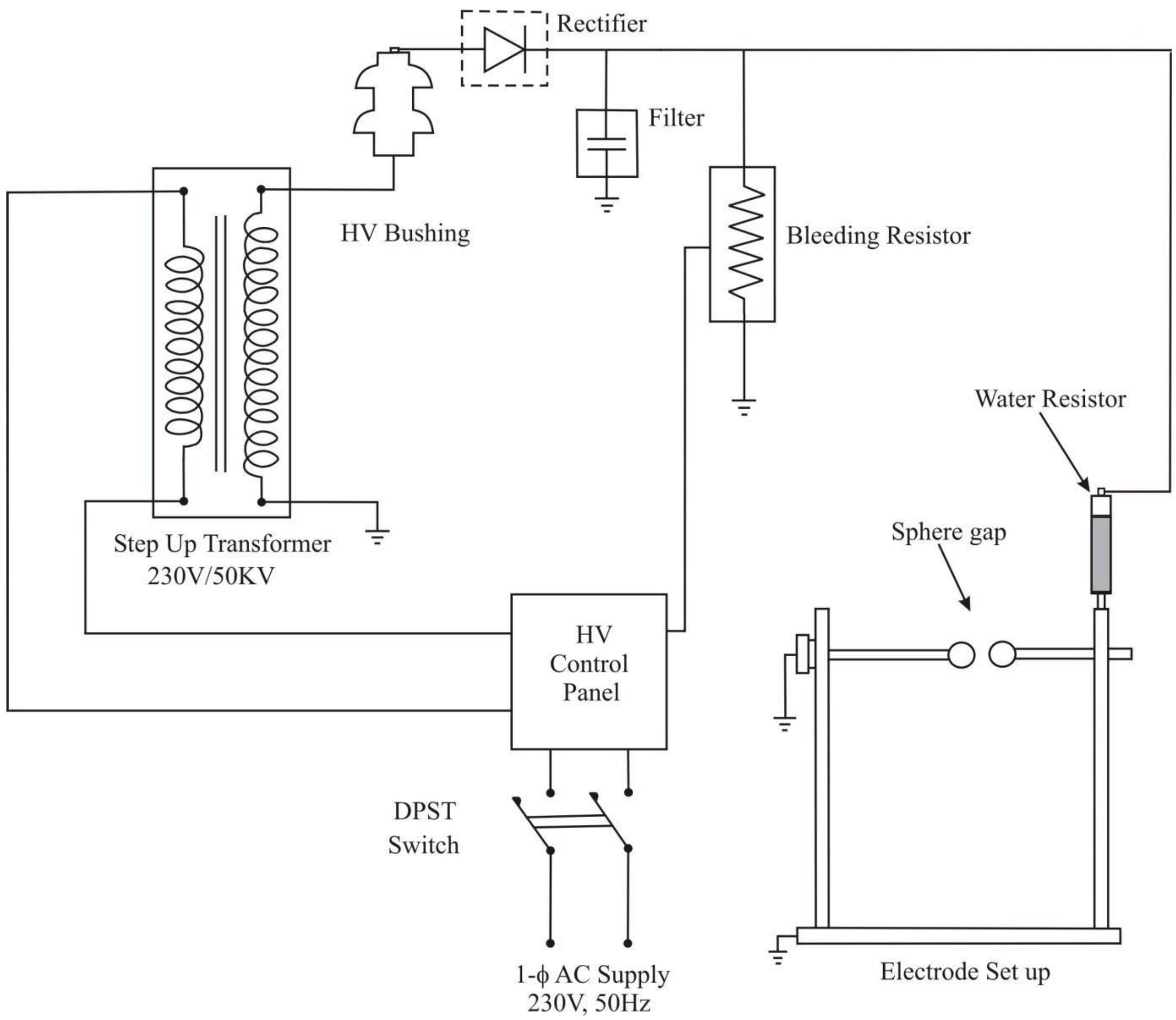
i) To limit the breakdown current
ii) To suppress unwanted oscillations in the source voltage when breakdown occurs.

Factors affecting spark over voltage of sphere gap are,

i) Nearby earthed objects.
ii) Atmospheric conditions and humidity.
iii) Irradiation.
iv) Polarity and rise time of voltage waveform.

CIRCUIT DIAGRAM:

MEASUREMENT OF HVDC USING STANDARD SPHERES



TABULAR COLUMN: FOR HVAC

S. No	Gap Length (mm)	Breakdown voltage measured from Sphere Gap V_0 in KV	Breakdown voltage at relative air density $V=KV_0$
1			
2			
3			
4			
5			
6			

SPECIMEN CALCULATIONS:

- Note down the temperature and pressure reading of the HV lab
- Air Temperature t = ^{0}C Air Pressure P = mm of Hg
- Determine the air density factor as **d**=P/760(293/273+t)
- From the table find the air density correction factor **K** to be applied for the above value of **d**

d	**0.7**	**0.75**	**0.8**	**0.85**	**0.9**	**0.95**	**1.0**	**1.05**	**1.1**	**1.15**
K	**0.72**	**0.77**	**0.82**	**0.86**	**0.91**	**0.95**	**1.0**	**1.05**	**1.09**	**1.12**

PRECAUTIONS:

1. Before starting the experiment note down the specification of the test kit.
2. Completely study the Test equipment on which experiment is conducted.
3. Use the specification book provided by the manufacturer to know about the equipment.
4. Check all the earthing connections, if not make proper earthing connections.
5. Ignore the first one or two readings, as the air between the electrodes may not be ionized.
6. Do not touch the equipment without grounding it with the grounding rod.
7. Before starting the experiment, make sure that the electrodes are properly aligned and zero reading is adjusted.
8. The electrodes must be cleaned properly, before and after the use.
9. In no case gap length should increase more than 0.5D (i.e. 25mm in this case)

PROCEDURE:

1. Connections are made as per the circuit diagram using sphere gap model.
2. Ensure all earth potentials are properly connected to the main earth point.
3. Keep the dimmer to zero position, make zero adjustment and keep certain space between the sphere electrodes configuration by using the standard chart.
4. Switch ON the mains supply to the control panel.
5. Slowly and gradually increase the voltage with the help of dimmer until the flashover occurs.
6. Then note down the gap length and flash over voltage with the help of meter provided in the control panel.
7. Repeat the above procedure for same gap length for HVDC (with both positive and negative polarity).
8. Then note down the temperature and pressure using the thermometer and barometer and apply the correction factor.
9. Then plot the graph between flashover voltages Vs the gap length.

TABULAR COLUMN: FOR HV DC (Positive Polarity)

S. No	Gap Length (mm)	Breakdown voltage measured from Sphere Gap V_0 in KV	Breakdown voltage at relative air density $V=KV_0$
1			
2			
3			
4			
5			
6			

TABULAR COLUMN: FOR HV DC (Negative Polarity)

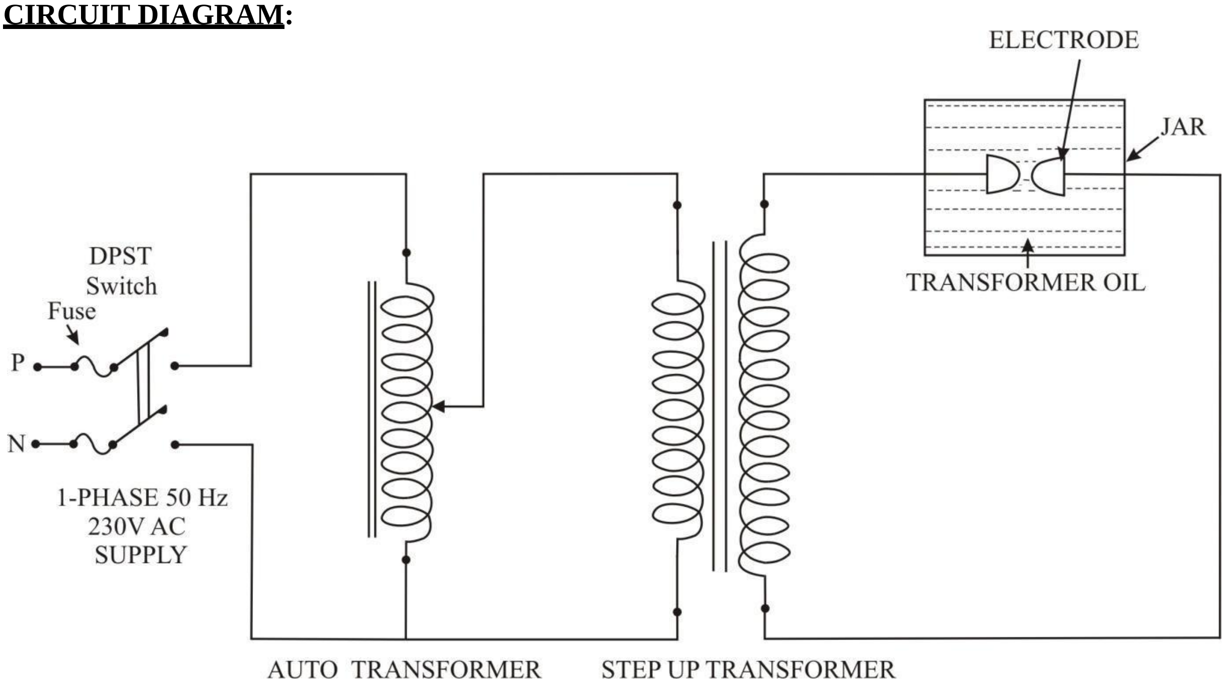
S. No	Gap Length (mm)	Breakdown voltage measured from Sphere Gap V_0 in KV	Breakdown voltage at relative air density $V=KV_0$
1			
2			
3			
4			
5			
6			

