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Name _____

Roll No. _____ Year 20____20____

Exam Seat No. _____

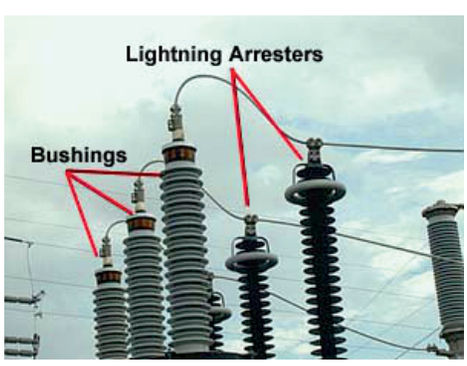
ELECTRICAL GROUP | SEMESTER - V | DIPLOMA IN ENGINEERING AND TECHNOLOGY

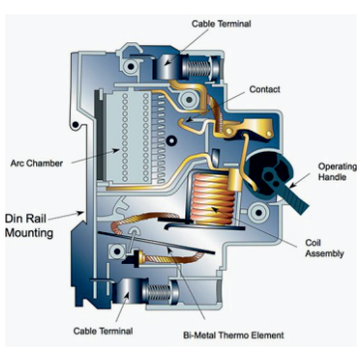
A LABORATORY MANUAL

FOR

SWITCHGEAR AND PROTECTION

(22524)





MAHARASHTRA STATE BOARD OF TECHNICAL EDUCATION, MUMBAI

(Autonomous) (ISO 9001 : 2015) (ISO / IEC 27001 : 2013)

VISION

To ensure that the Diploma level Technical Education constantly matches the latest requirements of technology and industry and includes the all-round personal development of students including social concerns and to become globally competitive, technology led organization.

MISSION

To provide high quality technical and managerial manpower, information and consultancy services to the industry and community to enable the industry and community to face the changing technological and environmental challenges.

QUALITY POLICY

We, at MSBTE are committed to offer the best in class academic services to the students and institutes to enhance the delight of industry and society. This will be achieved through continual improvement in management practices adopted in the process of curriculum design, development, implementation, evaluation and monitoring system along with adequate faculty development programmes.

CORE VALUES

MSBTE believes in the followings:

- Education industry produces live products.
- Market requirements do not wait for curriculum changes.
- Question paper is the reflector of academic standards of educational organization.
- Well designed curriculum needs effective implementation too.
- Competency based curriculum is the backbone of need based program.
- Technical skills do need support of life skills.
- Best teachers are the national assets.
- Effective teaching learning process is impossible without learning resources.

A Practical Manual for

Switchgear and Protection

(22524)

Semester – V

(EE, EP, EU)

Maharashtra State
Board of Technical Education, Mumbai
(Autonomous) (ISO:9001:2015) (ISO/IEC 27001:2013)

Maharashtra State Board of Technical Education,
(Autonomous) (ISO:9001: 2015) (ISO/IEC 27001 : 2013)
4th Floor, Government Polytechnic Building, 49, Kherwadi,
Bandra (East), Mumbai - 400051.
(Printed on May,2019)

Maharashtra State
Board of Technical Education

Certificate

This is to certify that Mr. / Ms…….

Roll No…….of Fifth Semester of Diploma in ……of Institute ……..

(Code……..) has completed the term work satisfactorily in course **Switchgear and Protection (22524)** for the academic year 20…….to 20…..... as prescribed in the curriculum.

Place ……. Enrollment No……

Date:…..... Exam Seat No. …….....

Course Teacher **Head of the Department** **Principal**

Seal of the Institute

Preface

The primary focus of any engineering laboratory/ field work in the technical education system is to develop the much needed industry relevant competencies and skills. With this in view, MSBTE embarked on this innovative 'I' Scheme curricula for engineering diploma programmes with outcome-base education as the focus and accordingly, relatively large amount of time is allotted for the practical work. This displays the great importance of laboratory work making each teacher; instructor and student to realize that every minute of the laboratory time need to be effectively utilized to develop these outcomes, rather than doing other mundane activities. Therefore, for the successful implementation of this outcome-based curriculum, every practical has been designed to serve as a ***'vehicle'*** to develop this industry identified competency in every student. The practical skills are difficult to develop through 'chalk and duster' activity in the classroom situation. Accordingly, the 'I' scheme laboratory manual development team designed the practicals to ***focus*** on the ***outcomes***, rather than the traditional age old practice of conducting practicals to 'verify the theory' (which may become a byproduct along the way).

This laboratory manual is designed to help all stakeholders, especially the students, teachers and instructors to develop in the student the pre-determined outcomes. It is expected from each student that at least a day in advance, they have to thoroughly read through the concerned practical procedure that they will do the next day and understand the minimum theoretical background associated with the practical. Every practical in this manual begins by identifying the competency, industry relevant skills, course outcomes and practical outcomes which serve as a key focal point for doing the practical. The students will then become aware about the skills they will achieve through procedure shown there and necessary precautions to be taken, which will help them to apply in solving real-world problems in their professional life.

This manual also provides guidelines to teachers and instructors to effectively facilitate student-centered lab activities through each practical exercise by arranging and managing necessary resources in order that the students follow the procedures and precautions systematically ensuring the achievement of outcomes in the students.

The electrical diploma holder has to work in industry as technical person in middle level management. He has to work as production, maintenance, testing engineer in various industries like power generation, transmission, distribution, traction etc. and has to deal with different electrical measurement. While performing above task he has to measure different electrical and electronic parameters with testing, therefore he/she must require the skills for these measurements and broad idea of different meters and equipment.

Although all care has been taken to check for mistakes in this laboratory manual, yet it is impossible to claim perfection especially as this is the first edition. Any such errors and suggestions for improvement can be brought to our notice and are highly welcome.

Programme Outcomes (POs) to be achieved through Practical of this Course

Following POs and PSO are expected to be achieved through the practicals of the Electrical and Electronic Measurement course.

PO2. Discipline knowledge: Apply Electrical Engineering knowledge to solve broad based Electrical Engineering related problems.

PO3. Experiments and practice: Plan to perform experiments and practices to use the results to solve broad-based Electrical Engineering problems.

PO4. Engineering tools: Apply relevant Electrical technologies and tools with an understanding of the limitations.

Program Specific Outcomes (PSOs)

PSO1. Electrical Equipment: Maintain various types of rotating and static electrical equipment.

PSO 2. Electric Power Systems: Maintain different types of electric power systems.

List of Industry Relevant Skills

The following industry relevant skills of the competency ‘Use electric motors and transformers are expected to be developed in the students by undertaking the laboratory work in this practical manual.

1. Select and use suitable switchgears for different applications.
2. Test the performance of different protective relays.
3. Maintain protection systems of alternators and transformers.
4. Maintain protection systems of motors and transmission lines.
5. Maintain protection schemes for power system against over voltages.

Practical- Course Outcome matrix

Course Outcomes (COs):-

a. Identify various types of faults in power system.
b. Select suitable switchgears for different applications.
c. Test the performance of different protective relays.
d. Maintain protection systems of alternators and transformers.
e. Maintain protection schemes for motors and transmission lines.

S. No.	Practical Outcome	CO a.	CO b.	CO c.	CO d.	CO e.
1.	Use switchgear testing kit.	√	-	-	-	-
2.	Identify various switchgears in the laboratory and write their specifications.	√	-	-	-	-
3.	Test HRC fuse by performing the load test.	-	√	-	-	_
4.	Test MCB by performing the load test	-	√	-	-	-
5.	Dismantle MCCB/ELCB and identify various parts.	-	√	-	-	-
6.	Video show on/Dismantle ACB/VCB and identify different parts.	-	√	-	-	-
7.	Carry out plug and time setting (with PSM, TSM) of induction type electromagnetic relay.	-	-	√	-	-
8.	Test electromagnetic over-current relay by performing load test.	-	-	√	-	-
9.	Simulate differential protection scheme for transformer on the power system simulation Kit. Part- I	-	-	-	√	-
10.	Simulate differential protection scheme for transformer on the power system simulation Kit. Part- II	-	-	-	√	-
11.	Test the working of the single phasing preventer using a three phase induction motor.	-	-	-	-	√
12.	Simulate transmission line protection by using the impedance relay/over current relay for various faults. (On transmission line protection simulation Kit). Part- I	-	-	-	-	√

13.	Simulate transmission line protection by using the impedance relay/over current relay for various faults. (On transmission line protection simulation Kit). Part- II	-	-	-	-	√
14.	Video show on /Dismantle Thyrite type arrester and identify different parts.	-	-	-	√	√
15.	Video show on / Demonstrate neutral earthing at different substation/ locations Part- I	-	-	√	√	-
16.	Video show on /Demonstrate neutral earthing at different substation/locations Part- II	-	-	√	√	-

Guidelines to Teachers

1. ***Teacher need to ensure that a dated log book*** for the whole semester, apart from the laboratory manual is maintained by every student which s/he has to ***submit for assessment to the teacher*** in the next practical session.
2. There will be two sheets of blank pages after every practical for the student to report other matters (if any), which is not mentioned in the printed practicals.
3. For difficult practicals if required, teacher could provide the demonstration of the practical emphasizing of the skills which the student should achieve.
4. Teachers should give opportunity to students for hands-on after the demonstration.
5. Assess the skill achievement of the students and COs of each unit.
6. One or two questions ought to be added in each practical for different batches. For this teachers can maintain various practical related question bank for each course.
7. If some repetitive information like data sheet, use of software tools etc. has to be provided for effective attainment of practical outcomes, they can be incorporated in Appendix.
8. For effective implementation and attainment of practical outcomes, teacher ought to ensure that in the beginning itself of each practical, students must read through the complete write-up of that practical sheet.
9. During practical, ensure that each student gets chance and takes active part in taking observations/ readings and performing practical.
10. Teacher ought to assess the performance of students continuously according to the MSBTE guidelines

Instructions for Students

1. For incidental writing on the day of each practical session every student should maintain a ***dated log book*** for the whole semester, apart from this laboratory manual which s/he has to ***submit for assessment to the teacher*** in the next practical session.
2. For effective implementation and attainment of practical outcomes, in the beginning itself of each practical, students need to read through the complete write-up including the practical related questions and assessment scheme of that practical sheet.
3. Student ought to refer the data books, IS codes, Safety norms, Electricity act/rules, technical manuals, etc.
4. Student should not hesitate to ask any difficulties they face during the conduct of practicals.
5. **Follow industrial safety procedures for operation of industrial machine/s.**

Content Page

List of Practicals and Progressive Assessment Sheet

11 *	Test the working of the single phasing preventer using a three phase induction motor.	55					
12	Simulate transmission line protection by using the impedance relay/over current relay for various faults. (On transmission line protection simulation Kit). Part- I	61					
13	Simulate transmission line protection by using the impedance relay/over current relay for various faults. (On transmission line protection simulation Kit). Part- II	61					
14 *	Video show on /Dismantle Thyrite type arrester and identify different parts.	67					
15 *	Video show on / Demonstrate neutral earthing at different substation/locations Part- I	72					
16 *	Video show on /Demonstrate neutral earthing at different substation/locations Part- II	72					
Total							

Note: A judicial max of maximum or more practical need to be performed, out of which practicals marked as * are compulsory.

Note : To be transferred to relevant proforma of CIAAN-2017

Practical No. 1: Use Switchgear testing kit

I. Practical Significance:

Switchgear kit is specially designed to suit relay testing requirements of power station testing engineers and used for testing different types of power system relays.

II. Relevant Program Outcomes (POs)

PO2- Discipline knowledge: Apply electrical engineering knowledge to solve broad - based electrical engineering related problems.
PO3- Experiments and practice: Plan to perform experiments and practices to use the results to solve broad-based electrical engineering problems.
PO4- Engineering tools: Apply relevant Electrical technologies and tools with an understanding of the limitations.

III. Competency and Skills

This practical is expected to develop the following skills for the industry identified
Competency: 'Maintain switchgear and protection schemes used in electrical power systems.'

- Use various electrical switchgears.
- Follow electrical safety practices.

IV. Relevant Course Outcomes

Identify various types of faults in power system.

V. Practical Outcome

Use switchgear testing kit.

VI. Minimum Theoretical Background

- Switchgear testing kit operates on single phase 230 V, AC, 50 Hz power supply and provides ac controllable test voltage and completely adjustable output current.
- All the switches, terminals, meters and knobs are mounted on front of the panel.
- Number of functional units are included in single cabinet and compact in size.
- The voltage circuit and current circuit can be used simultaneously.

VII. Work Situation :(Students shall write the details of switchgear kit under the guidance of the teacher)

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VIII. Resources required

S. No.	Name of resource	Specification	Quantity
1	Switchgear testing kit.	standard	01
2	Variable AC current	0 – 50 A with 500 VA /1000 VA	01
3	Variable AC voltage	0 – 230 V AC , 2 A	01
4	Variable DC voltage	0 – 230 V DC,2 A	01
5	Timer	Range 0-999.99 msec.	01
6	Relay	0 – 10 A	01

IX. Precautions to be followed

1. Read manufactures instruction before using kit.
2. There should not be any loose connection.
3. Ensure that the meters/components have proper rating.

