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 challenging technological & 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 following:

- 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 Laboratory Manual For

Electrical Material and Wiring Practice (313015)

Semester – III

(EE/EP)

"K-SCHEME"

Maharashtra State

Board of Technical Education, Mumbai

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

Maharashtra State Board of Technical Education, Mumbai

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

4th Floor, Government Polytechnic Building, 49, Kherwadi, Bandra (East), Mumbai- 400051.

(Printed on July, 2024)

MAHARASHTRA STATE

BOARD OF TECHNICAL EDUCATION, MUMBAI

Certificate

This is to certify that Mr. /Ms.……

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

(Code : ……) has completed the term work satisfactorily in course **Electrical Material and Wiring Practice (313015)** for the academic year 20…….to 20…….. as prescribed in the curriculum.

Place: …….. **Enrollment No: …….**

Date: ……. **Exam Seat No: ……**

Subject Teacher Head of department Principal

Seal of Institute

MAHARASHTRA STATE BOARD OF TECHNICAL EDUCATION MUMBAI

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 'K' Scheme curricula for engineering diploma programmes with outcome-based 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 K scheme laboratory manual development team designed the practical to ***focus*** on the ***outcome***s, rather than the traditional age old practice of conducting practical 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 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 basic aim of this course is that, the student must learn the basic concepts, rules and laws of electric and magnetic circuits and practical thereof. The basic concepts of electrical engineering in this course will be very useful for understanding electrical circuits.

Although best possible care has been taken to check for errors (if any) in this laboratory manual, perfection may elude us as this is the first edition of this manual. Any errors and suggestions for improvement are solicited and highly welcome.

Program Outcomes (POs) to be achieved through practical of this course

- **PO 1. Basic and Discipline specific knowledge:** Apply knowledge of basic mathematics, sciences and engineering fundamentals and engineering specialization to solve the engineering problems.
- **PO 2. Problem analysis:** Identify and analyse well-defined engineering problems using codified standard methods.
- **PO 3. Design/ development of solutions:** Design solutions for well-defined technical problems and assist with the design of system components or processes to meet specified needs.
- **PO 4. Engineering tools, Experimentation and Testing:** Apply modern engineering tools and appropriate technique to conduct standard tests and measurements.
- **PO 5. Engineering practices for society, sustainability and environment:** Apply appropriate technology in context of society, sustainability, environment and ethical practices.
- **PO 6. Project Management:** Use engineering management principles individually, as a team member or a leader to manage projects and effectively communicate about well-defined engineering activities.
- **PO 7. Life-long learning:** Ability to analyse individual needs and engage in updating in the context of technological changes.

List of Relevant expected psychomotor domain skills

The following relevant expected psychomotor domain skills of the competency are expected to be developed in student by undertaking the practicals of this laboratory manual.

1. To draw and connect the circuits as per given guidelines.
2. Ability to handle the tools and materials.
3. Ability to select and measure the electrical quantities using proper ranges of meters.
4. Ability to use tools rapidly, efficiently, effectively considering safety to perform work tasks on regular basis.

Practical-Course outcome matrix

COURSE LEVEL LEARNING OUTCOMES (COS)

1. CO1 – Follow safe working practices when undertaking electrical work.
2. CO2 - Select relevant conducting, electromagnetic and magnetic materials.
3. CO3 – Select relevant insulating materials.
4. CO4 – Perform different types of electrical wiring and cabling activities.
5. CO5 - Implement relevant earthing systems.

Sr. No.	Title of the Practical	CO1	CO2	CO3	CO4	CO5
1	* Use of different electrical safety accessories and follow safe practices.	✓	-	-	-	-
2	* Dousing of class 'A' type fire with suitable medium.	✓	-	-	-	-
3	* Rescue a person and practice artificial respiration.	✓	-	-	-	-
4	* Use of different types of electrical/electronic tools.	✓	-	-	-	-
5	Testing of single pole one way, two way switches and MCB using relevant tools and instruments.	✓	-	-	-	-
6	Demonstration of MCCB	✓	-	-	-	-
7	Testing of rewirable fuse.	✓	-	-	-	-
8	* Preparation of series lamp test board with 2m wire extention.	✓	-	-	-	-
9	Testing of the RCCB.	✓	-	-	-	-
10	* Selection of fuses in different lighting circuits.	-	✓	-	-	-
11	* Measurement of insulation resistance of cables using insulation tester	-	-	✓	-	-
12	Selection of insulating materials for specific applications from given samples (at least five).	-	-	✓	-	-
13	* Insulation resistance test on electrical installation.	-	-	✓	-	-
14	* Dielectric strength test of given insulating oil sample.	-	-	-	✓	-
15	Preparation of staircase wiring and its testing.	-	-	-	✓	-
16	Preparation of godown wiring and its testing.	-	-	-	✓	-
17	* Preparation of switch board containing four switch, four socket arrangements (with MCB, indicator etc.).	-	-	-	✓	-
18	LED tube light mounting, testing and fault finding.	-	-	-	✓	-