CONCLUSION:

Experiment No.4

MEASUREMEN OF BREAKDOWN STRENGTH OF TRANSFORMER OIL

CIRCUIT DIAGRAM:



TABULATION:

1. Breakdown voltage of transformer oil

No. of Trials	Breakdown voltage in KV
1.	
2.	
3.	
4.	
5.	

Mean breakdown voltage of transformer oil =______KV

2. One minute withstand voltage of transformer oil =______KV

Expt.no.4

BREAK DOWN VOLTAGE OF TRANSFORMER OIL

AIM: To determine the breakdown strength of transformer oil using oil testing unit.

APPARATUS REQUIRED:

S.no	Apparatus	Range	Quantity
1	Oil Test Kit	0-60KV AC	1No.
2	Transformer Oil	--	1 litre
3	Go/No Go Gauge	--	1 No.

THEORY:

The electrical properties that are essential is determining the dielectric performance of a liquid dielectric are,

1. Its capacitance per unit volume or its relative permeability.
2. Its resistivity.
3. Its loss tangent (tanδ)
4. Its ability to withstand high electric stresses.

Permeability of most of the petroleum oils vary from 2.0 to 2.6 while those of silicon oils from 2.0 to 7.3. In case of non-planar liquids the permeability is dependent on frequency.

Resistivity of insulating liquids used for high voltage applications should be more than $10^{16}\Omega$ /m. Power factor of a liquid dielectric under ac voltage will have a very low power factor varying between 10^{-4} at 20º C and at 10^{-3}at 90º at a frequency of 50Hz.

Transformer oil:

Transformer oil is the most commonly used liquid dielectric in power apparatus. It is an almost colourless liquid containing a mixture of hydrocarbons which include paraffisso-paraffius, naphthalene and aromatics. When in service, the liquid in a transformer is subjected to prolonged heating at high temperature of about 95ºC and consequently, it undergoes a gradual ageing process with time the oil becomes darker, due to the formation of acids and resins or sludge in the liquid. Complete specifications for the testing of transformer oils are given IS 1866(1983) and IEG 474 (1974).

PROCEDURE:

1. Pour the given oil in the testing Jar of the HV oil tester and take care no bubbles should be formed and allow it to settle for few minutes.
2. Adjust the spacing between the electrodes to 4 mm using the gauge provided with the kit.
3. Before switching 'ON' the supply, ensure the dimmer is at zero position.
4. Then switch 'ON' the supply and slowly vary the voltage with the help of auto transformer until flash over occurs.
5. Note down the values of this voltage and then find the one minute withstand voltage of the transformer oil.

PRECAUTIONS:

1. Before starting the experiment note down the specifications of the test kit.
2. Completely study the test equipment on which experiment is conducted.
3. Check all the earthing connections if not make proper earthing connections.

OBSERVATIONS:

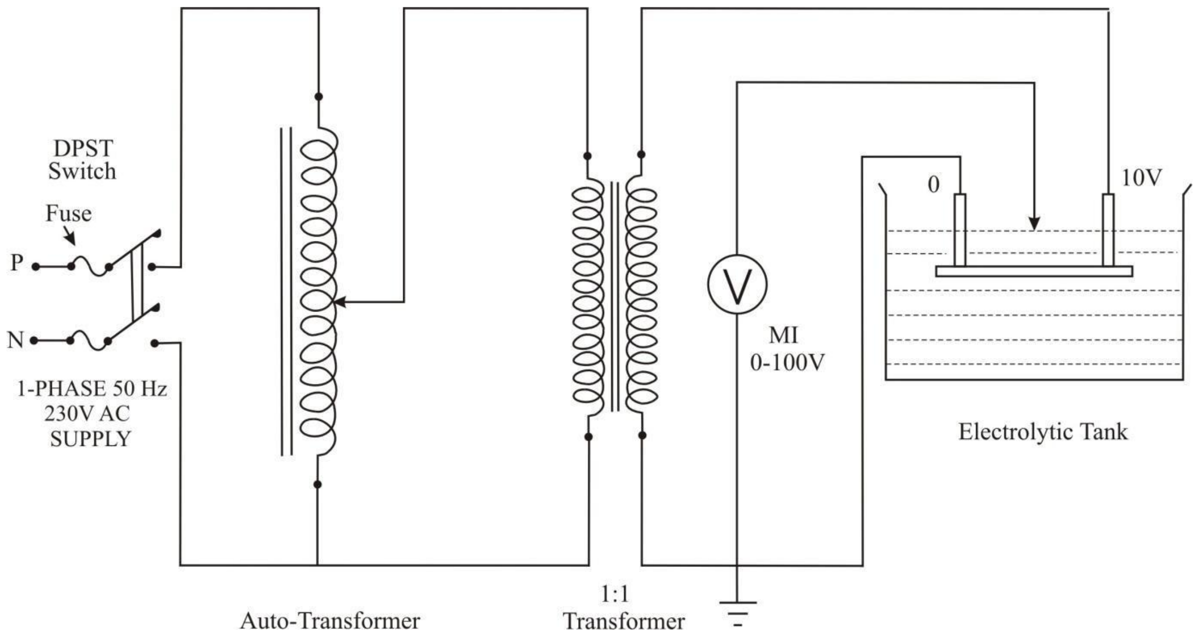
1. Breakdown voltage of transformer oil__________KV
2. One minute withstand voltage of transformer oil_______KV

CONCLUSION:

Experiment No.5

FIELD MAPPING USING ELECTROLYTIC TANK

CIRCUIT DIAGRAM:



Expt.no.5

FIELD MAPPING

AIM: To draw the equipotential lines using electrolytic tank for different electrode models.

i. Parallel plate model

ii. Co-axial cable model

APPARATUS REQUIRED:

S.no	Particulars	Range	Quantity
1	Electrolytic Tank with all its assembly	--	1 set
2	Electrodes set	Parallel plate model and Circular plate	1 No
3	Voltmeter	MI 0-100V	1 No.
4	Autotransformer	230V/0-260V	1 No.
5	Connecting wires	--	Few

THEORY:

Electrolytic tank is useful tool to draw equipotential lines. Equipotential line is the path along which voltage remains the same. This experiment plays the very important role for the analysis of electric field or electric stress of dielectrics. Geometrically simple model like electrolytic tank model can be used to draw equipotential lines. Electrolytic tank consisting of tank, pentagraph and base area tank made up of high quality mild steel and epoxy powder is coated to protect it from corrosion on the top of the tank transparent glass is fixed with the help of frame.

The drawing sheet on which equipotential lines have to be plotted is kept and fixed on the glass plate. The tank has provision to drain the water after the experiment is over. Pentagraph is the most important part of the electrolytic tank and it is specially designed to have two parallel moving arms exactly one over the other. These arms can be moved in x and y directions. The lower arm has the provision to hold the probe which can move between.

PRECAUTIONS:

1. Before starting the experiment note down the specifications of the test kit.
2. Completely study the Test equipment on which experiment is conducted.
3. Use the specification book provided by the manufacturer to know about the equipment.
4. High impedance digital multimeter should be used to read the equipotential points.
5. Don’t mix salt in the water.
6. Don’t apply more voltage from the safety point of view.
7. Drain out the water as soon as experiment is over and clean and dry the tank with cloth.
8. Clean the electrodes after the experiment is over.