X. Procedure

1. Connect relay coil to current range selector.
2. Switch on the main supply.
3. Select current and adjust current range, keep the timer open.
4. Select AC /DC voltage source as per requirement.
5. After setting the current range, short the time terminals to automatically stop the current source.
6. Reset the timer and the current circuit by pushing the start button.
7. After testing of the relay for 2 to 3 times at various ranges, zero the current control knob.
8. Switch OFF the main supply.

XI. Resources used (with major specifications)

S. No.	Name of Resource	Broad Specifications		Quantity	Remarks (If any)
		Make	Details		
1.					
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3.					
4.					

XII. Actual procedure followed

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XIII. Precautions followed

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XIV. Observations and calculations :

Sr. No.	% set	Current (A)	Time of operation(sec.)
1	2.5 A (50%)		
2	3.75 A (75%)		
3	5 A (100 %)		
4	6.25A(125%)		
5	7.5 A (150%)		
6	8.75A(175%)		
7	10 A (200%)		

XV. Results:

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XVI. Interpretation of results (Write meaning of the above obtained results.)

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XVII. Conclusion

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XVIII. Practical related Questions

Note: Below given are few sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO.

1. State the specification of any one switchgear kit.
2. Write down the approximate cost and make of one switchgear kit.
3. State the need of switchgear kit.

[Space for Answers]

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XIX. References / Suggestions for Further Reading

1. www.electrical4u.com
2. https://www.mytech-info.com
3. https://circuitglobe.com

XX. Suggested assessment Scheme

Performance Indicators		Weightage
Process related (15 Marks)		**(60%)**
1	Selection of meters and components	20 %
2	Handling of the switchgear testing kit	10 %
3	Reading meters accurately	10 %
4	connection of circuits	10 %
5	Follow safe practices	10 %
Product related (10 Marks)		**(40%)**
6	Writing result	10 %
7	Interpretation of result	10 %
8	Conclusions	05 %
9	Practical related questions	10%
10	Submitting the journal in time	05%
Total (25 Marks)		**100 %**

Names of Student Team Members

1. …….
2. …….
3. …….
4. …….

Marks Obtained			Dated signature of Teacher
Process Related (15)	**Product Related (10)**	**Total (25)**	

Practical No. 2: Identify various switchgears in the laboratory and write their specifications

I Practical Significance:

Switchgears are the most important components of electrical power system. They provide protection as well as safety to the system. Hence it is very important to survey different switchgear equipment used in electrical power system and appreciate their specification.

II Relevant Program Outcomes (POs)

PO4-Engineering tools: Apply relevant electrical technologies and tools with an understanding of the limitations.

PO8-Individual and teamwork: Function effectively as a leader and team member in diverse/multidisciplinary teams.

III Competency and Skills

This practical is expected to develop the following skills for the industry identified

Competency: **'**Maintain switchgear and protection schemes used in electrical power systems**.'**

- Identify various switchgears
- Select their specification
- Follow safety practices while using them.

IV Relevant Course Outcomes

- Select suitable switchgears for different applications.

V Practical outcome

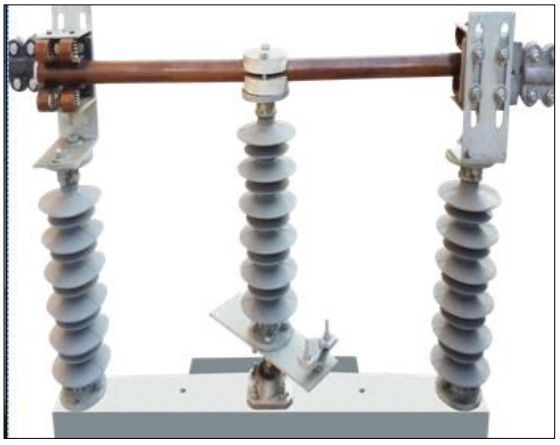
- Identify various switchgears in laboratory and write their specifications.

VI Minimum Theoretical Background

- Switchgear is the term used to describe apparatus used for switching, controlling and protection of electric circuit and equipment.
- It covers wide range of equipment concerned with switching and interrupting supply to a circuit in normal and abnormal conditions.
- Switchgear equipment is installed indoor or outdoor depending upon voltage levels .Generally for voltages up to 33kV switchgear is installed indoor and for above 33kV it is installed outdoors.

VII Illustrative photographs of different switchgear equipments

Current Transformer



Isolator

Lightning Arrester

Two Pole MCB

SF6 CB

HRC Fuse

VIII Resources required

S. No.	Name of resource	Specification	Quantity	Remarks
1	Fuse	6A,10A,16A,32Aetc	01	
2	Isolator	32A, 63A, 100A etc.	01	
3	Circuit Breaker	32A, 8000A, 80KV	01	
4	Relay	10A, 32A	01	
5	C.T	50A/5A, 500A/5A	01	
6	P.T	11KV/110V	01	
7	Lightning arrester	200A, 500A	01	
8	Earth Switch	32A, 63A, 100A	01	

IX Precautions to be followed

1. Use ISI mark switchgears.
2. Use proper switchgear for proper work.
3. Never use damaged switchgears.

X Procedure

1. Collect information about various switchgear equipments. (industry/vendor/web based search)
2. Observe and identify various switchgear equipment.
3. Note the technical specifications and also write their function.(A table of equipments is given below)

XI Resources used (with major specifications)

Sr. No	Name of Resource	Broad Specifications		Quantity	Remarks (If any)
		Make	Details		
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3.					
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XII Actual procedure followed

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XIII Precautions followed

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XIV Observations:

A) Prepare a summary report on the information collected.

Sr. No.	Equipment/ device	Function	Technical specification	Symbol
1.	Fuse	It is used for over current and short circuit protection.		
2.	Switch/Isolator			
3.	Contactor			
4.	Relay			
5.	Circuit breaker			
6.	MCB			
7.	CT			

8.	PT			
9.	Lightning arrester			
10.	Earth switch			

XV Results:

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XVI Interpretation of results (Write meaning of the above obtained results**.)**

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XVII Conclusion

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XVIII Practical related Questions

Note: Below given are few sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO.

1. List out four important switchgear equipments and give their cost.
2. Differentiate between isolator and circuit breaker on the basis of operation and use.
3. Arrange the following devices as per sequence of operation during opening and closing a circuit - (Isolator, earthing switch, circuit breaker)
4. Explain the need of switchgear equipments.

(Space for Answer)

XIX References / Suggestions for Further Reading

Sr. No.	Title of Book	Author	Publication
1	Switchgear Protection and Power Systems	Sunil S. Rao	Khanna Publisher
2	Power System Switchgear and Protection	Veerapan .N, Krishnamurty S.R.,	S. Chand & Co.

1) www.electrical4u.com
2) www.electricaltechnology.org

XX Assessment Scheme

Performance Indicators		Weightage
Process related (15 Marks)		**(60%)**
1	Identification of components/ equipments	20 %
2	Handling of the tools / components	20 %
3	Working in team	10 %
4	Follow safe practices	10 %
Product related (10 Marks)		**(40%)**
5	Writing Result	10 %
6	Interpretation of result	05 %
7	Conclusions	05 %
8	Practical related questions	15 %
9	Submitting the journal in time	05%
Total (25 Marks)		**100 %**

Names of Student Team Members

1. …….....
2. …….....
3. ……...….
4. ……

Marks Obtained			Dated signature of Teacher
Process Related (15)	**Product Related (10)**	**Total (25)**	

Practical No. 3: Test HRC fuse by performing the load test.

I Practical Significance:

The primary drawback of low and uncertain breaking capacity of semi-enclosed re-wireable fuse is overcome in HRC cartridge fuse. HRC fuse has high short circuit current and gives reliable and very accurate operation. They do not deteriorate with age and also give consistent performance.

II Relevant Program Outcomes (POs)

PO2- Discipline knowledge: Apply electrical engineering knowledge to solve broad - based electrical engineering related problems.
PO3- Experiments and practice: Plan to perform experiments and practices to use the results to solve broad-based electrical engineering problems.
PO4- Engineering tools: Apply relevant Electrical technologies and tools with an understanding of the limitations.

III Competency and Skills

This practical is expected to develop the following skills for the industry identified Competency: **'**Maintain switchgear and protection schemes used in electrical power systems**.'**:

- Use HRC fuse in an electrical circuit
- Test the working of HRC fuse

IV Relevant Course Outcomes

Select suitable switchgears for different applications.

V Practical Outcome

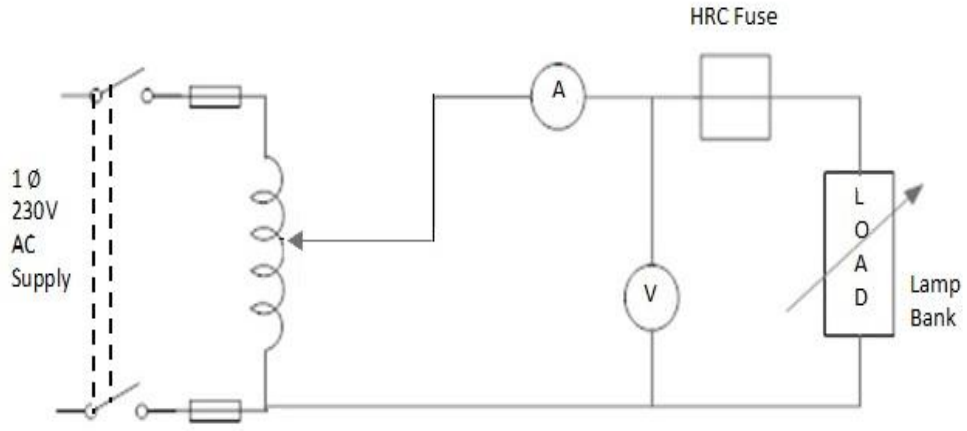
Test HRC fuse by performing the load test.

VI Minimum Theoretical Background

- A fuse is a short piece of metal inserted in the circuit which melts when excessive current flows through it and thus breaks the circuit.
- Fusing action - Heat produced by overcurrent causes current carrying fuse element to melt open and disconnecting load from source voltage.
- Classification of fuse- In general fuse may be classified into :
  - Low voltage fuse
  - High voltage fuse
- Characteristics of fuses-
  Fuse exhibits inverse time characteristics i.e. Increase in current through the fuse causes reduction in pre-arcing time.
- HRC fuse consists of a heat resisting ceramic body having metal end caps to which is welded silver current carrying element. It is completely packed with a filling powder. When a fault occurs, the current increases and the fuse element melts. The heat produced vaporizes the melted silver element. The chemical

reaction results in the formation of high resistance substance which quenches the arc.

VII Circuit diagram:



VIII Resources required

Sr. No.	Instrument /Object	Specification	Quantity	Remarks
1.	HRC fuse	Range- 0 to 6A	01	
2.	Lamp bank	Range- 10 to 20 A	01	
3.	A.C Voltmeter	Range- 0 to 300V	01	
4.	A.C Ammeter	Range- 0 to 10A	01	
5.	Autotransformer	0-270V,15A,1-2kVA	01	

IX Precautions to be followed

1. There should not be any loose connection.
2. Ensure that proper rating of HRC fuse is selected for the given circuit.
3. Ensure that supply is OFF while replacing the fuse.
4. Follow electrical safety rules.

X Procedure

1. Connections are made as per the circuit diagram.
2. Switch on the supply and adjust rated load current.
3. Gradually increase the load current in steps of 10% of rated and note down the time of operation for each current above rated till fuse blows.
4. Plot the graph between current and time of operation.

XI Resources used (with major specifications)

Sr. No	Name of Resource	Broad Specifications		Quantity	Remarks (If any)
		Make	Details		
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2.					
3.					
4.					

XII Actual procedure followed

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XIII Precautions followed

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XIV Observations:

Sr. No.	Load current in Amps.	Current through fuse element in Amps.	Time of operation in seconds
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XV Results:

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XVI Interpretation of results (Write meaning of the above obtained results.)

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XVII Conclusion

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XVIII Practical related Questions

Note: Below given are few sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO.

1) Compare fuse and circuit breaker based on capacity, voltage, life and operation.
2) State the function of fuse.
3) State the limitation of fuse.
4) Give the application of HRC fuse.
5) Why fuse is not connected in neutral.

(Space for Answer)

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XIX References / Suggestions for Further Reading Books

Sr. No.	Title of Book	Author	Publication
1	Switchgear Protection and Power Systems	Sunil S. Rao	Khanna Publisher
2	Switchgear and power system protection	Singh R.P.	PHI Learning
3	Principles of power system	Mehta V.K. ; Rohit Mehta	S. Chand & Co.

1. www.electrical4u.com
2. www.electricaltechnology.org

XX Assessment Scheme

Performance Indicators		Weightage
Process related (15 Marks)		**(60%)**
1	Selection of meters and components	20 %
2	Handling of the HRC fuse and load	10 %
3	Reading meters accurately	10 %
4	connection of circuits	10 %
5	Follow safe practices	10 %
Product related (10 Marks)		**(40%)**
6	Writing result	10 %
7	Interpretation of result	05 %
8	Conclusions	05 %
9	Practical related questions	15 %
10	Submitting the journal in time	05%
Total (25Marks)		**100 %**

Names of Student Team Members

1. …….....
2. …….....
3. ……....
4. ……

Marks Obtained			Dated signature of Teacher
Process Related (15)	**Product Related (10)**	**Total (25)**	

Practical No. 4: Test MCB by performing the load test

I Practical Significance:

MCB is the most important component of a power distribution system. It provides safety and proper operation of the system .It is essential to ensure its working by testing the same.