19	Power cable tracing. (For machine installation in laboratory)	-	-	-	✓	-
20	* Electrical installation testing.	-	-	-	✓	-
21	LT cable tracing. (from LT substation- transformer of your college to your laboratory.)	-	-	-	✓	-
22	* Preparation of electrical wire joints (simple twist, married, Tee and western union joints).	-	-	-	✓	-
23	* Preparation of electrical wire joints (britannia straight, Britannia tee and rat tail joints).	-	-	-	✓	-
24	Lug crimping for cable leads.	-	-	-	✓	-
25	* Preparation of PVC casing-capping, conduit wiring for minimum four points of 3m length.	-	-	-	✓	-
26	One lamp control from three and/or four different places.	-	-	-	✓	-
27	* Tracing of electrical schematic drawings of a panel of any electrical machine in your laboratory.	-	-	-	✓	-
28	* Plate earthing.	-	-	-	-	✓
29	Chemical earthing.	-	-	-	-	✓
30	Testing and measurement of earthing resistance.	-	-	-	-	✓

Guidelines to Teachers

1. Teacher should provide the guideline with demonstration of practical to the students with all features.
2. Teacher shall explain prior concepts to the students before starting of each experiment
3. Involve students in performance of each experiment.
4. Teacher should ensure that the respective skills and competencies are developed in. the students after the completion of the practical exercise.
5. Teachers should give opportunity to students for hands on experience after the demonstration.
6. Teacher is expected to share the skills and competencies to be developed in the students.
7. Teacher may provide additional knowledge and skills to the students even though not covered in the manual but are expected the students by the industry.
8. Finally give practical assignment and assess the performance of students based on task assigned to check whether it is as per the instructions.

Instructions for Students

1. Listen carefully the lecture given by teacher about subject, curriculum, learning structure, skills to be developed.
2. Organize the work in the group and make record all programs.
3. Students shall develop maintenance skill as expected by industries.
4. Student shall attempt to develop related hand-on skills and gain confidence.
5. Student shall develop the habits of evolving more ideas, innovations, skills etc. those included in scope of manual
6. Student shall refer technical magazines.
7. Student should develop habit to submit the practicals on date and time.
8. Student should well prepare while submitting write-up of exercise.
9. Attach/paste separate papers wherever necessary.

Content Page

List of Practical's and Progressive Assessment Sheet

Sr.No.	Title of the Practical	Page no.	Date of Performance	Date of Submission	Assessment Marks (25)	Dated sign.of Teacher	Remarks (If any)
1	* Use of different electrical safety accessories and follow safe practices.	1					
2	* Dousing of class 'A' type fire with suitable medium.	6					
3	* Rescue a person and practice artificial respiration.	12					
4	* Use of different types of electrical/electronic tools.	20					
5	Testing of single pole one way, two way switches and MCB using relevant tools and instruments.	26					
6	Demonstration of MCCB	32					
7	Testing of rewirable fuse.	37					
8	* Preparation of series lamp test board with 2m wire extention.	42					
9	Testing of the RCCB.	47					
10	* Selection of fuses in different lighting circuits.	52					
11	* Measurement of insulation resistance of cables using insulation tester.	57					
12	Selection of insulating materials for specific applications from given samples (at least five).	61					
13	* Insulation resistance test on electrical installation.	65					
14	* Dielectric strength test of given insulating oil sample.	70					
15	Preparation of staircase wiring and its testing.	76					
16	Preparation of godown wiring and its testing.	81					
17	* Preparation of switch board containing four switch, four socket arrangements (with MCB, indicator etc.).	85					
18	LED tube light mounting, testing and fault finding.	91					

19	Power cable tracing. (For machine installation in laboratory)	97					
20	* Electrical installation testing.	101					
21	LT cable tracing. (from LT substation- transformer of your college to your laboratory.)	107					
22	* Preparation of electrical wire joints (simple twist, married, Tee and western union joints).	111					
23	* Preparation of electrical wire joints (britannia straight, Britannia tee and rat tail joints).	116					
24	Lug crimping for cable leads.	120					
25	* Preparation of PVC casing-capping, conduit wiring for minimum four points of 3m length.	125					
26	One lamp control from three and/or four different places.	130					
27	* Tracing of electrical schematic drawings of a panel of any electrical machine in your laboratory.	136					
28	* Plate earthing.	141					
29	Chemical earthing.	146					
30	Testing and measurement of earthing resistance.	151					
Total							

Note:

Out of above suggestive LLOs -

- '*' Marked Practicals (LLOs) are mandatory.
- Minimum 80% of above list of lab experiment are to be performed.
- Judicial mix of LLOs are to be performed to achieve desired outcomes.