PROCEDURE:

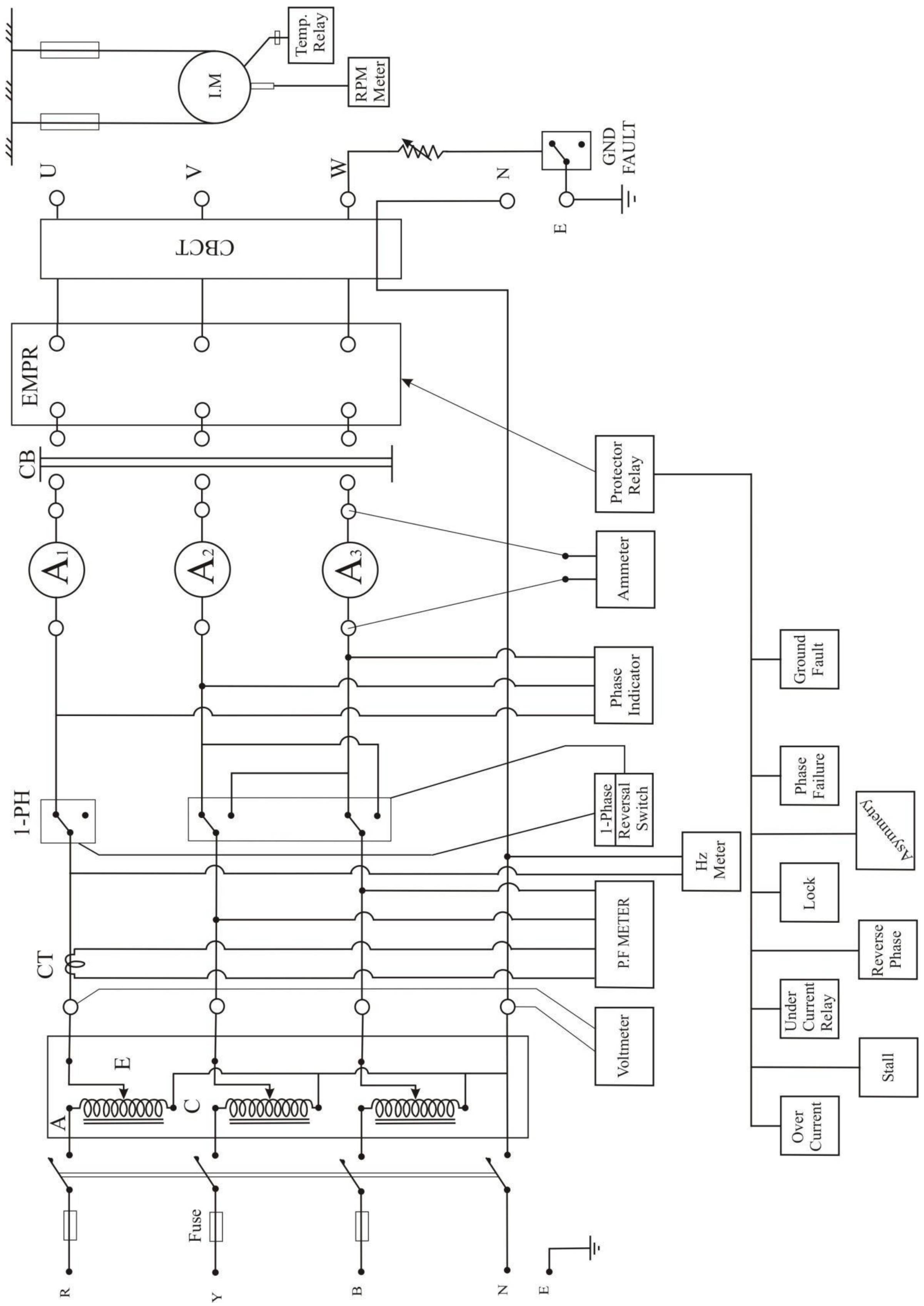
1. Connections are made as per the circuit diagram.
2. Adjust the given electrodes in the electrolytic tank with cables provided.
3. Switch ON the supply.
4. Adjust the voltage to 10Volts using the dimmer.
5. Move the pointer immersed in the tank, which contains the water in such a way that to get the equipotential points on the drawing sheet.
6. Then join all the equipotential points.
7. Repeat the above procedure for different set of electrodes.
8. Reduce the voltage to zero and switch OFF the supply.

CONCLUSION:

Experiment No.6

MOTOR PROTECTION AGAINST FAULTS

CIRCUIT DIAGRAM:



Expt.no.6

MOTOR PROTECTION AGAINST FAULTS

AIM: Simulation study of protection of Induction motor against the following faults

1. Reverse Phase
2. Single Phase on the motor
3. Over Current
4. Ground fault

APPARATUS REQUIRED:

S.no	Particulars	Range	Quanti
1	Motor Protection Relay Kit	--	01
2	3 phase Induction Motor with loading arrangement	3HP,1500rpm	01 Set.
3	Connecting wires	--	Few

THEORY:

The three phase induction motors are used in numerous industrial applications. Hence the study of abnormal conditions, faults that may occur on induction motor and the protection against these faults is important. Over current, under voltage, unbalanced voltage, overloading, reverse phase sequence, phase to phase fault, single phasing etc are the faults occurring on induction motor. Some of these can be explained as follows-

i) Over current fault:

When the induction motor is operated at under voltage i.e. voltage below the rating, then the motor draws more current for the same load. For protection over current relays or under voltage relays are used.

ii) Ground fault protection:

When the leakage current or fault current flows through earth path then it forms the earth fault or ground fault. These faults are relatively frequent and hence protection is required against these which is provided by Earth leakage circuit Breaker (ELCB).

iii) Phase reversal protection:

The direction of IM depends on the direction of rotating magnetic field produced by stator windings. For particular phase sequence RYB the motor rotates in a particular direction, due to corresponding direction of magnetic field. But, if any two lines are interchanged after repairs, the phase sequence changes. This makes the IM to rotate in the reverse direction. Such a change is dangerous, if IM is used for cranes, hoists, lifts or in threading mills etc.

Thus to disconnect IM from supply, if three phase reversal, phase reversal protection is provided.

iv) Single phasing:

If one of the supply line is disconnected, due to open circuit or improper contact in the switch, then still motor continues to run. The power is then supplied to remaining windings. The current in the other phase increases to about $\sqrt{3}$ times its normal value. This is called single phasing which results in unbalanced stator currents. The component which represents this fault is called as negative sequence component, this causes magnetic flux. This results in double frequency current to induce in the rotor to cause its heating. Thus major damage may take place due to 1-phase, if proper care is not taken.

For small motors separate protection circuit is not required, thermal relays are provided in the motor circuit only. For larger motors separate protection is required. Even small unbalance can cause damage to motor winding and rotor.

To protect the IM against the above said faults, Digital motor protection relay model HV1-101A-DMP-SZ is used in this experiment. Digital motor protection relay model is a digital based design which offers a selective range of inverse and definite trip time characteristics. It is suitable for protection of 3-phase ac motors against over current, under current, stall, lock, phase failure, reverse phase, asymmetry and ground fault.

PROCEDURE:

GROUND FAULT:

1.	Connect the power cords to terminals; connect the RPM cord, Temperature detector to respective terminals.
2.	Connect the Voltmeter, Ammeters to the respective positions shown on the panel board.
3.	Keep all the switches at its home positions (1-φ, Reverse Phase and Ground fault switches)
4.	Short the rheostat terminal using patch cord.
5.	Set the EMPR using proper procedure. [For following settings definite characteristics, RP protection, Ground fault, Stall function, Lock function, CT ratio, Phase failure]
6.	Switch ON the supply to the protection kit using MCB.
7.	With the help of three dimmers adjust the voltage to 230V.
8.	Switch ON the motor using the press button provided on the panel board.
9.	Create ground fault using ground fault switch provided on the panel board.
10.	Note all meter readings and clear the fault and reset the EMPR.
11.	Accept the fault and clear the fault and reset the EMPR.

PHASE FAULT:

1. Connect the power cords to terminals; connect the RPM cord, temperature detector to respective terminals.
2. Connect the voltmeter, Ammeters to the respective positions shown on the panel board.
3. Keep all the switches at its home positions (1-φ, Reverse phase and Ground fault switches)
4. Set the EMPR using proper procedure.
5. Keep the position of the switch (Ground Fault switch) to position 2.
6. Switch ON the supply to the protection kit using MCB.
7. With the help of three dimmers adjust the voltage to 230V.
8. Switch ON the motor using the press button provided on the panel board.
9. Create the single phase fault using the proper switch by turning it towards position 2.
10. Note all meter readings and time taken for trip for ground fault.
11. Accept the fault and clear the fault and reset EMPR.