II Relevant Program Outcomes (POs)

PO2- Discipline knowledge: Apply electrical engineering knowledge to solve broad - based electrical engineering related problems.

PO3- Experiments and practice: Plan to perform experiments and practices to use the results to solve broad-based electrical engineering problems.

PO4- Engineering tools: Apply relevant Electrical technologies and tools with an understanding of the limitations.

III Competency and Skills

This practical is expected to develop the following skills for the industry identified

Competency: **'**Maintain switchgear and protection schemes used in electrical power systems**.'**:

- Test the working of MCB
- Use MCB in an electrical circuit

IV Relevant Course Outcome(s)

Select suitable switchgears for different applications.

V Practical Outcome(s)

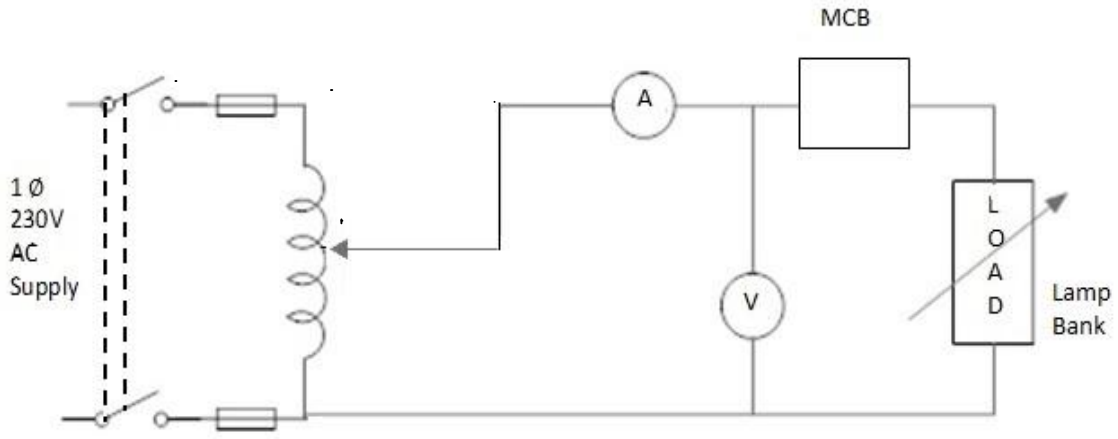
Test MCB by performing the load test.

VI Minimum Theoretical Background

MCB switches "OFF" the electrical circuit during overload and short circuits .It is compact in size and has current ratings from 0.5A to 100A .MCBs are classified according to current range at which they trip instantly mainly three types of MCBs are available. They are

1. Type B- Trips at 3 to 5 times rated current.
2. Type C- Trips at 5 to 10 times rated current.
3. Type D- Trips at 10 to 20 times rated current.

VII Circuit diagram:



VIII Resources required

Sr.No	Instrument /Object	Specification	Quantity	Remarks
1	Single pole MCB	0.5/1A,Type B, 6kA,240V	01	
2	Lamp bank	Suitable rating	01	
3	A.C Voltmeter	Range- 0 to 300V	01	
4	A.C Ammeter	Range- 0 to 10A	01	
5	Autotransformer	0-270V,15A, 1-2kVA	01	

IX Precautions to be followed

1. While testing MCB proper rating of fuses should be used in ICDP.
2. Ensure that proper rating of MCB is selected for the given circuit .
3. Follow electrical safety rules.

X Procedure

1. Connect ICDP, Variac, MCB, ammeter and load as per the circuit diagram shown.
2. Switch on the supply.
3. Gradually increase the voltage up to voltage rating of MCB
4. Increase the load up to 3 times current rating of MCB.
5. Record the tripping time of MCB and ammeter reading in the observation table.
6. Switch on MCB.
7. Increase the load up to 4 to 5 times of current rating of MCB
8. Record the tripping time of MCB and ammeter reading in the observation table.

XI Resources used (with major specifications)

Sr. No	Name of Resource	Broad Specifications		Quantity	Remarks (If any)
		Make	Details		
1					
2					
3					
4					

XII Actual procedure followed

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XIII Precautions followed

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XIV Observations Table:

Sr.No.	Current through circuit.	Tripping time of MCB
1.		
2.		
3.		
4.		
5.		
6.		
7.		

XV Results

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XVI Interpretation of results (Write meaning of the above obtained results**.)**

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XVII Conclusion

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XVIII Practical related Questions

Note: Below given are few sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO.

1. MCB selection needs to be done carefully; explain.
2. State the specification of MCB.
3. Explain the significance of the kA rating of MCB?
4. State the method to select rating of MCB used in residential installation.

(Space for Answer)

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XIX References / Suggestions for Further Reading Books:

Sr.No.	Title of Book	Author	Publication
1	Switchgear Protection and Power Systems	Sunil S. Rao	Khanna Publisher
2	Power system Switchgear and protection	Veerapan .N, Krishnamurty S.R.	S. Chand & Co.
3	Estimation and costing	Surjit Singh	Dhanpat Rai& Co.

1. www.electrical4u.com
2. www.electricaltechnology.org
3. www.youtube.com
4. www.studyelectrical.com
5. www.library.e.abb.com

XX Assessment Scheme

Performance Indicators		Weightage
Process related (15 Marks)		**(60%)**
1	Selection of meters and components	20 %
2	Handling of the MCB and Load	10 %
3	Reading meters accurately	10 %
4	connection of circuits	10 %
5	Follow safe practices	10 %
Product related(10 Marks)		**(40%)**
6	Writing result	10 %
7	Interpretation of result	05 %
8	Conclusions	05 %
9	Practical related questions	15 %
10	Submitting the journal in time	05%
Total (25 Marks)		**100 %**

Names of Student Team Members

1. …….....
2. …….....
3. …….....
4. ……

Marks Obtained			Dated signature of Teacher
Process Related (15)	**Product Related (10)**	**Total (25)**	

Practical No. 5: Dismantle MCCB/ELCB and identify various parts

I. Practical Significance:

In power system it is required to dismantle (dissemble) the LT switchgear such as MCCB/ELCB for maintenance. The electrical technician must be well conversant with the different parts and their fitment in regards such switchgear.

II. Relevant Program Outcomes (POs)

PO4- Engineering tools: Apply relevant Electrical technologies and tools with an understanding of the limitations.

PSO2-Electric Power Systems: Maintain different types of electrical power systems.

III. Competency and Skills

This practical is expected to develop the following skills for the industry identified

Competency: **'**Maintain switchgear and protection schemes used in electrical power systems**.'**

- Use various tools such as screw driver, plier, and spanner.
- Identify the circuit breaker and its different internal parts.
- Reassemble the circuit breaker.

IV. Relevant Course Outcome(s)

Select suitable switchgears for different applications.

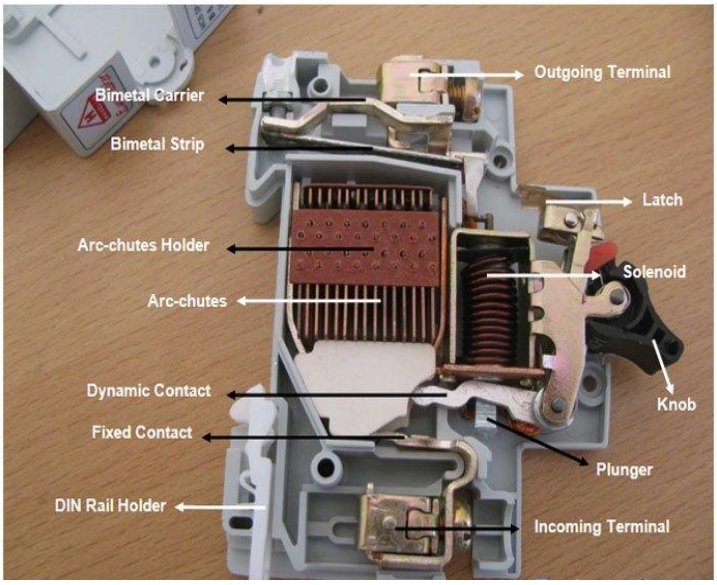
V. Practical Outcome(s)

Dismantle MCCB/ELCB and identify the different parts.

VI. Minimum Theoretical Background

- Moulded case circuit breaker is a circuit breaker and trip device assembled in a molded case .It can automatically cut off electric power in a case of overload and short circuit.
- MCCB can have very high current rating, therefore they are used for protection of motor , main electric feeder , capacitor bank etc.
- ELCB is a safety device used in electrical installations with high impedance to prevent shock.
- It detects small stray voltages on the metal enclosures of electrical equipment and interrupts the circuit if a dangerous voltage is detected.
- At the event of earth leakage, imbalance occurs between line current and neutral current. The coil in a toroidal transformer senses residual current which is connected to the relay.
- Current operated ELCBs are called residual current circuit breaker.

VII. Illustrative photographs of ELCB and MCCB



VIII. Resources required

Sr.No	Name of resources	Specification	Quantity	Remarks
1	ELCB/ MCCB	1mA/ 6A	01	
2	Screw driver	Set	01	
3	Spanner	Set	01	
4	Hammer	½ kg	01	

IX. Precautions to be followed

1. Make sure that the main switch is in OFF position and circuit breaker is disconnected from the supply.
2. Follow electrical safety practices.

X. Procedure

1 View the external parts such as outgoing terminal and incoming terminal.
2 Remove the outer cover.
3 Observe the various internal parts and their positions.
4 Identify each part and note material of each part
5 Reassemble it correctly.

XI. Resources used (with major specifications)

Sr. No.	Name of Resource	Broad Specifications		Quantity	Remarks (If any)
		Make	Details		

XII. Actual procedure followed (use blank sheet if space is not sufficient)

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XIII. Precautions followed

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XIV. Observations Table (use blank sheet if space is not sufficient)

Sr.No.	Name of the part	Material used	Function
1.			
2.			
3.			
4.			
5.			
6.			
7.			
8.			

XV. Results:

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XVI. Interpretation of results (Write meaning of the above obtained results)

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XVII. Conclusion

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XVIII. Practical related Questions

Note: Below given are few sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO.

1. State the parameters in the specifications of MCCB/ELCB.
2. Draw a neat labeled schematic diagram of ELCB.
3. State whether the MCCB operates on earth faults? Give reasons.
4. State how ELCB differs from MCCB.
5. Name the device used for earth leakage as well as over current protection.

(**Space for Answer**)

XIX. References / Suggestions for Further Reading Books:

Sr.No.	Title of Book	Author	Publication
1	Switchgear Protection and Power Systems	Sunil S. Rao	Khanna Publisher
2	Power system Switchgear and protection	Veerapan .N, Krishnamurty S.R.	S. Chand & Co.
3	Estimation and costing	Surjit Singh	DhanpatRai& Co.

1. www.electrical4u.com
2. www.quora.com
3. www.galco.com

XX. Assessment Scheme

Performance Indicators		Weightage
Process related (15 Marks)		**(60%)**
1	Identification of parts	20 %
2	Handling of the tools / components	10 %
3	Recognizing the material of each part	10 %
4	Working in team	10 %
5	Follow safe practices	10 %
Product related (10 Marks)		**(40%)**
6	Noting down the observation	10 %
7	Interpretation of result	05 %
8	Conclusions	05 %
9	Practical related questions	15 %
10	Submitting the journal in time	05%
Total (25 Marks)		**100 %**

Names of Student Team Members

1. …….
2. …….
3. …….
4. …….

Marks Obtained			Dated signature of Teacher
Process Related (15)	**Product Related (10)**	**Total (25)**	

Practical No. 6: Video show on / Dismantle ACB/VCB and identify different parts.

I. Practical Significance:

In power system it is required to dismantle (dissemble) the HT switchgear such as ACB/VCB for maintenance. The electrical technician must be well conversant with the different parts and their fitment in regards such switchgear.

II. Relevant Program Outcomes (POs)

PO4- Engineering tools: Apply relevant Electrical technologies and tools with an understanding of the limitations

PSO2-Electric Power Systems: Maintain different types of electrical power systems.

III. Competency and Skills

This practical is expected to develop the following skills for the industry identified

Competency: 'Maintain switchgear and protection schemes used in electrical power systems.'

- Use various tools such as screw driver, pliers and spanner.
- Identify the circuit breaker and its different internal parts.
- Reassemble the circuit breaker.

IV. Relevant Course Outcomes

Select suitable switchgears for different applications.

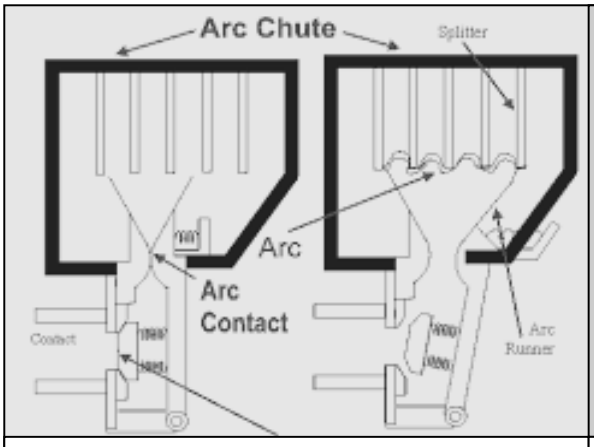
V. Practical Outcome

Dismantle ACB/VCB and identify the different parts.

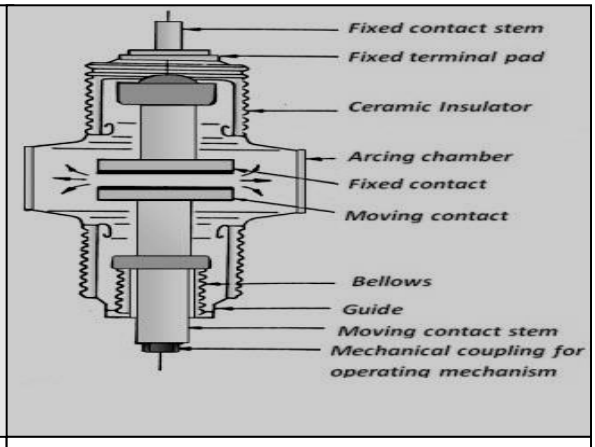
VI. Minimum Theoretical Background

- Air Circuit Breaker is a circuit breaker that operates in the air as arc extinguishing medium at a given atmospheric pressure.
- It is an electrical device used to provide over current and short circuit protection for electric circuits over 800 A to 10 kA and usually used in low voltage applications
- Air Circuit Breaker is designed to overcome the defects and safe guard the equipments before it breakdown.
- A Vacuum Circuit Breaker is a circuit breaker where the arc quenching takes place in vacuum medium.
- It has extreme superior arc quenching properties than any other medium.
- It is fast in operation and suitable for repeated operation and is almost maintenance free.

VII. Practical set up / work situation.



Air Circuit Breaker



Vacuum Circuit Breaker

VIII. Resources required

Sr. No.	Name of resources	Specification	Quantity	Remarks
1	ACB/VCB(models also will suffice)	Suitable rating	01	
2	Screw driver	Set	01	
3	Spanner	Set	01	
4	Hammer	½ kg	01	

IX. Precautions to be followed

1. Make sure that the main switch is in OFF position and circuit breaker is disconnected from the supply.
2. Follow electrical safety practices.

X. Procedure

1. View the external parts such as outgoing terminal and incoming terminal.
2. Remove the outer cover.
3. Observe the various internal parts and their positions.
4. Note the material with which each part is made up of.
5. Write down in brief the function of each part after observation.
6. Reassemble it back correctly.

XI. Resources used (with major specifications)

S. No.	Name of Resource	Broad Specifications		Quantity	Remarks (If any)
		Make	Details		
1.					
2.					
3.					

4.					
5.					

XII. Actual procedure followed (use blank sheet if space is not sufficient)

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XIII. Precautions followed

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XIV. Observations Table (use blank sheet if space is not sufficient)

Sr. No.	Name of the part	Material used	Function
1			
2			
3			
4			
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XV. Results:

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XVI. Interpretation of results (write meaning of the above obtained results)

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XVII. Conclusion

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XVIII. Practical related Questions

Note: Below given are few sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO.

1. State the parameters in the specifications of ACB/VCB.
2. State any two applications of ACB and VCB.
3. List with functions the different parts of ACB/VCB.
4. Write the advantages of VCB.

(**Space for Answer**)

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XIX. References / Suggestions for Further Reading

Sr.No.	Title of Book	Author	Publication
1	Switchgear Protection and Power Systems	Sunil S. Rao	Khanna Publisher
2	Switchgear and power system protection	Singh R.P.	PHI Learning
3	Principles of power system	Mehta V.K. ; Rohit Mehta	S. Chand & Co.

1. www.electrical4u.com
2. www.electricaltechnology.org
3. www.wikipedia.com

XX. Assessment Scheme

Performance Indicators		Weightage
Process related (15 Marks)		**(60%)**
1	Identification of parts	20 %
2	Handling of the tools	10 %
3	Recognizing the materials of parts	10 %
4	Working in team	10 %
5	Follow safe practices	10 %
Product related (10 Marks)		**(40%)**
6	Noting down the observation	10 %
7	Interpretation of result	05 %
8	Conclusions	05 %
9	Practical related questions	15 %
10	Submitting the journal in time	05%
Total (25 Marks)		**100 %**

Names of Student Team Members

1. ……
2. ……
3. ……
4. ……

Marks Obtained			Dated signature of Teacher
Process Related (15)	**Product Related (10)**	**Total (25)**	

Practical No. 7: Carry out plug and time setting (with PSM, TSM) of induction type electromagnetic relay.

I. Practical Significance:

In electromagnetic relay, the current setting can be done by adding resistance value. This action is performed by inserting plugs. The plug position ensures the current setting value of the relay. Plug setting multiplier (PSM) indicates the severity of the fault. The plus setting multiplier is used only in Electromagnetic relays not in numerical relays.

The time setting multiplier is used to adjust or speed up the dial setting. The dial is nothing but a rotating disc, which rotates when the fault current in the relay coil reaches the pickup current. The TMS setting value will be in percentage %

II. Relevant Program Outcomes (POs)

PO2- Discipline knowledge: Apply electrical engineering knowledge to solve broad - based electrical engineering related problems.
PO3- Experiments and practice: Plan to perform experiments and practices to use the results to solve broad-based electrical engineering problems.
PO4- Engineering tools: Apply relevant Electrical technologies and tools with an understanding of the limitations.

III. Competency and Skills

This practical is expected to develop the following skills for the industry identified
Competency: 'Maintain switchgear and protection schemes used in electrical power systems.'

- Test the working of induction type electromagnetic relay.
- Use relay in an electrical circuit

IV. Relevant Course Outcomes

Test the performance of different protective relays.

V. Practical Outcome

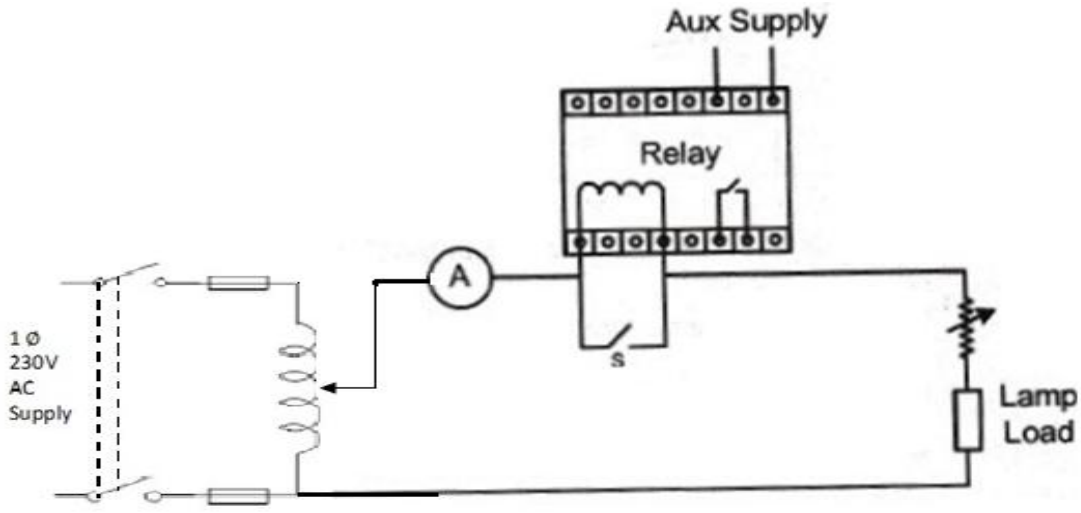
Carry out plug and time setting (with PSM, TSM) of induction type electromagnetic relay.

VI. Minimum Theoretical Background

- A protective relay senses the abnormal electrical conditions and sends signal to circuit breaker which disconnects supply to the faulty section of the circuit.
- The electromagnetic relay operates on the principle of a split-phase induction motor.
- It has long operating time at low multiples of current setting and a shorter operating time at high multiples of current setting.
- Plug-setting (PS): It is given in the terms of either ampere or % of relay rated current. It is the threshold above which relay will start operating.
- Plug-setting multiplier (PSM): It is the ratio of actual fault current in the relay coil to its pickup current .

- Time multiplier setting (TMS)-It controls the relays disc movement. The position of the moving contact is usually adjusted by turning the time multiplier knob, which ranges from 0.1 to 1.0.

VII. Circuit diagram:



VIII. Resources required

S. No.	Instrument /Object	Specification	Quantity
1	Induction type relay	6 A or other suitable	01
2	Lamp bank	0-20A	01
3	A.C Ammeter	0 -10 A	01
4	Single pole switch	0 -5 A	01
5	Rheostat	Suitable rating	01

IX. Precautions to be followed

1. Make sure that the main switch is in OFF position before connection.
2. Wires used for circuit connection have proper size.
3. Follow safety practices.

X. Procedure

1. Make the connection as per circuit diagram shown in figure.
2. .Adjust the plug setting to … %.
3. Keep the TMS setting at maximum position (1sec.)
4. Keep the switch ‘S’ closed and slowly increase load current up to …. A..
5. Open the switch and note the time of operation of the relay.
6. Repeat the procedure for various current values and time multiplier setting values.
7. Switch OFF the main supply.

XI. Resources used (with major specifications)

S. No.	Name of Resource	Broad Specifications		Quantity	Remarks (If any)
		Make	Details		
1.					
2.					
3.					
4.					

XII. Actual procedure followed (use blank sheet if space is not sufficient)

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XIII. Precautions followed

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XIV. Observations and calculations:

Time multiplier setting (TMS): ….....

Sr. No.	% tap used	Current through relay coil (A)	Time of operation(sec.)	PSM value
1				
2				
3				
4				
5				
6				
7				

Note: The current plug setting range used from 50% to 200% in steps of 25% for phase to phase fault and 10% to 70% in steps of 10% for earth fault.

PSM value = Current through relay coil / (Nominal current of relay X % tap used /100)

XV. Results:

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XVI. Interpretation of results (write meaning of the above obtained results.)

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XVII. Conclusion

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XVIII. Practical related Questions

Note: Below given are few sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO.

1. State the need of current setting and time setting multiplier in the operation of a relay.
2. State essential qualities of protective relay.
3. Name the relay used for current flow in the reverse direction? Give reason.
4. Explain PSM and TSM.

(Space for Answer)

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XIX. References / Suggestions for Further Reading

Sr.No.	Title of Book	Author	Publication
1	Switchgear Protection and Power Systems	Sunil S. Rao	Khanna Publisher
2	Switchgear and power system protection	Singh R.P.	PHI Learning
3	Principles of power system	Mehta V.K. ; Rohit Mehta	S. Chand & Co.

1. www.electrical4u.com
2. https://www.mytech-info.com
3. https://circuitglobe.com

XX. Suggested assessment Scheme

Performance Indicators		Weightage
Process related (15 Marks)		**(60%)**
1	Selection of meters and components	20 %
2	Handling of the relay and load	10 %
3	Reading meters accurately	10 %
4	connection of circuits	10 %
5	Follow safe practices	10 %
Product related (10 Marks)		**(40%)**
6	Calculation/ writing Result	10 %
7	Interpretation of result	10 %
8	Conclusions	05 %
9	Practical related questions	10%
10	Submitting the journal in time	05%
Total (25 Marks)		**100 %**

Names of Student Team Members

1. …….
2. …….
3. …….
4. …….

Marks Obtained			Dated signature of Teacher
Process Related (15)	**Product Related (10)**	**Total (25)**	

Practical No. 8: Test electromagnetic over-current relay by performing load test.

I Practical Significance:

Over current relays are frequently used in power network systems because in most of the faulty conditions current generally increases beyond its design limits. Over current relay provide protection against excessive current caused by short circuit, ground faults to important power system equipments including power transformers, generators, transmission lines, motors, bus bars etc. They are employed as primary protection as well as backup protection .

II Relevant Program Outcomes (POs)

PO2- Discipline knowledge: Apply electrical engineering knowledge to solve broad - based electrical engineering related problems.

PO3- Experiments and practice: Plan to perform experiments and practices to use the results to solve broad-based electrical engineering problems.

PO4- Engineering tools: Apply relevant Electrical technologies and tools with an understanding of the limitations.

III Competency and Skills

This practical is expected to develop the following skills for the industry identified

- **Competency: '**Maintain switchgear and protection schemes used in electrical power systems.'
- Test the working of induction type electromagnetic relay.
- Use relay in an electrical circuit

IV Relevant Course Outcomes

Test the performance of different protective relays.