<u>REVERSE PHASE</u>:

1. Connect the power cords to terminals; connect the RPM cord, Temperature detector to respective terminals.
2. Connect the Voltmeter, Ammeters to the respective positions shown on the panel board.
3. Keep all the switches at its home positions (1-φ, Reverse phase and Ground fault switches)
4. Set the EMPR using proper procedure. [For following settings definite characteristics, RP protection, Ground fault, Stall function, Lock function, CT ratio, Phase failure]
5. Keep the position of the switch (Ground Fault switch) to position 2.
6. Switch ON the supply to the protection kit using MCB.
7. With the help of three dimmers adjust the voltage to 230V.
8. Switch ON the motor using the press button provided on the panel board.
9. Immediately the motor stops because of the reverse phase condition on the motor.
10. Note all meter readings and time taken for trip for reverse phase fault.
11. Accept the fault and clear the fault and rest the EMPR.

<u>OVER CURRENT</u>:

1. Connect the power cords to terminals; connect the RPM cord, Temperature detector to respective terminals.
2. Connect the Voltmeter, Ammeters to the respective positions shown on the panel board.
3. Keep all the switches at its home positions (1-φ, Reverse phase and Ground fault switches)
4. Set the EMPR using proper procedure. [For following settings definite characteristics, RP protection, Ground fault, Stall function, Lock function, CT ratio, Phase failure]
5. Switch ON the supply to the protection kit using MCB.
6. With the help of three dimmers adjust the voltage to 230V.
7. Switch ON the motor using the press button provided on the panel board.
8. Adjust the motor current more than the current that is set in the EMPR.
9. Relay trips once current goes behind the set value, without disturbing the load on the motor start the motor once again.
10. Immediately the motor stops because of the over current condition on the motor.
11. Note all meter readings and time taken for trip for over current condition on the motor.
12. Accept the fault and clear the fault and rest the EMPR.

OVER VOLTAGE:

1. Connect the power cords to terminals; connect the RPM cord, Temperature detector to respective terminals.
2. Connect the Voltmeter, Ammeters to the respective positions shown on the panel board.
3. Keep all the switches at its home positions (1-φ, Reverse phase and Ground fault switches)
4. Set the EMPR using proper procedure.
5. Switch ON the supply to the protection kit using MCB.
6. With the help of three dimmers adjust the voltage to 230V.
7. Turn the switch of OV/UV relay to ON mode.
8. Adjust the relay to OV/UV mode and its different characteristics (Definite/IDMT) and for its different voltage levels (where V_n=220V) and remove the ground fault cable (keep position of ground fault switch to 1)
9. Switch ON the motor using the press button provided on the panel board.
10. Adjust the voltage above the set value of the voltage using Dimmers (Y and B phases only)
11. Simultaneously press start button provided on the OV/UV Relay and turn ground fault switch to position 2.
12. Reset the relay and also reset the complete set up.

TABULATION:

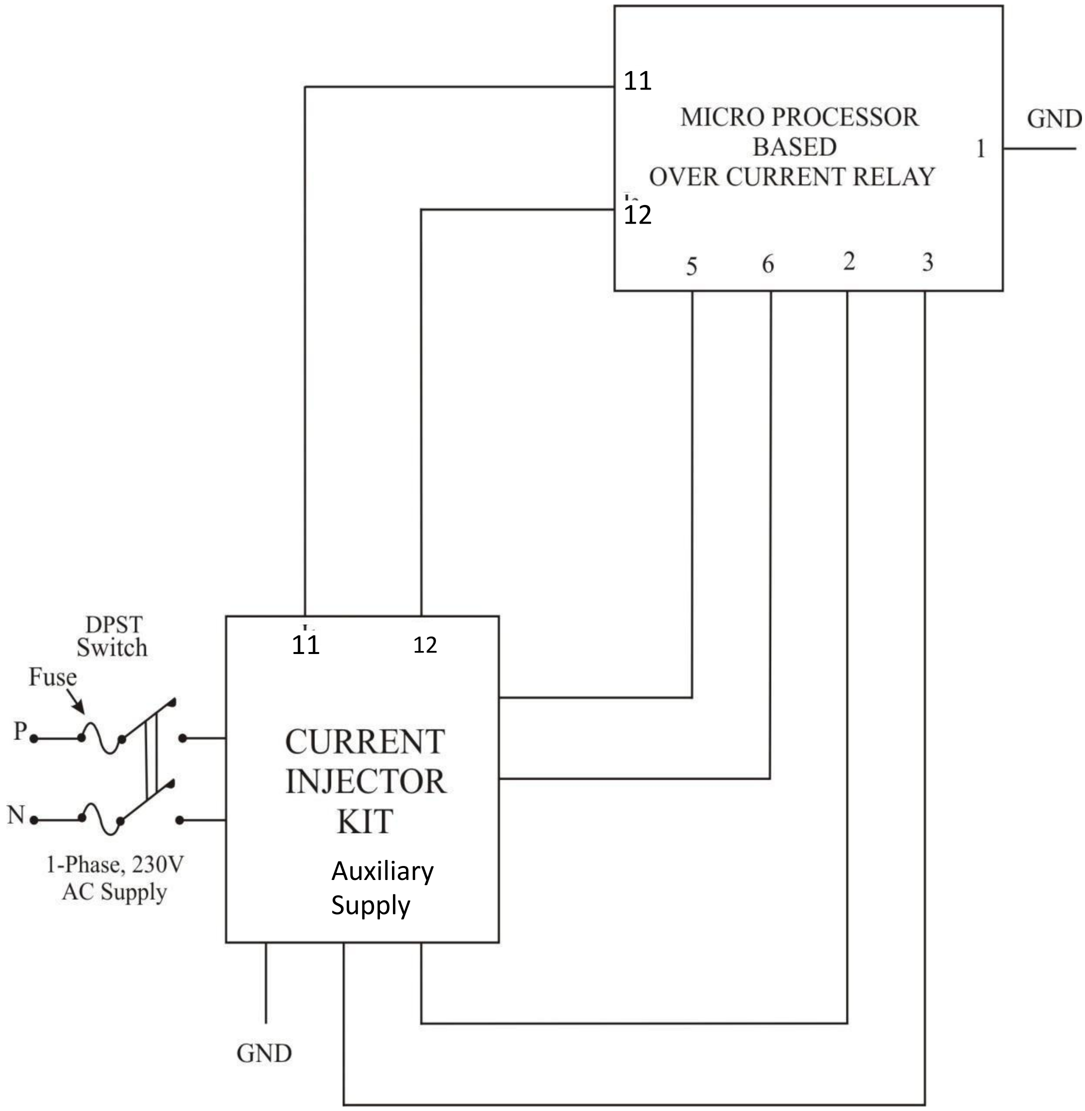
Fault Type	Voltmeter Reading			Ammeter Reading			Speed	Trip time
	R	Y	B	R	Y	B		
No Load Over Current Fault **Current Setting:** **Time Setting:**								
Over Current Fault With load **Current Setting:** **Time Setting:**								
Ground Fault								
Single Phasing								
Phase Reversal								

CONCLUSION:

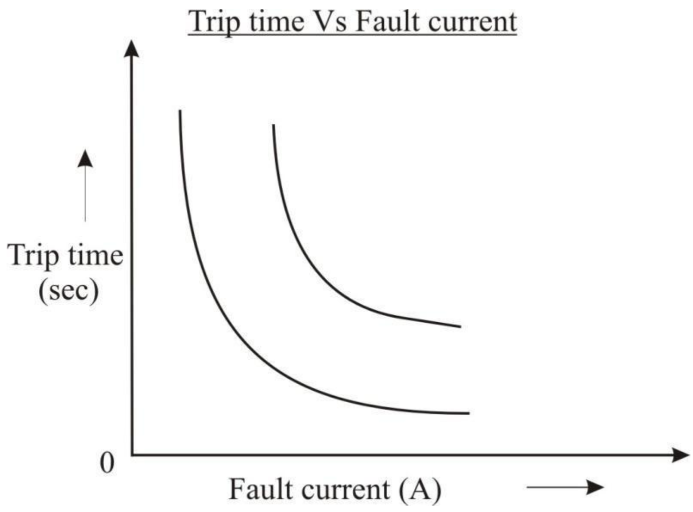
Experiment No.7

OPERATING CHARACTERISTICS OF MICROPROCESSOR BASED OVER CURRENT RELAY

CIRCUIT DIAGRAM:



NATURE OF GRAPH:



Expt.no.7

OPERATING CHARACTERISTICS OF MICROPROCESSOR BASED OVER CURRENT RELAY

AIM: To determine the operating characteristic of Microprocessor based Over Current Relay.