V Practical Outcome

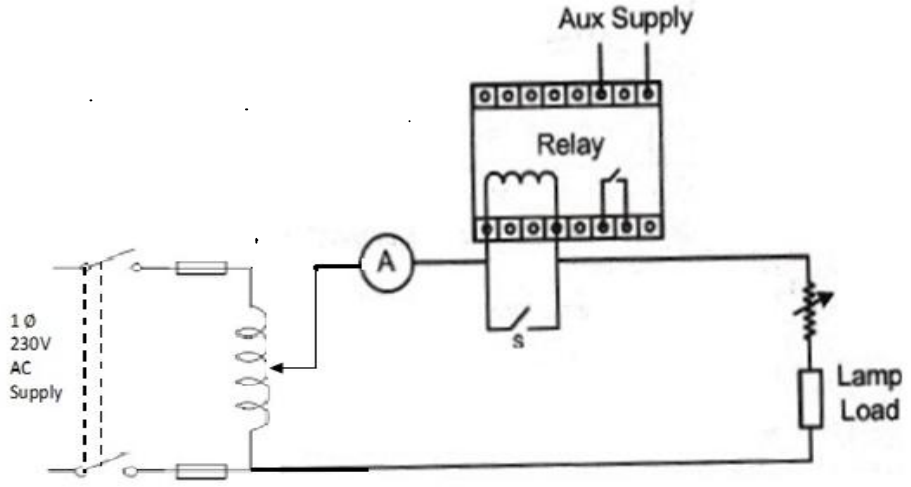
Test electromagnetic over-current relay by performing load test.

VI Minimum Theoretical Background

- An over current relay is a protective relay which operates when the load current exceeds a preset value called pick up value.
- Depending upon time of operation there are various types of over current relays.
  - Instantaneous over current relay: The contacts of the relay are closed instantly
    When current inside the relay rises beyond the operational value. It has low operating time.
  - Inverse time over current relay: The relay operates only when the magnitude of their operating current is inversely proportional to the magnitude of the energize quantities.
  - Inverse Definite Minimum Time over current relay (IDMT) : This relay is used for the protection of the distribution line.
  - Very inverse time over current relay: It is used in the feeder and on long transmission line.

- Extremely inverse time overcurrent relay: This is used for protecting the cable, transformer etc. The relay provides faster operation even under the fault current.

VII Circuit diagram:



VIII Resources required

Sr. No.	Instrument /Object	Specification	Quantity
1	Over current relay	6 Amp or other suitable	01
2	Lamp bank	Suitable rating	01
3	A.C Ammeter	0 to 10 Amp.	01
4	Single pole switch	0 to 5 Amp.	01
5	Rheostat	Suitable rating	01

IX Precautions to be followed

1. Make sure that the main switch is in OFF position before connection.
2. Wire used for circuit connection has proper size.
3. Follow safety practices.

X Procedure

1. Make the connection as per circuit diagram shown in figure.
2. Adjust the plug setting to … %.
3. Keep the TMS setting at maximum position (1sec.)
4. Keep the switch ‘S’ closed and slowly increase load current up to…A..
5. Open the switch and note the time of operation of the relay.
6. Repeat the procedure for various current values and time multiplier setting values.
7. Switch OFF the main supply.

XI Resources used (with major specifications)

Sr. No.	Name of Resource	Broad Specifications		Quantity	Remarks (If any)
		Make	Details		
1					
2					
3					
4					

XII Actual procedure followed (use blank sheet if space is not sufficient)

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XIII Precautions followed

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XIV Observations and calculations:

Time multiplier setting (TMS): ….....

Sr. No.	% tap used	Current through relay coil (A)	Time of operation(sec.)
1			
2			
3			
4			

Note: The current plug setting range used from 50% to 200% in steps of 25% for phase to phase fault and 10% to 70% in steps of 10% for earth fault.

XV Results

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XVI Interpretation of results (write meaning of the above obtained results**.)**

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XVII Conclusion

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XVIII Practical related Questions

Note: Below given are few sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO.

1. Compare electromagnetic relay with static relay.
2. Name the relay used for protection of transmission line.
3. Name the relay used for protection of cable and transformer.
4. Write any one application of thermal relay.

(Space for Answer)

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XIX References / Suggestions for Further Reading

Sr.No.	Title of Book	Author	Publication
1	Switchgear Protection and Power Systems	Sunil S. Rao	Khanna Publisher
2	Switchgear and power system protection	Singh R.P.	PHI Learning
3	Principles of power system	Mehta V.K. ; Rohit Mehta	S. Chand & Co.

1. www.electrical4u.com
2. https://www.researchgate.net
3. https://nptel.ac.in

XX Suggested assessment Scheme

Performance Indicators		Weightage
Process related (15 Marks)		**(60%)**
1	Selection of meters and components	20 %
2	Handling of the relay and load	10 %
3	Reading meters accurately	10 %
4	Connection of circuits	10 %
5	Follow safe practices	10 %
Product related (10 Marks)		**(40%)**
6	Writing Result	10 %
7	Interpretation of result	10 %
8	Conclusions	05 %
9	Practical related questions	10 %
10	Submitting the journal in time	05%
Total (25 Marks)		**100 %**

Names of Student Team Members

1. …….
2. …….
3. ……..……
4. …….

Marks Obtained			Dated signature of Teacher
Process Related (15)	**Product Related (10)**	**Total (25)**	

Practical No. 9 and 10: Simulate differential protection scheme for transformer on the power system simulation kit.

I Practical Significance

Transformer is the major component of Electrical Power System. It is desirable and necessary to protect transformer from a variety of faults. The differential system provides automatic protection against both earth and phase to phase faults. This method of protection is most commonly employed due to its greater sensitivity and reliability.

II Relevant Program Outcomes (POs)

PO2 – Discipline knowledge: Apply electrical engineering knowledge to solve broad-based electrical engineering related problems.

PO3- Experiments and practice-Plan to perform experiments and practices to use the results to solve broad-based Medical electronics engineering problems.

PO4 – Engineering Tools: Apply relevant electrical technologies and tools with an understanding of the limitations.

III Competency and Skills

This practical is expected to develop the following skills for the industry identified

Competency: 'Maintain switchgear and protection schemes used in electrical power systems.'

- Select relevant transformer protection simulation kit.
- Simulate the fault
- Provide protection to the transformer
- Follow safe practices

IV Relevant Course Outcomes

Maintain protection systems of alternators and transformers.

V Practical Learning Outcomes

Simulate differential protection scheme for transformer on the power system simulation kit. Part – I

Simulate differential protection scheme for transformer on the power system simulation kit. Part – II

VI Minimum Theoretical Background

Merz-price circulating current principle is commonly used for the protection of power transformers against earth and phase faults. In this scheme of protection, currents at the two sides of the transformer are compared. Under normal conditions, they are made equal by overcoming all difficulties and taking proper remedial measures. But on the occurrence of a fault in the protected section, currents may become unequal and difference of the currents is arranged to pass through the operating coil of the relay. The relay then closes its contacts to isolate the protected section from the healthy part of the system.

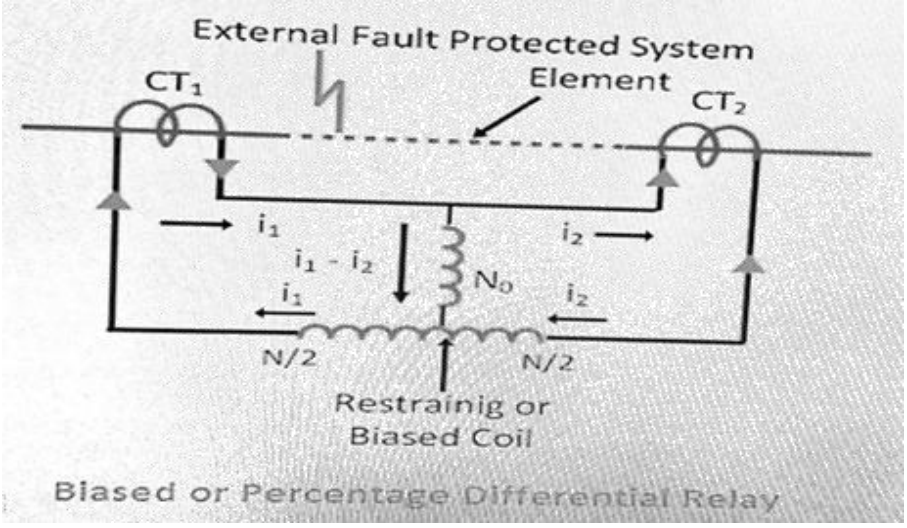
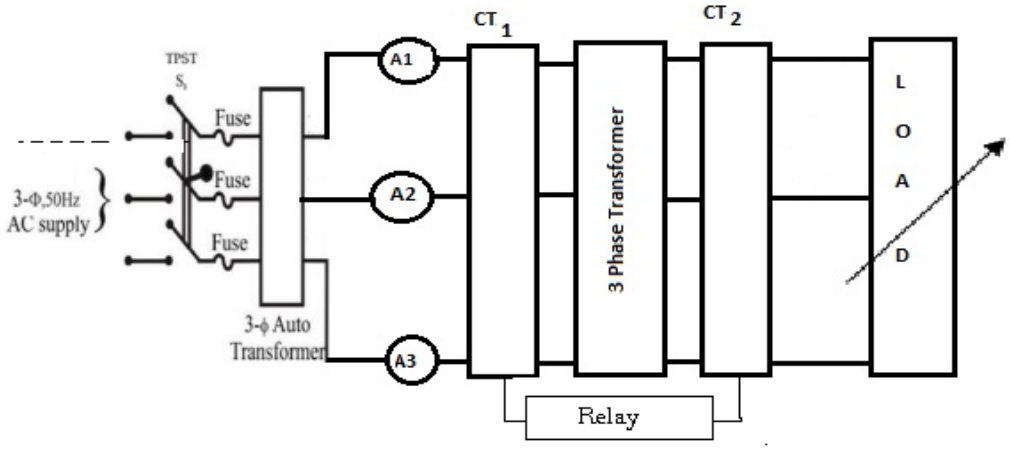


Diagram for Merz price circulating current system

VII Practical setup



VIII Resources required:

(Use Necessary Software/Simulation Kit/Kit by using Required Components)

S. No.	Name of resource	Specification	Quantity	Remarks
1	Simulation kit for Transformer differential protection	Available standard Rating	1	
2	3-Phase Transformer	1kVA,415V/230V,Star-Delta,50 Hz	1	
3	CTs	Suitable Rating	6	
4	Relays	Suitable Rating	3	

IX Precautions to be followed

1. CTs of proper ratio should be used so that currents under normal condition are equal in primary and secondary windings.
2. Tapping of Power Transformer and CT turns ratio should be adjusted simultaneously.
3. Phase difference in primary and secondary should be compensated by proper connections of CTs.
4. Ensure that no load current does not trip the breaker under normal condition.
5. Make sure that voltage applied is very less.

X Procedure:

Part I

1. Make the circuit as per the diagram.
2. Ensure that load applied is zero and 3-phase auto-transformer is at zero position.
3. Apply low voltage with the help of auto-transformer.
4. Apply equal load in all the 3 phases and note down the value of voltage and currents in all the three phases.
5. Simulate a Short circuit between any two phases.
6. Note down the values of currents at which circuit breaker trips.
7. Switch off the load and supply.

Part II

1. Make the circuit as per the diagram.
2. Ensure that load applied is zero and 3-phase auto-transformer is at zero position.
3. Apply low voltage with the help of auto-transformer.
4. Apply equal load in all the 3 phases and note down the value of voltage and currents in all 3 phases.
5. Simulate an earth fault in any one of the windings and note down the current at which circuit breaker trips.
6. Switch off the load and supply.

XI Actual Resources used (with major specifications)

Sr. No	Name of Resource	Broad Specifications		Quantity	Remarks (If any)
		Make	Details		

XII Actual procedure followed

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XIII Precautions followed

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XIV Observations:

Sr. No.	Type of fault	Normal Current	Fault current
1	Phase to phase fault		
2	Earth fault		

XV Results:

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XVI Interpretation of results (Write meaning of the above obtained results.)

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XVII Conclusion

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XVIII Practical related Questions

Note: Below given are few sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO.

1. List out the important faults that may occur on a transformer.
2. Give the factors that cause difficulty in applying circulating current principle to a power transformer. Also provide remedy for each difficulty.
3. Describe with neat diagram the merz price circulating current system for the protection of transformers.
4. State the main difference between an earth relay and an over current relay.
5. Describe with neat diagram, core balance leakage protection for transformers.

(Space for Answer)

XIX References / Suggestions for Further Reading

Sr. No.	Title of Book	Author	Publication
1	Switchgear Protection and Power Systems	Sunil S. Rao	Khanna Publisher
2	Principles of Power System	Mehta V.K. ; Rohit Mehta	S. Chand & Co.
3	Power system switchgear and protection	Dr. N veerappan Dr. S. R. Krishnamurthi	S. Chand & Co.