APPARATUS REQUIRED:

S.no	Particulars	Range	Quantity
1	μP based O.C. Relay	--	01
2	Current Injection Kit	--	01
3	Connecting wires	--	Few

THEORY:

Over current/ earth fault relay model μPOC-LT fitted with MC12A, L&T is an electronic μP based non- directional single phase over current relay. It is suitable for over current protection scheme in LV, MV & HV power distribution system. It is also suitable for applications such as providing selective protection for overhead and underground feeders, AC machines, back up protection for transformer etc.

It is μc based design offers a wide range of field selectable trip time characteristics. It incorporates high set (Instantaneous trip) as standard failure and accepts very wide auxiliary supply range. It employs fundamental frequency extraction to ensure that it doesn't operate on spikes generated by switching of various loads.

MC12A is designed for flash mounting. It is very compact in size, which results in saving of panel space. It draws out construction makes installation and maintain very easy.

Using PSCT-S current injection unit static and μP type. Over current relay can be tested. Necessary provisions have been made for testing the above said type of relays. Equipment has in built variable current. Auxiliary source, time interval meter, ammeter, protection timers and BTI connector etc.

$$\text{Plug setting multipliers} = \frac{\text{Fault current}}{\text{Plug setting}}$$

TABULATION:

S.no	Plug setting Set current (I_S)	Fault current (Amp)	Operating time		PSM
			TMS=0.5	TMS=1.0	
1.					
2.					
3.					
4.					
5.					
6.					
7.					
8.					

SPECIMEN CALCULATION:

- Plug setting Multiplier (PSM) = $\frac{\text{Fault current}}{\text{Plug setting}}$

S.no	Plug setting Set current (I_S)	Fault current (Amp)	Operating time		PSM
			TMS=0.5	TMS=1.0	
1.					
2.					
3.					
4.					
5.					
6.					
7.					
8.					

SPECIMEN CALCULATION:

- Plug setting Multiplier (PSM) = $\frac{\text{Fault current}}{\text{Plug setting}}$

PROCEDURE:

1. Connections are made as per the circuit diagram.
2. Set the operating characteristics (Definite / Normal Inverse) using the switch [SW_2], which is provided on the panel board of MC12A Relay.
3. Using DIP switches [of SW_1 switch] select the current range (i.e. Is=10-40% or 20-80% or 50-200%)
4. Set the relay current (Is)(Fault Current Level) to any required value using the equation as below
   $(I_s)=[0.1R + R \sum a]I_n$,
   Where Is= Set Current level (Fault current level) in Amps.
   In= CT rating (1A/5A)
   a=Weight of switch in ON position.
   R=Constant depending on the current setting range.

Current setting Range	R
10-40%	1
20-80%	2
50-200%	5

5. Using DIP switches set the TMS and Trip using the equation,
   Trip Time (T)=k[0.1+∑t]
   Time multiplier Setting (TMS)=[0.1+∑t]
   Where t= Weight of switch in ON position.
   K is the constant depends upon Trip time characteristics used for the relay.

   value of K for different Trip characteristics is as indicated below

Trip time characteristics	Value of K
Normal Inverse (1.3 sec)	1.3
Normal Inverse (3.0 sec)	3.0
Normal Inverse (1.5 sec)	1.5
Normal Inverse (0.8 sec)	0.8
Definite Time (1.0 sec)	1.0
Definite Time (10 sec)	10
Definite Time (100 sec)	100

6. Switch ON the supply and press TEST START BUTTON.
7. Adjust the fault current above Fault Current Level (I_S). Set with the help of dimmer.
8. Press START STOP / RESET BUTTON and do not disturb the position of dimmer.
9. Press TEST START BUTTON and note down the fault current and tripping time.
10. Repeat the above procedure for different values of fault currents.
12. The same relay can be made to trip at definite time, by adjusting the relay for definite time characteristics.

CONCLUSION:

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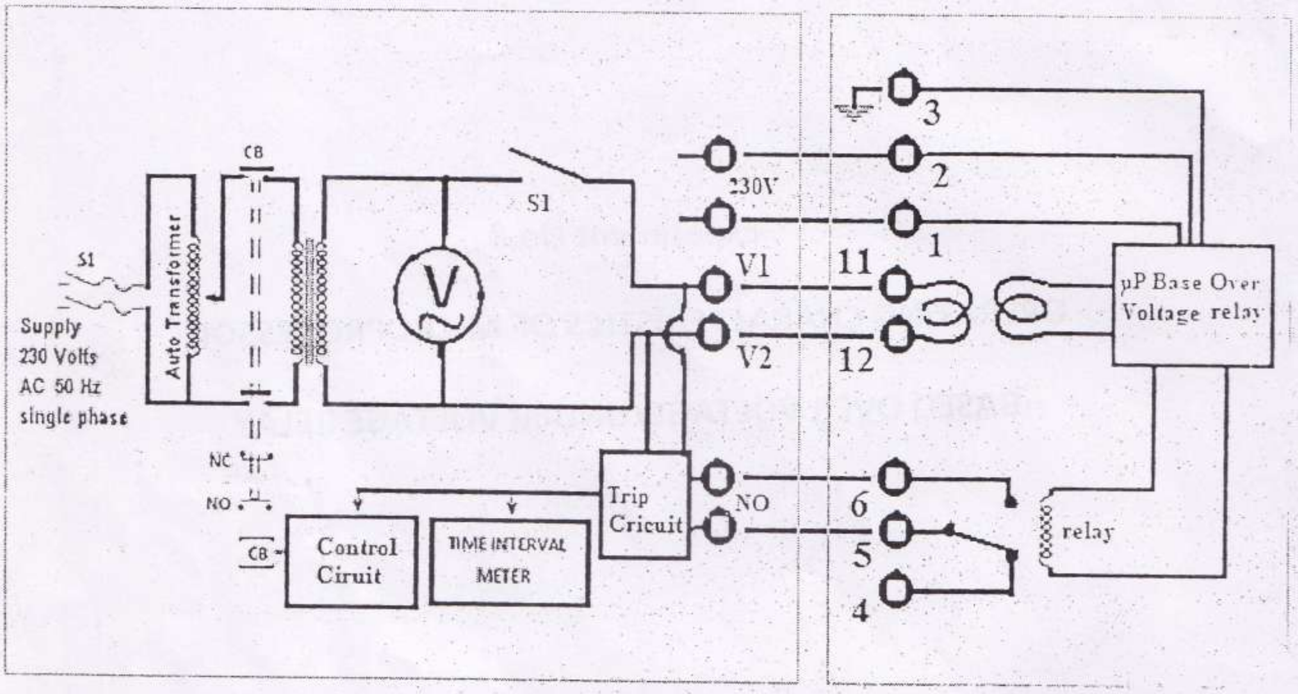
Experiment No.8

OPERATING CHARACTERISTICS OF MICROPROCESSOR BASED OVER VOLTAGE/UNDER VOLTAGE RELAY


CB
S1
Supply
230 Volts
AC 50 Hz
single phase
Auto Transformer
NC
NO
CB
V
S1
230V
V1
V2
Trip
Cricuit
NO
Control
Ciruit
TIME INTERVAL
METER
3
2
1
11
12
6
5
4
μP Base Over
Voltage relay
relay

EXPT. NO:8

OPERATING CHARACTERISTICS OF MICROPROCESSOR BASED OVER VOLTAGE/UNDER VOLTAGE RELAY

AIM: To determine the operating characteristics of µP based Over Voltage/Under Voltage Relay

APPARATUS REQUIRED:

SL. NO	ITEM	RANGE	QTY
1	µP based OV Relay	--	01
2	Injector kit	--	01
3	Connecting Wires	--	Few

PRECAUTIONS:

1. Before starting the experiment note down the specifications of the test kit.
2. Completely study the Test equipment on which experiment is conducted.
3. Use the specification book provided by the manufacturer to know about the equipment.