1. www.electrical4u.com
2. www.electricaltechnology.org
3. www.electrical-engineering-portal.com
4. www.researchgate.net

XX Assessment Scheme

Performance Indicators		Weightage
Process related (15 Marks)		**(60%)**
1	Selection of meters and components	20 %
2	Handling of the meters and components	10 %
3	Reading meters accurately	10 %
4	Connection of circuits	10 %
5	Follow safe practices	10 %
Product related (10 Marks)		**(40%)**
6	Writing result	10 %
7	Interpretation of result	05 %
8	Conclusions	05 %
9	Practical related questions	15 %
10	Submitting the journal in time	05%
Total (25 Marks)		**100 %**

Names of Student Team Members

1. ……
2. ……
3. ……
4. ……

Marks Obtained			Dated signature of Teacher
Process Related (15)	**Product Related (10)**	**Total (25)**	

Practical No.11: Test the working of the single phasing preventer using a three phase induction motor.

I. Practical Significance:

3- Phase induction motor undergoes various types of abnormal conditions. One of the fault associated with this motor is single phasing. So it is necessary to protect the motor from this fault using a single phasing preventer, otherwise the useful life of the motor decreases due to the thermal stresses.

II. Relevant Program Outcomes (POs)

PO2- Discipline knowledge: Apple electrical engineering knowledge to solve broad-based Electrical engineering related problems.

PO3- Experiments and practice: Plan to perform experiments and practices to use the results to solve broad-based electrical engineering problems.

PO4- Engineering tools: Apply relevant Electrical technologies and tools with an understanding of the limitations

PO5-The engineer and society: Assess societal, health, safety, legal and cultural issues the consequent responsibilities relevant to practice in field of electrical engineering.

III. Competency and Skills

This practical is expected to develop the following skills for the industry identified competency: 'Maintain switchgear and protection schemes used in electrical power systems**.'**

- Select relevant meters required
- Select appropriate single phasing preventer
- Use single phasing preventer to protect the motor from single phasing

IV. Relevant Course Outcome(s)

Maintain protection schemes for motors and transmission lines.

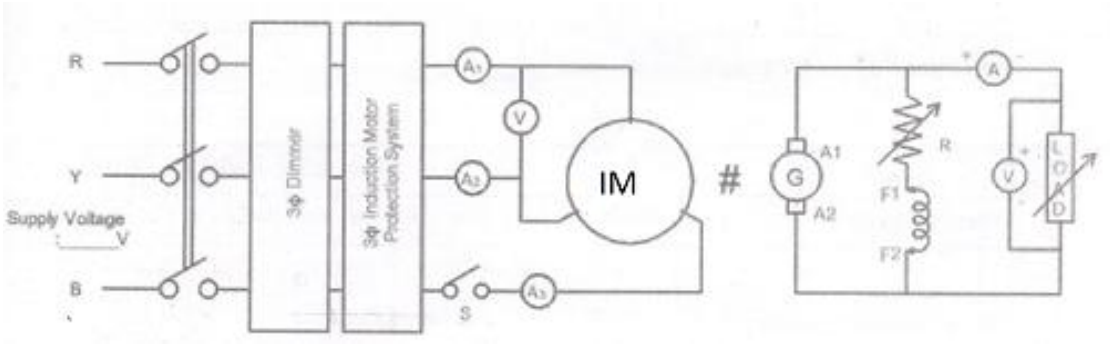
V. Practical Outcome(s)

Test the working of the single phasing preventer using a 3-phase induction motor.

VI. Minimum Theoretical Background

When one of the phases connected to a 3-phase induction motor goes out of order due to some reason, the motor runs on two phases. This is known as single phasing and motor is to be disconnected immediately from the supply automatically. This automatic protection can be given to the motor by using single phasing preventer.

VII. Circuit Diagram



VIII. Resources required

S. No.	Name of resources	Specification	Quantity	Remarks
1	A.C Ammeter	0-20A	03	
2	A.C Voltmeter	0-500V	01	
3	Single Phasing preventer	0-10A	01	
4	SPST switch	0-20A	01	
5	3 phase induction motor	2-5HP, 440V	01	

IX. Precautions to be followed

1. Make sure that all connections are tight.
2. Do not touch/make/alter any connection when the circuit is live.
3. All the loads connected should be in OFF position initially.

X. Procedure

1. Start the motor with a starter.
2. Load the motor to$1/4^{th}$ of rated load.
3. Create single phasing condition by opening switch ‘S’.
4. Observe voltage and current values and operation of single phasing preventer.

XI. Resources used (with major specifications)

S. No.	Name of Resource	Broad Specifications		Quantity	Remarks (If any)
		Make	Details		

XII. Actual procedure followed (use blank sheet if space is not sufficient)

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XIII. Precautions followed

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XIV. Observations Table (use blank sheet if space is not sufficient)

Sr.No.	Conditions	Motor Side Current		
		I_1	I_2	I_3
1	Normal			
2	Abnormal			

XV. Results:

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XVI. Interpretation of results (Write meaning of the above obtained results)

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XVII. Conclusion

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XVIII. Practical related Questions

Note: Below given are few sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO.

1. Explain the term 'Single phasing'.
2. List out the effects of single phasing.
3. State abnormal conditions in supply system to which motor needs to be protected.
4. Draw a neat labeled diagram of single phasing preventer

(Space for Answer)

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XIX. References / Suggestions for Further Reading

Sr.No	Title of Book	Author	Publication
1	Switchgear Protection and Power Systems	Sunil S. Rao	Khanna Publisher
2	Power system Switchgear and protection	Veerapan.N,Krishna murty S.R.	S. Chand & Co.

1. www.electrical4u.com
2. www.motorcontroller.in
3. www.gelco-world.com

XX. Assessment Scheme

Performance Indicators		Weightage
Process related (15 Marks)		**(60%)**
1	Selection of meters and components	20 %
2	Handling of the meters and components	10 %
3	Reading meters accurately	10 %
4	connection of circuits	10 %
5	Follow safe practices	10 %
Product related (15 Marks)		**(40%)**
6	Writing results	10 %
7	Interpretation of result	05 %
8	Conclusions	05 %
9	Practical related questions	15 %
10	Submitting the journal in time	05%
Total (25 Marks)		**100 %**

Names of Student Team Members

1. ……
2. ……
3. ……
4. ……

Marks Obtained			Dated signature of Teacher
Process Related (15)	**Product Related (10)**	**Total (25)**	

Practical No. 12 and 13: Simulate transmission line protection by using the impedance relay/over current relay for various faults.

I. Practical Significance

Transmission line is the vital part of electric power system and requires the immediate attention of protection engineers for safe guard against the possible faults occurring on them. The probability of faults occurring on the lines is much more due to their greater length and exposure to atmospheric conditions. Less expensive methods namely over current protection or distance protection can be adopted to provide automatic protection to transmission lines and to isolate the smallest possible part of the system.

II. Relevant Program Outcomes (POs)

PO2 – Discipline knowledge: Apply electrical engineering knowledge to solve broad-based electrical engineering related problems.
PO3- Experiments and practice- Plan to perform experiments and practices to use the results to solve broad-based Medical electronics engineering problems.
PO4 – Engineering Tools: Apply relevant electrical technologies and tools with an understanding of the limitations.

III. Competency and Skills

This practical is expected to develop the following skills for the industry identified
Competency: **'**Maintain switchgear and protection schemes used in electrical power systems**.'**

- Select transmission line protection simulation kit.
- Simulate the fault
- Provide protection to the transmission lines
- Follow safe practices

IV. Relevant Course Outcomes

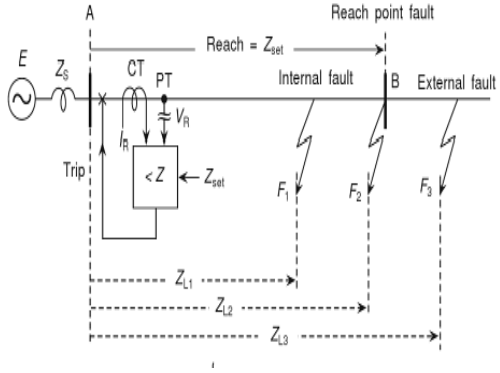
Maintain protection schemes for motors and transmission lines.

V. Practical Learning Outcomes

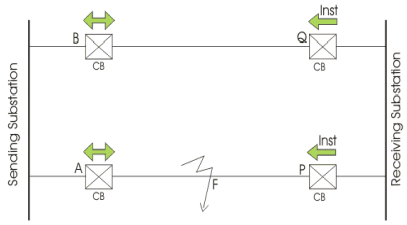
Simulate transmission line protection by using the impedance relay/over current relay for various faults. Part I
Simulate transmission line protection by using the impedance relay/over current relay for various faults. Part II

VI. Minimum Theoretical Background

In the event of a short circuit, the circuit breaker closest to the fault should open, all other breaker remaining in closed position. In case the nearest circuit breaker to the fault fails to open, backup protection should be provided by the adjacent circuit breakers. The relay operating time should be as short as possible in order to preserve system stability. The common methods of line protection are time graded over current protection, differential protection and distance protection.

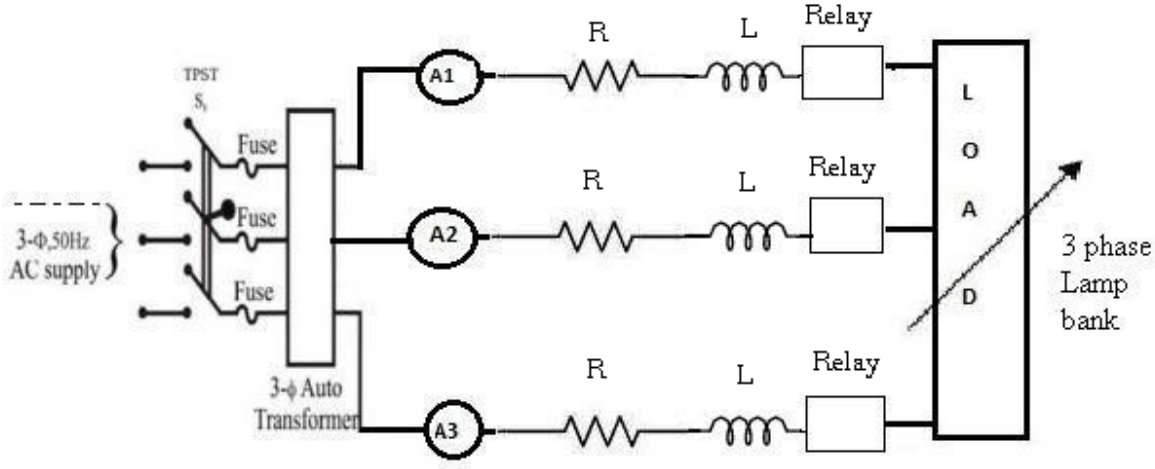


Distance Protection



Over-current Protection for Parallel Feeders

VII. Practical setup



VIII. Resources required

Sr. No.	Instrument /Object	Specification	Quantity	Remarks
1	Transmission line protection simulation kit	Standard	1	
2	3 phase auto transformer	Suitable rating	1	
3	AC ammeter	Suitable rating	3	
4	Resistors and inductors	Suitable rating	3 and 3	
5	Relay	Suitable rating	3	
6	3 Phase Lamp Bank	Suitable rating	1	
7	CT and PT	Suitable rating	1	

IX. Precautions to be followed :

1. Ensure that connection is tight before giving the supply.
2. Don't touch live parts of the circuit.

X. Procedure

Part I

1. Make the circuit as per the diagram.
2. Ensure that load applied is zero and 3-phase auto-transformer is at zero position.
3. Apply low voltage with the help of auto-transformer.
4. Apply equal load in all the 3phases and note down the values of currents in all three phases.
5. Short any two lines and note down the currents at which circuit breaker trips.

Part II

1. Make the circuit as per the diagram.
2. Ensure that load applied is zero and 3-phase auto-transformer is at zero position.
3. Apply low voltage with the help of auto-transformer.
4. Then increase the load in such a way that current exceeds the preset value of the over current relay.
5. Note down the value of currents at which circuit breaker trips.

XI. Resources used (with major specifications)

Sr. No.	Name of Resource	Broad Specifications		Quantity	Remarks (If any)
		Make	Details		
1					
2					
3					
4					

XII. Actual procedure followed

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XIII. Precautions followed

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XIV. Observations:

Sr. No.	Type of fault	Tripping current in Amperes		
		I_1	I_2	I_3
1	Short circuit			
2	Over current			

XV. Results:

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XVI. Interpretation of results (Write meaning of the above obtained results.)

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XVII. Conclusion

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XVIII. Practical related Questions

Note: Below given are few sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO.

1. State the requirements of protection of lines?
2. Describe distance protection scheme for the protection of feeders.
3. Draw a neat labelled diagram of differential pilot wire method for protection of feeders.
4. List out the types of relays used for transmission line protection.

(Space for Answer)

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XIX. References / Suggestions for Further Reading

Sr.No.	Title of Book	Author	Publication
1	Switchgear Protection and Power Systems	Sunil S. Rao	Khanna Publisher
2	Principles of Power System	Mehta V.K. ; Rohit Mehta	S. Chand & Co.
3	Power system switchgear and protection	Dr. N. Veerapan, Dr. S. R. Krishnamurthy	S. Chand & Co.

1. www.electrical4u.com
2. www.electricaltechnology.org
3. www.electrical-engineering-portal.com
4. www.Electrical power energy.com
5. www.Reasearchgate.net

XX. Assessment Scheme

Performance Indicators		Weightage
Process related (15 Marks)		**(60%)**
1	Selection of meters and components	20 %
2	Handling of the meters and components	10 %
3	Reading meters accurately	10 %
4	connection of circuits	10 %
5	Follow safe practices	10 %
Product related (10 Marks)		**(40%)**
6	Writing results	10 %
7	Interpretation of result	05 %
8	Conclusions	05 %
9	Practical related questions	15 %
10	Submitting the journal in time	05%
Total (25 Marks)		**100 %**

Names of Student Team Members

1. ……..…...
2. …….
3. ……..……
4. ……..…..

Marks Obtained			Dated signature of Teacher
Process Related (15)	**Product Related (10)**	**Total (25)**	

Practical -14: Video show on / Dismantle Thyrite type arrester and identify different parts.

I. Practical Significance:

Lightning is one of the nature's most powerful and destructive phenomenon. So it is necessary to protect the insulation and conductors of electrical power system and telecommunication system from the damaging effect of lightning using various types of lighting arrestors. By dismantling one can identify the various parts of thyrite type arrestor and can do maintenance or repair.

II. Relevant Program Outcomes (POs)

PO2-Discipline knowledge: Apply electrical engineering knowledge to solve broad-based Electrical engineering related problems.

PO4- Engineering tools: Apply relevant Electrical technologies and tools with an understanding of the limitations.

III. Competency and Skills

This practical is expected to develop the following skills for the industry identified

Competency: 'Maintain switchgear and protection schemes used in electrical power systems**.'**

- Use of tools to dismantle the arrestor
- Identify the parts
- Reassemble the same.

IV. Relevant Course Outcome(s)

Maintain protection schemes for power system against over voltages.

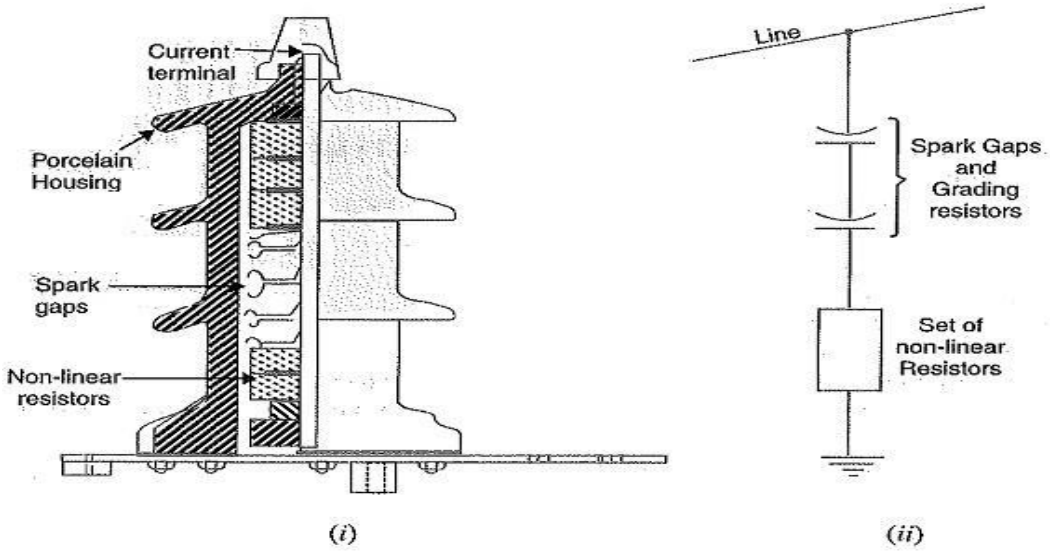
V. Practical Outcome

Dismantle Thyrite type arrester and identify different parts.

VI. Minimum Theoretical Background

Lightning arrester is a protective device which conducts in the event of high voltage surge on the power system. The basic form of surge diverter consists of a spark gap in series with a nonlinear resistor. Types of arresters are: Rod gap, Multi gap, Horn gap, Expulsion type and thyrite type arrester.

VII. Illustrative photographs of Thyrite type arrestor



VIII. Resources required

S. No.	Name of resources	Specification	Quantity	Remarks
	Lightning arrester	200A(suitable rating)	01	
	Screwdriver	Set	01	
	Spanner	Set	01	

IX. Precautions to be followed

1. Make sure that the lightning arrester is disconnected from the supply
2. Tighten the cover properly while reassembling

X. Procedure

1. Remove the outer cover
2. Observe the parts
3. Note down the material with which each part is made up of
4. Reassemble it back correctly.

XI. Resources used (with major specifications)

S. No.	Name of Resource	Broad Specifications		Quantity	Remarks (If any)
		Make	Details		
1.					
2.					
3.					
4.					

XII. Actual procedure followed(use blank sheet if space is not sufficient)

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XIII. Precautions followed

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XIV. Observation Table (use blank sheet if space is not sufficient).

Sr .No.	Name of the part	Material used	Function
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XV. Results:

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XVI. Interpretation of results(write meaning of the above obtained results)

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XVII. Conclusion

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XVIII. Practical related Questions

Note: Below given are few sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO.

1. State the causes of over voltages in the power system.
2. State the harmful effects of lightning on power system.
3. Name the lightning arrestor preferred in industry.
4. List out any two resistor materials used in lightning arrester.

(Space for Answer)

XIX. References / Suggestions for Further Reading Reference books:

Sr.No.	Title of Book	Author	Publication
1	Switchgear Protection and Power Systems	Sunil S. Rao	Khanna Publisher
2	Principles of Power System	Mehta V.K. ; Rohit Mehta	S. Chand & Co.
3	Power system protection and switchgear	Ram, Badri Vishwakarma D.N.	McGraw Hill, New Delhi

1. www.electrical4u.com
2. www.engineeringenotes.com
3. www.researchgate.net
4. www.wikipedia.org/wiki/Lightning_arrester
5. www.circuitglobe.com

XX. Assessment Scheme

Performance Indicators		Weightage
Process related (15 Marks)		**(60%)**
1	Identification of parts	20 %
2	Handling of the tools / components	10 %
3	Recognizing the material of parts	10 %
4	Working in team	10 %
5	Follow safe practices	10 %
Product related (10 Marks)		**(40%)**
6	Writing result	10 %
7	Interpretation of result	05 %
8	Conclusions	05 %
9	Practical related questions	15 %
10	Submitting the journal in time	05%
Total (25 Marks)		**100 %**

Names of Student Team Members

1. ……
2. ……
3. ……
4. ……

Marks Obtained			Dated signature of Teacher
Process Related (15)	**Product Related (10)**	**Total (25)**	

Practical No. 15 and 16: Video show on/ Demonstrate Neutral earthing at different substations/locations.

I Practical Significance:

Earthing system of an electrical network acts as a safety measure to protect human life as well as equipment. The main objective of earthing system is to provide an alternate path for dangerous fault current to flow so as to avoid shock and damage to the equipment. Substation Earthing consists of Grounding electrodes and ground bus connected to form mesh. The neutral earthing is provided for the purpose of protection against arcing ground, unblanced voltages and lightning.

II Relevant Program Outcomes (POs)

PO2-Discipline knowledge: Apply electrical engineering knowledge to solve broad based Electrical engineering related problems.
PO3-Experiments and Practice: Plan to perform experiments and practices to use the results to solve broad based electrical engineering problems.
PO4- Engineering tools :Apply relevant electrical technologies and tools with an understanding of the limitations.

III Competency and Skills

This practical is expected to develop the following skills for the industry identified
Competency: 'Maintain switchgear and protection schemes used in electrical power systems.'

- Select type of earthing
- Select material required and proper size of components
- Follow safe practices

IV Relevant Course Outcomes

Maintain protection schemes for power system against over voltages.

V Practical outcome

Perform Neutral earthing at different substations/locations.

VI Minimum Theoretical Background

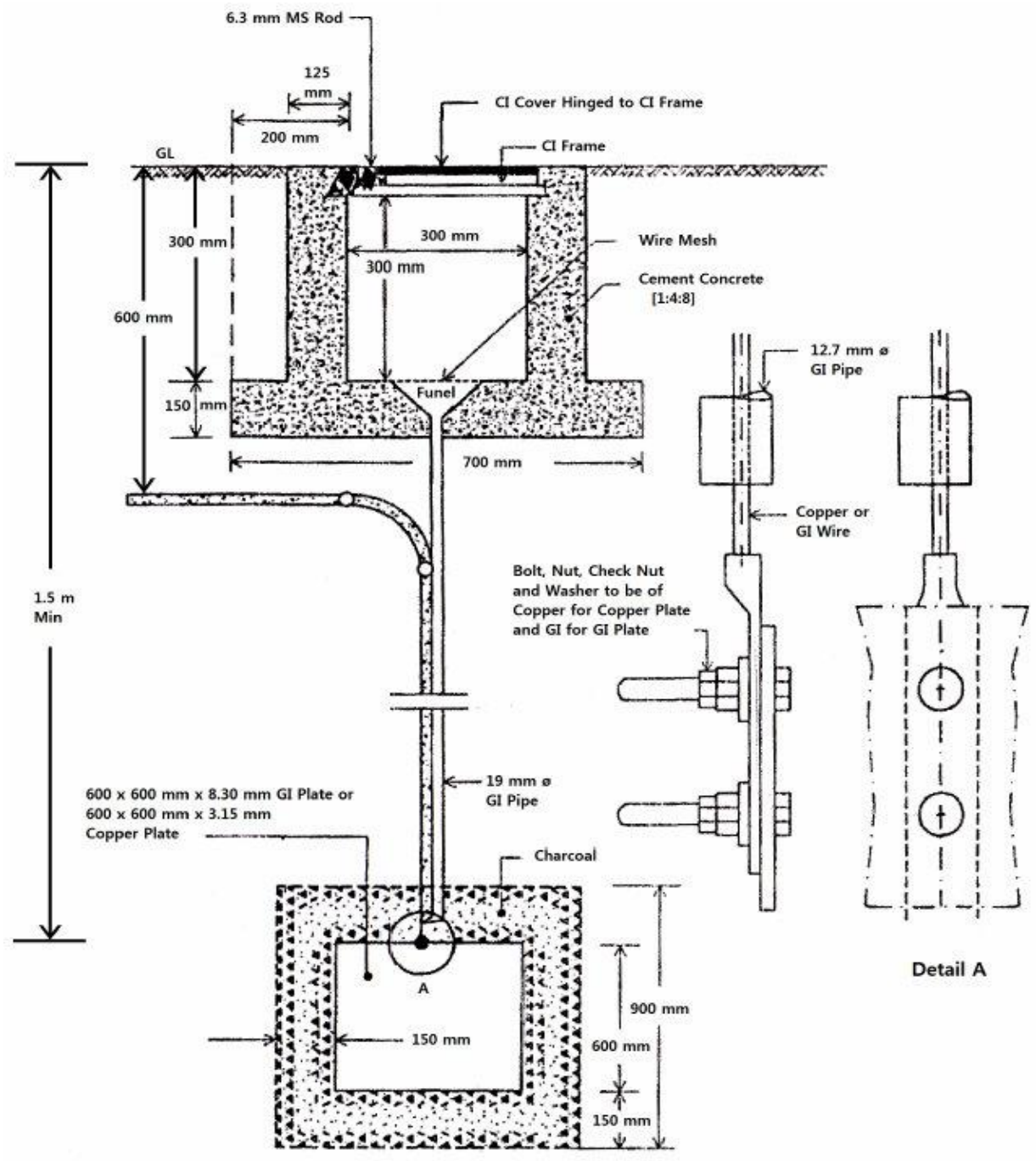
The process of connecting non-current carrying metal parts (metallic enclosure) of the electrical equipment to earth is called equipment earthing. When some electrical Part of the power system is connected to earth, it is called as system grounding. There are two types of earthing namely pipe earthing and plate earthing.

A neutral earthing system is a system in which th neutral is connected to earth, either solidly or through a resistance or through a reactance of value sufficient to materially reduce transients, and to give sufficient current for selective earth fault protection devices to operate.