PROCEDURE: 1) FOR OVER VOLTAGE RELAY

1. Connections are made as per circuit diagram.
2. Set the relay to OVER VOLTAGE mode using the switch [SW_1].
3. Set the operating characteristics (Definite/ Normal Inverse) using the switch [SW_2] which is provided on the panel board of MV12 Relay.
4. Using DIP switches set the Fault Voltage Level V_s as below,

   $V_s = [\ 1 + (\ 0.05 + \sum a\ )\ ]\ V_n$ where V_n = 110 V / 240 V/ 415 V
5. Using standard DIP switches set the TMS and Trip Time using the standard equation given,

   $$\text{Trip Time}\ (\ T\ ) = k\ [\ 0.1 + \sum\ t\ ]$$

   $$TMS = [\ 0.1 + \sum\ t\ ]$$

   Where k is constant depends upon Trip Time characteristics used for the relay
6. Keep (TIM) Time Interval Meter , Protection Timer Switch and dimmer at zero position.
7. Switch on the supply and bring the toggle switch to SET MODE.
8. PUSH the TEST START BUTTON.
9. Using the dimmer 2 adjust the voltage above the fault voltage level (V_S).

TABULAR COLUMN :

For Inverse Characteristics(Over Voltage)

- V_n = 110 Volts and V_s = 93.2 of V_n

S.No.	Set Voltage (V_s) Volts	Fault Voltage (Volts)	Operating time (Sec)		Multiple of set Voltage V_s
			TMS = 0.5	TMS = 1.0	
1					
2					
3					
4					
5					

SPECIMEN CALCULATIONS:

- Multiple of set voltage V_s(PSM) = Fault Voltage / Plug setting Voltage.

= ---------

=----------

For Definite Characteristics

- Fault Voltage Level (V_s)= ______% V_n , where V_n = 110V

S.No.	Set Voltage (V_s) Volts	Fault Voltage (Volts)	Operating Time (Sec)
1			
2			

10. Press TEST STOP / RESET button and don't disturb the position of the dimmer2.
11. Bring the toggle switch to TEST MODE.
12. Press the TEST START button.
13. Note down the voltage and time taken by the relay to trip.
14. Press the RESTART button and increase the voltage to some value using dimmer2.
15. Press TEST START button and note down the voltage and trip time.
16. Repeat the above procedure for different values of voltage above fault voltage level.

2) FOR UNDER VOLTAGE RELAY

1.Connections are made as per circuit diagram.

2.Set the relay to UNDER VOLTAGE mode using the switch [SW_1].

3.Set the operating characteristics (Definite/ Normal Inverse) using the switch [SW_2] which is provided on the panel board of MV12 Relay.

4.Using DIP switches set the Fault Voltage Level V_s as below,

$$V_s = [\ 1 - (\ 0.05 + \sum a\ )\ ]\ V_n \text{ where } V_n = 110\text{ V} / 240\text{ V} / 415\text{ V}$$

5.Using standard DIP switches set the TMS and Trip Time using the standard equation given,

$$\text{Trip Time}\ (\ T\ ) = k\ [\ 0.1 + \sum\ t\ ]$$

$$\text{TMS} = [\ 0.1 + \sum\ t\ ]$$

Where k is constant depends upon Trip Time characteristics used for the relay

6. Keep (TIM) Time Interval Meter , Protection Timer Switch and dimmer at zero position.
7. Switch on the supply and bring the toggle switch to SET MODE.
8. PUSH the TEST START BUTTON.
9. Adjust the voltage level above the threshold level of under voltage level setting using dimmer1
10. Press TEST STOP / RESET button and don't disturb the position of the dimmer1.
11. Adjust the under voltage level(i.e. less than relay set voltage) using dimmer 2.
12. Push TEST STOP/RESET BUTTON.
13. Don't disturb the dimmers 1&2.
14. Bring toggle switch to TEST mode.
15. Push TEST START button, Note down the voltage and time taken by the relay to trip.

TABULAR COLUMN :

For Inverse Characteristics (Under Voltage)

- V_n = 110 Volts and V_s = % of V_n

S.No.	Set Voltage (V_s) Volts	Fault Voltage (Volts)	Operating time (Sec)		Multiple of set Voltage V_s
			TMS = 0.5	TMS = 1.0	
1					
2					
3					
4					
5					

SPECIMEN CALCULATIONS:

- Multiple of set voltage V_s(PSM) = Fault Voltage / Plug setting Voltage.

= --------

=----------/

For Definite Characteristics

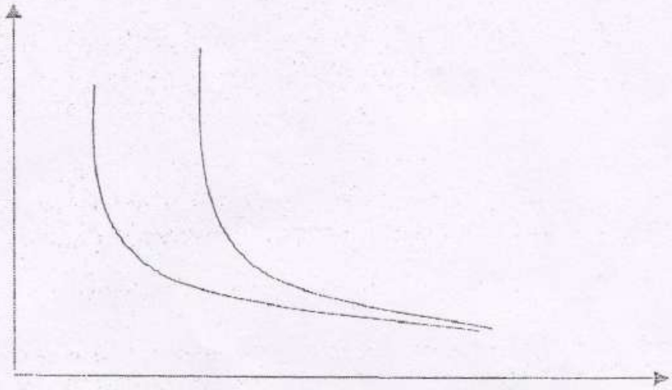
- Fault Voltage Level (V_s)= % V_n , where V_n = 110V

S.No.	Set Voltage (V_s) Volts	Fault Voltage (Volts)	Operating Time (Sec)
1			
2			

16. Press the RESTART button and adjust the voltage using dimmer2.
17. Press TEST START button and note down the voltage and trip time.
18. Repeat the above procedure for different values of voltage.
19. Draw the graph Trip Time V/S Plug setting Voltage.

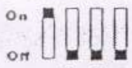
SPECIMEN GRAPHS:

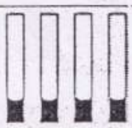
Time (Sec)

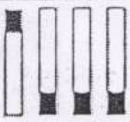


Fault Voltage (Volts)

Different setting for μP OV / UV Relay

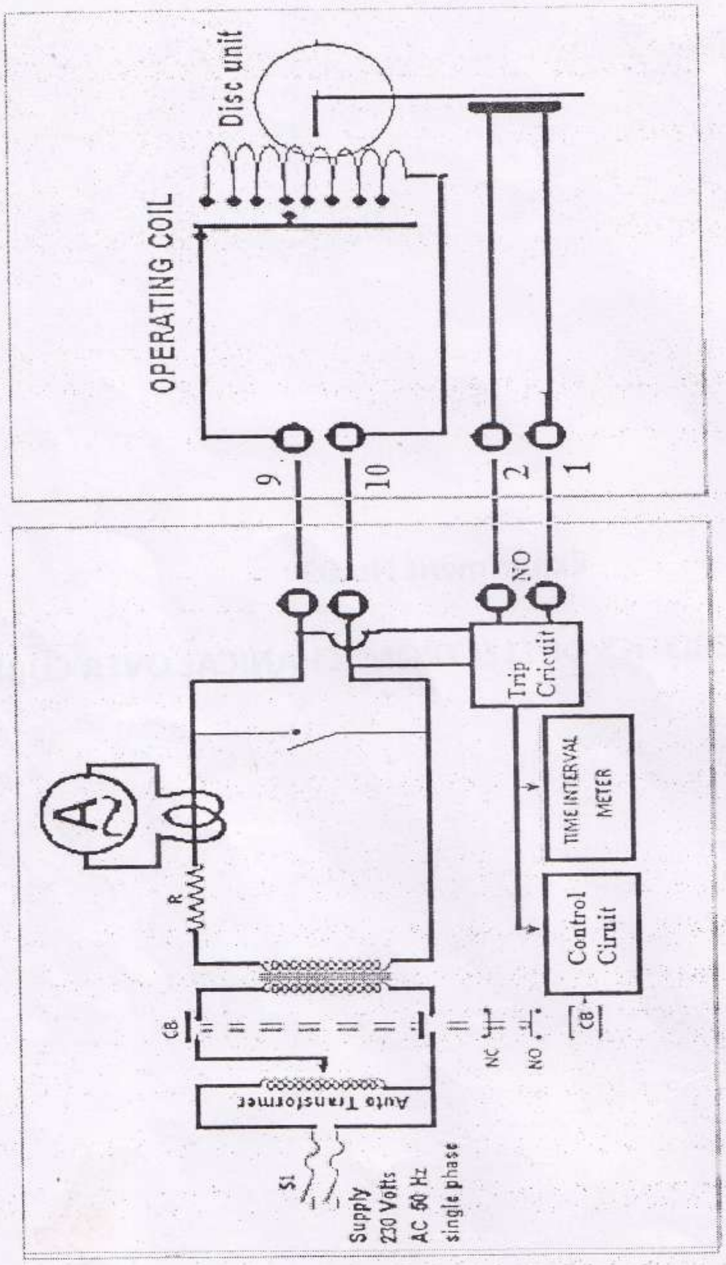
Setting for inverse characteristics					
 Sw2	Trip time characteristic	Sw_1	Sw_2	Sw_3	Sw_4
	Normal Inverse time (3.5 sec)	ON	OFF	OFF	OFF

Setting for Definite characteristics						
 On Off Sw2	Trip time characteristic	Sw_1	Sw_2	Sw_3	Sw_4	K
	Definite time 1 sec	ON	OFF	ON	OFF	**1**
	Definite time 10 sec	ON	ON	OFF	OFF	**10**
	Definite time 100 sec	ON	ON	ON	OFF	**100**

Setting for different Normal Voltage Values (V_n)					
 On Off Sw1	Voltage range selection	Sw_1	Sw_2	Sw_3	Sw_4
	0-110 Volts	ON	OFF	OFF	OFF
	0-240 volts	OFF	ON	OFF	OFF
	0-415 volts	OFF	OFF	ON	OFF

Experiment No.09

OPERATING CHARACTERISTICS OF ELECTROMECHANICAL OVER CURRENT RELAY


Disc unit
OPERATING COIL
9
10
2
1
NO
Trip
Cricuit
TIME INTERVAL
METER
Control
Ciruit
R
A
CB
NC
NO
CB
Auto Transformer
S1
Supply
230 Volts
AC 50 Hz
single phase

EXPT. NO: 09

OPERATING CHARACTERISTICS OF ELECTROMECHANICAL OVER CURRENT RELAY

AIM: To determine the operating characteristics of Electromechanical Over Current Relay

APPARATUS REQUIRED:

SL. NO	ITEM	RANGE	QTY
1	OC Relay	--	01
2	Injector kit	--	01
3	Connecting Wires	--	Few

PRECAUTIONS:

1. Before starting the experiment note down the specifications of the test kit.
2. Completely study the Test equipment on which experiment is conducted.
3. Use the specification book provided by the manufacturer to know about the equipment.

PROCEDURE:

1. Connections are made as per circuit diagram.
2. Adjust the voltage I_s to any value using the knob provided on the relay.
   (Between).
3. Keep Time Interval Meter switch in (TIM) ON position and protection timer switch in ON position.
4. Keep the dimmer at zero position.
5. Switch on the supply.
6. Switch on the supply and press TEST START BUTTON.
7. Adjust the fault current above Fault Current Level (I_s) with the help of dimmer.
8. Do not disturb the dimmer and bring toggle switch to test postion.
9. Press TEST START Button and note down fault current and tripping time.
10. Press START BUTTON and set the relay current above I_s and Press START BUTTON.
11. Note down the values of current and trip time for every increase of current and set value.

TABULAR COLUMN :

- V_s= 121 Volts

S.No.	Set Current (I_s) Amps	Fault Current (Amps)	Operating time (Sec)		Multiple of set Current (PSM) I_s
			TMS = 0.5	TMS = 1.0	
1					
2					
3					
4					
5					
6					

SPECIMEN CALCULATIONS:

- Multiple of set voltage I_S (PSM) = Fault Current / Plug setting Current.

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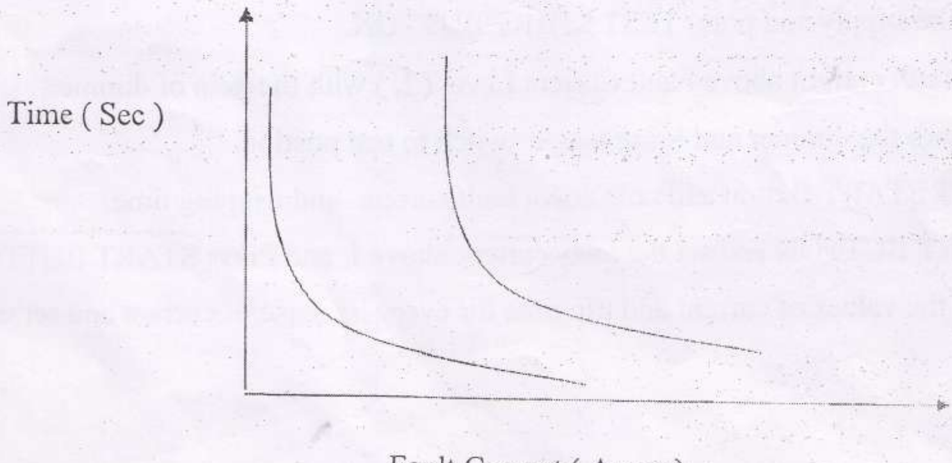
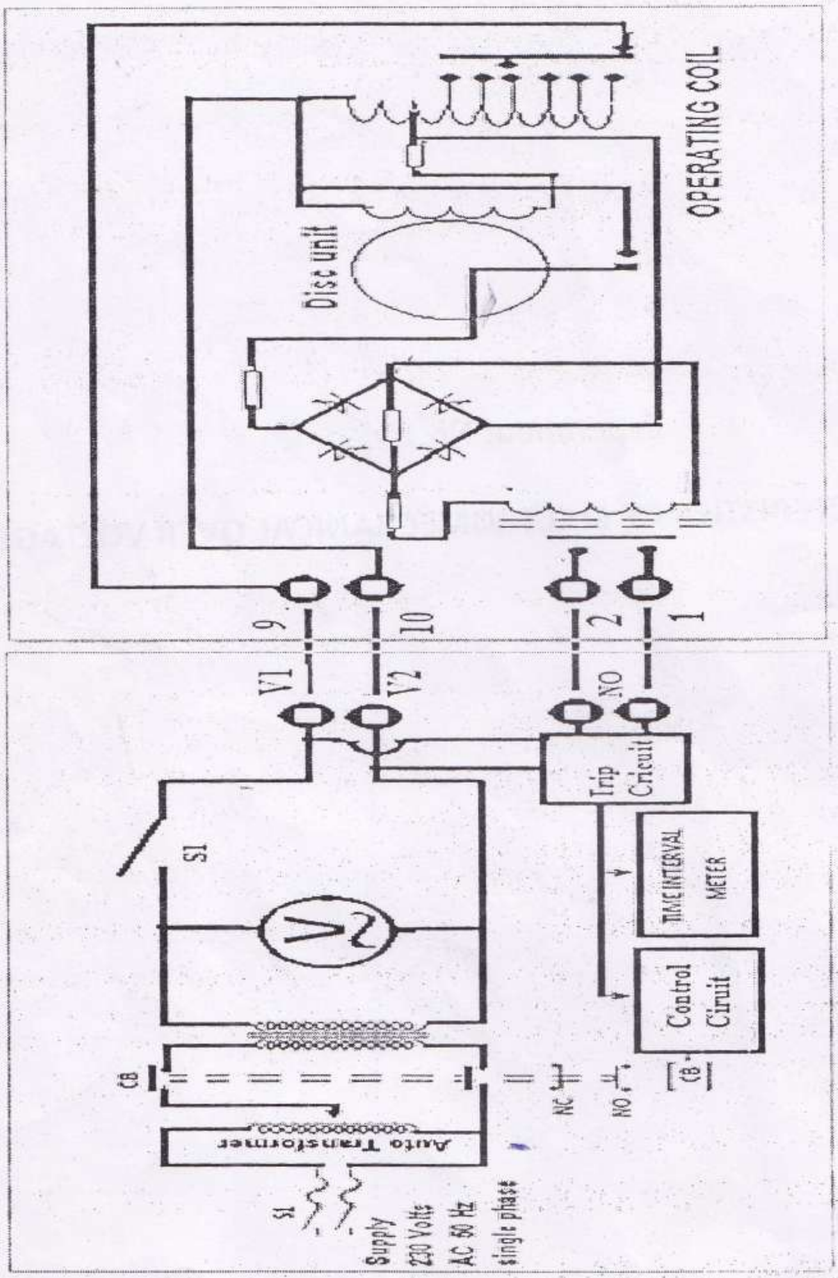
SPECIMEN GRAPHS:



Experiment No.10

OPERATING CHARACTERISTICS OF ELECTROMECHANICAL OVER VOLTAGE RELAY


OPERATING COIL
Disc unit
9
10
2
1
V1
V2
NO
Trip
Crieuit
TIME INTERVAL
METER
Control
Ciruit
S1
CB
NC
NO
CB
Auto Transformer
S1
Supply
230 Volts
AC 50 Hz
single phase

EXPT. NO:10

OPERATING CHARACTERISTICS OF ELECTROMECHANICAL OVER VOLTAGE RELAY

AIM: To determine the operating characteristics of Electromechanical Over Voltage Relay

APPARATUS REQUIRED:

SL. NO	ITEM	RANGE	QTY
1	OV Relay	--	01
2	Injector kit	--	01
3	Connecting Wires	--	Few

PRECAUTIONS:

1. Before starting the experiment note down the specifications of the test kit.
2. Completely study the Test equipment on which experiment is conducted.
3. Use the specification book provided by the manufacturer to know about the equipment.