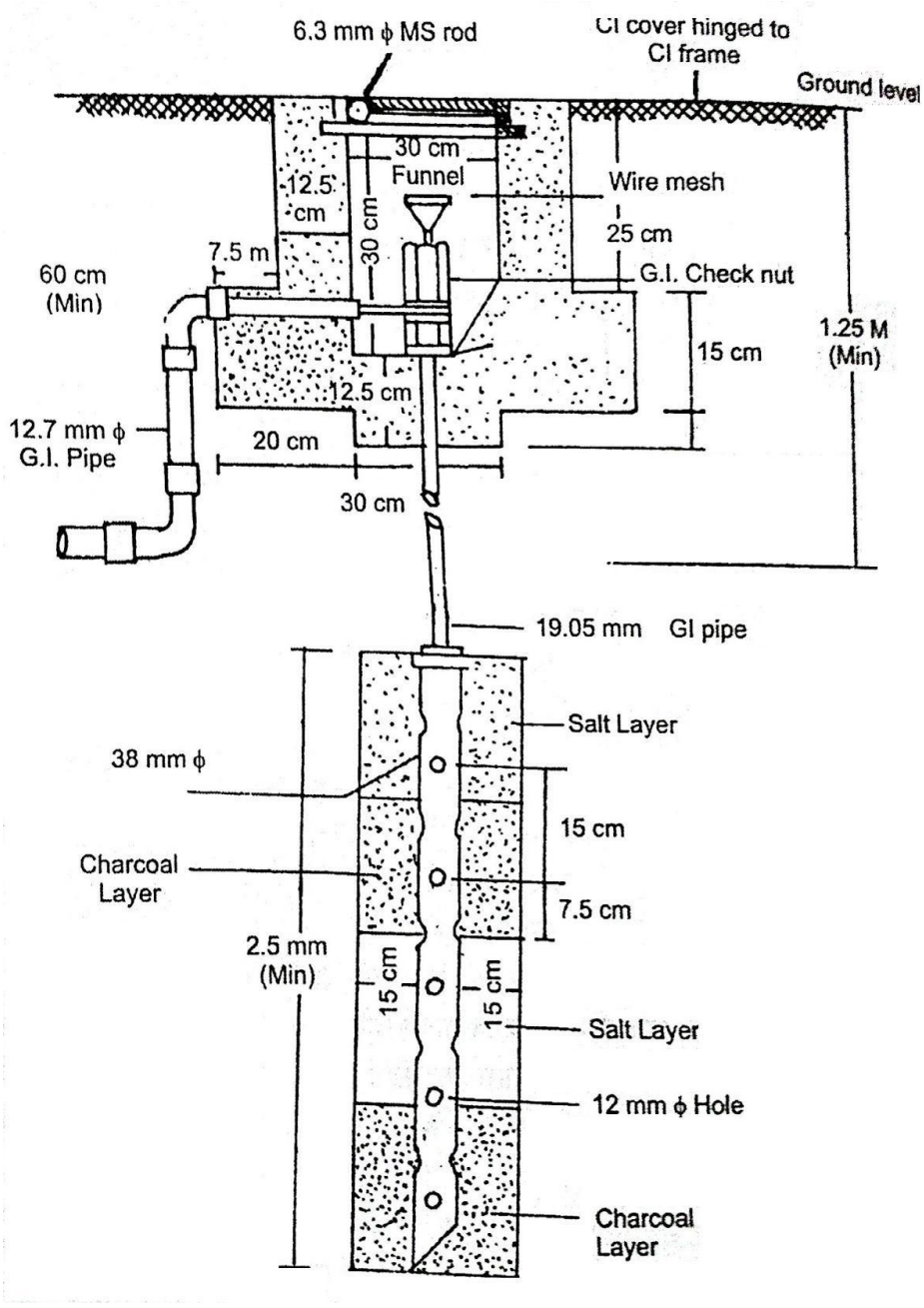
Earthing mat is made by joining the number of rods through copper conductors it reduces the overall grounding resistance such type of system helps in limiting the ground potential. Number of grounding rods depends upon the fault level of

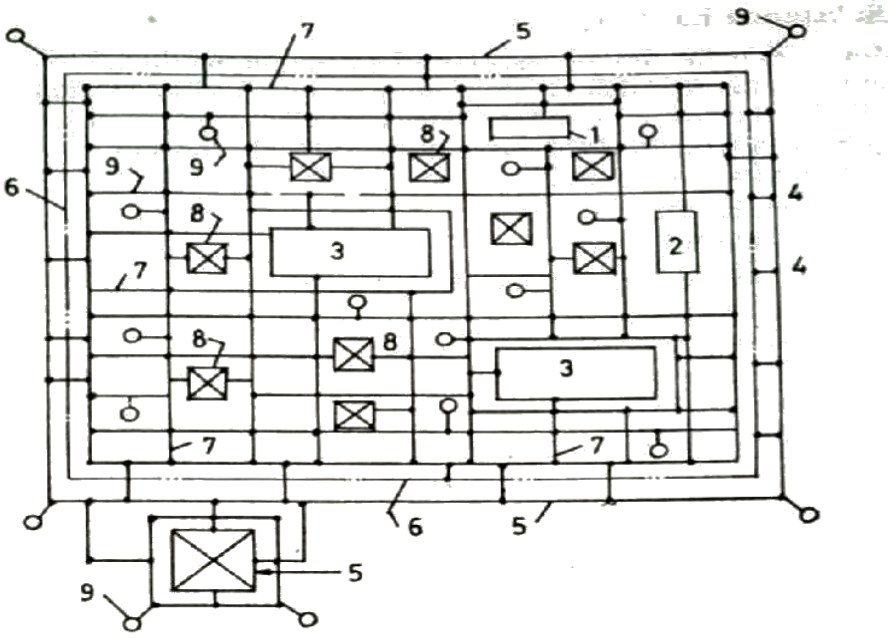
substation. One rod per 250 amperes. Earthing mat is mostly used in place where large fault current is experienced.

VII Illustrative photographs of Plate earthing



Illustrative photographs of Pipe earthing





1. Metal Tank
2. Transformer Foundation
3. Building
4. Welded joints+
5. Tower
6. Fence
7. Earthing rods of mesh+
8. Structures in substation
9. Earthing spikes/elctrodes+

Substation Earthing System.

VIII Resources required

Sr. No.	Name of resource	Specification	Quantity	Remarks
1	GI/Copper earthing plate	Standard Size	01	
2	GI/Copper pipe	Standard Size	01	
3	GI/Copper wire	Standard Size	01	

IX Precautions to be followed

1. Switch off the main supply before demonstration
2. Don't touch live parts while observing earthing system.
3. Observe all the parts properly

X Procedure

Part I (Residential Earthing /LV)

1 Observe the various material of the earthing system thoroughly.

2 Note down the various material with specification of the earthing system.

Part II (Substation earthing / HV)

1 Observe the various material of the substation earthing thoroughly.
2 Note down the various material with specification of the substation earthing system.

XI Resources Used

Sr. No	Name of Resource	Broad Specifications		Quantity	Remarks (If any)
		Make	Details		
1.					
2.					
3.					
4.					

XII Actual procedure followed

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XIII Precautions followed

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XIV Observations: (Student shall draw the diagram and write down the material and specification after visiting the substation/site)

Part I (**Residential Earthing /LV**)

Sr. No	Name of Material	Specification
1		
2		
3		
4		

5		
6		

Part II (Substation earthing / HV)

Sr. No	Types of Earthing	Name of Material/symbol	Specification
1			
2			
3			
4			
5			
6			

XV Results:

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XVI Interpretation of results Write meaning of the above obtained results.)

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XVII Conclusion

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XVIII Practical related Questions

Note: Below given are few sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO.

1. Explain the term earth resistance?
2. List the factors on which earth resistance depend.
3. State, why charcoal and salt is used in earthing.
4. Give the difference between equipment earthing and system earthing.
5. State the importance of neutral earthing.
6. State the meaning of resistance earthing.
7. Which of the following will you prefer for substation earthing?
   a) Copper plate earthing
   b) GI earthing

(**Space for Answer**)

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XIX References / Suggestions for Further Reading

Sr.No.	Title of Book	Author	Publication
1	Switchgear Protection and Power Systems	Sunil S. Rao	Khanna Publisher
2	Principles of Power System	Mehta V.K. ; Rohit Mehta	S. Chand & Co.
3	Estimation and costing	Surjit singh	Dhanpat Rai & Co.

1) https://www.electricaltechnology.org
2) https://www.electrical-installation.org
3) www.howstuffworks.com
4) www.electrical4u.com

XX Assessment Scheme

Performance Indicators		Weightage
Process related (15 Marks)		**(60%)**
1	Identification of Parts	20 %
2	Recognizing the material of parts	20 %
3	Working in team	10 %
4	Follow safe practices	10 %
Product related (10 Marks)		**(40%)**
5	Noting down the observation	10 %
6	Interpretation of result	05 %
7	Conclusions	05 %
8	Practical related questions	15 %
9	Submitting the journal in time	05%
Total (25 Marks)		**100 %**

Names of Student Team Members

1. …….....
2. …….....
3. ……...…
4. .....

Marks Obtained			Dated signature of Teacher
Process Related (15)	**Product Related(10)**	**Total (25)**	

List Of Laboratory Manuals Developed by MSBTE

First Semester:

1	Fundamentals of ICT	22001
2	English	22101
3	English Work Book	22101
4	Basic Science (Chemistry)	22102
5	Basic Science (Physics)	22102

Second Semester:

1	Bussiness Communication Using Computers	22009
2	Computer Peripherals & Hardware Maintenace	22013
3	Web Page Design with HTML	22014
4	Applied Science (Chemistry)	22202
5	Applied Science (Physics)	22202
6	Applied Machines	22203
7	Basic Surveying	22205
8	Applied Science (Chemistry)	22211
9	Applied Science (Physics)	22211
10	Fundamental of Electrical Engineering	22212
11	Elements of Electronics	22213
12	Elements of Electrical Engineering	22215
13	Basic Electronics	22216
14	'C' programming Language	22218
15	Basic Electronics	22225
16	Programming in "C"	22226
17	Fundamentals of Chemical Engineering	22231

Third Semester:

1	Applied Multimedia Techniques	22024
2	Advanced Serveying	22301
3	Highway Engineering	22302
4	Mechanics of Structures	22303
5	Building Construction	22304
6	Concrete Technology	22305
7	Strength Of Materials	22306
8	Automobile Engines	22308
9	Automobile Transmission System	22309
10	Mechanical Operations	22313
11	Technology Of Inorganic Chemicals	22314
12	Object Oriented Programming Using C++	22316
13	Data Structure Using 'C'	22317
14	Computer Graphics	22318
15	Database Management System	22319
16	Digital Techniques	22320
17	Principles Of Database	22321
18	Digital Techniques & Microprocessor	22323
19	Electrical Circuits	22324
20	Electrical & Electronic Measurment	22325
21	Fundamental Of Power Electronics	22326
22	Electrical Materials & Wiring Practice	22328
23	Applied Electronics	22329
24	Electrical Circuits & Networks	22330
25	Electronic Measurments & Instrumentation	22333
26	Principles Of Electronics Communication	22334
27	Thermal Engineering	22337
28	Engineering Matrology	22342
29	Mechanical Engineering Materials	22343
30	Theory Of Machines	22344

Fourth Semester:

1	Hydraulics	22401
2	Geo Technical Engineering	22404
3	Chemical Process Instrumentation & Control	22407
4	Fluid Flow Operation	22409
5	Technology Of Organic Chemicals	22410
6	Java Programming	22412
7	GUI Application Development Using VB.net	22034
8	Microprocessor	22415
9	Database Managment	22416
10	Electric Motors And Transformers	22418
11	Industrial Measurements	22420
12	Digital Electronics And Microcontroller Applications	22421
13	Linear Integrated Circuits	22423
14	Microcontroller & Applications	22426
15	Basic Power Electronics	22427
16	Digital Communication Systems	22428
17	Mechanical Engineering Measurments	22443
18	Fluid Mechanics and Machinery	22445
19	Fundamentals Of Mechatronics	22048

Fifth Semester:

1	Design of Steel and RCC Structures	22502
2	Public Health Engineering	22504
3	Heat Transfer Operation	22510
4	Environmental Technology	22511
5	Operating Systems	22516
6	Advanced Java Programming	22517
7	Software Testing	22518
8	Control Systems and PLC's	22531
9	Embedded Systems	22532
10	Mobile and Wireless Communication	22533
11	Industrial Machines	22523
12	Switchgear and Protection	22524
13	Energy Conservation and Audit	22525
14	Power Engineering and Refrigeration	22562
15	Solid Modeling and Additive Manufacturing	22053
16	Guidelines & Assessment Manual for Micro Projects & Industrial Training	22057

Sixth Semester:

1	Solid Modeling	17063
2	Highway Engineering	17602
3	Contracts & Accounts	17603
4	Design of R.C.C. Structures	17604
5	Industrial Fluid Power	17608
6	Design of Machine Elements	17610
7	Automotive Electrical and Electronic Systems	17617
8	Vehicle Systems Maintenance	17618
9	Software Testing	17624
10	Advanced Java Programming	17625
11	Mobile Computing	17632
12	System Programing	17634
13	Testing & Maintenance of Electrical Equipments	17637
14	Power Electronics	17638
15	Illumination Engineering	17639
16	Power System Operation & Control	17643
17	Environmental Technology	17646
18	Mass Transfer Operation	17648
19	Advanced Communication System	17656
20	Mobile Communication	17657
21	Embedded System	17658
22	Process Control System	17663
23	Industrial Automation	17664
24	Industrial Drives	17667
25	Video Engineering	17668
26	Optical Fiber & Mobile Communication	17669
27	Therapeutic Equipment	17671
28	Intensive Care Equipment	17672
29	Medical Imaging Equipment	17673

Pharmacy Lab Manual

First Year:

1	Pharmaceutics - I	0805
2	Pharmaceutical Chemistry - I	0806
3	Pharmacognosy	0807
4	Biochemistry and Clinical Pathology	0808
5	Human Anatomy and Physiology	0809

Second Year:

1	Pharmaceutics - II	0811
2	Pharmaceutical Chemistry - II	0812
3	Pharmacology & Toxicology	0813
4	Hospital and Clinical Pharmacy	0816

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