PROCEDURE:

1. Connections are made as per circuit diagram.
2. Adjust the voltage V_s to any value using the knob provided on the relay. (Between 110 to 170 %).
3. Keep Time Interval Meter switch in (TIM) ON position.
4. Keep the dimmer at zero position and Toggle switch at TEST position.
5. Switch on the supply.
6. Press TEST START Button and immediately adjust fault voltage above the set voltage (V_s)
7. Press TEST START Button and note down fault voltage and tripping time.
8. Above procedure is repeated for different values of voltage above the set value of the voltage (V_s)
9. Plot the graph of Trip Time V/S multiple of plug Setting.

TABULAR COLUMN :

- V_s= 121 Volts

S.No.	Set Voltage (V_s) Volts	Fault Voltage (Volts)	Operating time (Sec)		Multiple of set Voltage (PSM) V_s
			TMS = 0.5	TMS = 1.0	
1					
2					
3					
4					
5					
6					
7					

SPECIMEN CALCULATIONS:

- Multiple of set voltage V_S (PSM) = Fault Voltage / Plug setting Voltage.

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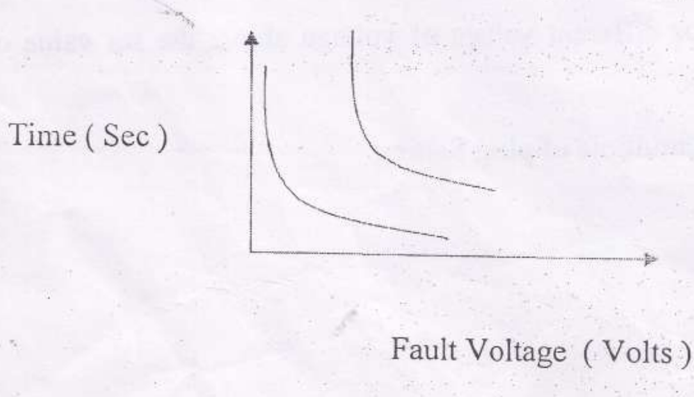
=---------

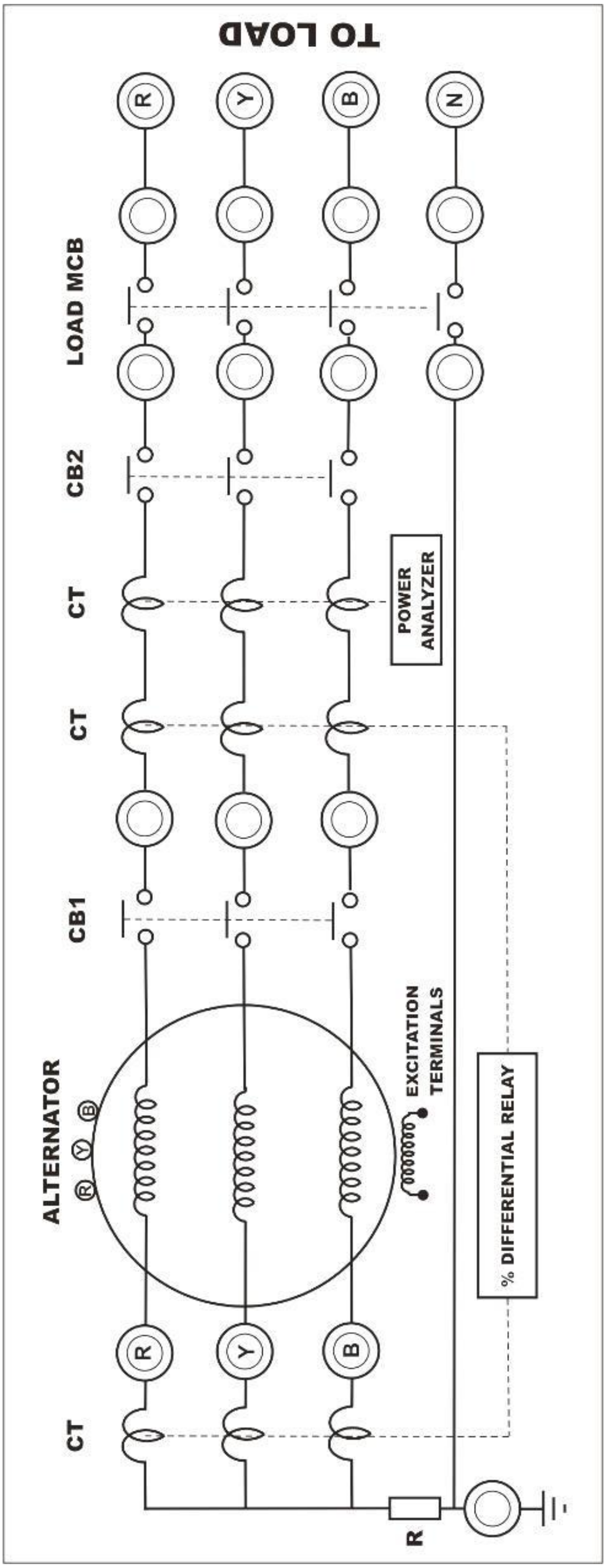
SPECIMEN GRAPHS:



Experiment No. – 11

Study of Merz-price | Differential protection

Circuit Diagram:



STUDY OF MERZ-PRICE /DIFFERENTIAL PROTECTION ON ALTERNATOR

Aim: Study of Merz price/deferential protection on alternator. Merz price/differential protection on alternator is done using a protection relay of CS make the relay is connected through with a CT ratio of 5A:1A.

Theory: This is most commonly used protection scheme for alternator stator winding the scheme is also called biased differential production and percentage differential protection.

In this method the currents of the two ends of the protect section are secured using current transformers. The wires connected to relay coils to the current transformers secondary are called pilot wires.

Under normal conditions, when there is no fault in the winding the currents in pilot wires fed from CT secondary are equal. The differential current I1-I2 through the operating coils of the relay is zero. Hence the relay is in operative and system is said to be balanced.

Operating procedure:

1. Switch on the MCB on the panel. All meters, relays will switch on.
2. To switch on the motor, press VED ON.
3. Run the motor at 1500 RPM or at 50Hz by varying the speed through the inverter drive using the multiunpot provided.
4. To switch on the generator bring the variac to zero position.
5. Check for the generator ready indication and press CB1 ON push button.
6. Apply field excitation using variac to generate voltages to 220V/230V (L-N) or 400V (L-L)
7. Connect the load and switch on the supply to it by putting on CB-2 through CB-2 push button.

Analysis using fault simulation switch:

a) Connect the generator terminals to the fault simulation terminals as shown in connection diagram depending on the type of fault required.
b) Change the fault simulation switch from position 1 to position 2 and to create the fault.

Analysis using the load:

a) Connect the generator terminals to directly to the load as shown in connection diagram.
b) Create fault by applying load either for balanced system or un balanced system.
c) The relay trips indicating the phase in which the fault has occurred.
d) Reset the relay and panel using RESET push button.
e) Again repeat from step 5 for different types of faults.

Conclusion:

Tabular Column

No load							
S. N.	Frequency in Hz	Excitation Voltage (V)	Line to Line Voltage			Type of faults	Relay State
			L1	L2	L3		
1							
2							
3							
4							
5							

With load							
S. N.	Frequency in Hz	Excitation Voltage (V)	Line to Line Voltage			Type of faults	Relay State
			L1	L2	L3		
1							
2							
3							
4							
5							

Ratings:

3ϕ Induction motor

kW/HP _______________

Current _______________

RPM _________________

P. F. __________________

Alternator

KvA________________

Volts_______________

RPM________________