Practical No. 1: Use of different electrical safety accessories and follow safe practices

I Practical Significance

It is essential to observe safety while working with electrical installation, appliance, panel etc. The knowledge of safety accessories & procedures to be followed while performing the electrical work is essential for human life as well as the quality & life of machine/equipment/wires & cables.

II Industry/Employer Expected Outcome(s)

Use different electrical safety accessories and follow safe practices

III Course Level Learning Outcome(s)

Follow safe working practices when undertaking electrical work.

IV Laboratory Learning Outcome(s)

LLO 1 Use different electrical safety accessories and follow safe practices.

V Relevant Affective Domain related outcome(s)

Follow safety electrical rules for safe practices.

VI Relevant Theoretical Background (With diagrams if required)

Safety procedures and practices are essential in electrical work. Basic approaches to electrical work from the point of view of ensuring safety which include inbuilt safety in procedures such as permit-to-work system, safety instructions and safety practices are covered in SP 30 (2011): National Electrical Code 2011; Section 19, Safety in electrical work.

VII Actual Circuit diagram used in laboratory with equipment Specifications:

Fig. 1.1 Electrical Safety Accessories

VIII Required Resources/apparatus/equipment with specification

S. No.	Name of Resource	Suggested Broad Specification	Quantity
1	National Electrical Code 2011	SP 30 (2011): National Electrical Code 2011	1 No.
2	Recommendations on Safety Procedures and Practices in Electrical Work, Part I: General	IS 5216 (Part 1)	1 No.
3	Rubber Insulated Electrical Gloves	Working potential: 7,500V	1 No.
4	Electrical Shock Proof Safety Shoes	Insulation range- 15 to 30 KV	1 No.
5	Safety Jacket	Standard	1 No.
6	Safety Helmet	Standard	1 No.
7	Safety Belt	Standard	1 No.
8	Safety Goggles	Standard	1 No.

IX Precautions to be followed:

1. Switch "OFF" the mains (from which supply is fed to the circuit) for the electrical circuit to be overhauled or worked on. Always hang a tag on a main switch. The tag should read "Work in Progress".
2. Use rubber gloves, rubber boots, apron, safety helmets and safety belts etc. before starting the work over head.
3. All electrical leads should be considered as live until it is positively proved that they are not. Check the circuit with the test lamp.
4. If ladder is used, it must be held by another person so that it may not slip away.
5. Before replacing a blown fuse, always remember to put the switch in "OFF" position.

X Procedure

1. Identify various electrical safety accessories.
    i. Identify various electrical safety accessories.
    ii. Note down its specification in the table "Resources used".

2. Use Rubber Insulated Electrical Gloves.
    i. Wear insulated rubber hand gloves in both hands.
    ii. Switch "OFF" any main switch in the laboratory.
    iii. Remove the kit-kat fuses from the main switch.

iv. Check the fuse wires. Replace it with same ratings (if necessary).

v. Place the kit-kat fuses in the main switch.

vi. Switch "ON" the main switch.

(Note: Students shall use other electrical safety accessories like rubber boots, apron, safety helmets and safety belts in vigilance of teacher).

3. Follow electrical Practices.

i. Read SP 30 (2011): National Electrical Code 2011; Section 19, Safety in electrical work and IS 5216 (Part 1).

ii. Prepare a report on Permit to work/ safety instructions/ safety practices.

XI Observations and calculations

Not applicable

XII Result(s)

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XIII Interpretation of results

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XIV Conclusion and recommendation

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XV Practical related questions (Provide space for answers)

(Teacher should provide various questions related to practical- sample given)

1. State the different safety accessories used while working on electrical installation.
2. State the use of different safety accessories used while working on electrical installation.

……
……

XVI References/Suggestions for further reading:

1. https://www.mtu.edu/ehs/programs/electrical-safety/, assessed on 11th April, 2018.
2. https://www.electrical4u.com/safety-precautions-for-electrical-system/, assessed on 11th April, 2018.
3. https://archive.org/details/gov.in.is.sp.30.2011, ,assessed on 11th April, 2018
4. https://ia801005.us.archive.org/4/items/gov.in.is.5216.1.1982/is.5216.1.1982.pdf, assessed on 11th April, 2018.

XVII Suggested Assessment Scheme

Performance Indicators		Weightage
Process Related : 30 Marks		**60 %**
1	Handling of the components	10%
2	Identification of components	20%
3	Measuring value using suitable instrument	20%
4	Working in teams	10%
Product Related: 20 Marks		**40%**
5	Calculated theoretical values of given component	10%
6	Interpretation of result	05%
7	Conclusions	05%
8	Practical related questions	15%
9	Submitting the journal in time	05%
Total (50 Marks)		**100 %**

Marks Obtained			Dated signature of teacher
Process Related (30)	**Product Related (20)**	**Total (50)**	

Practical No. 2: Dousing of class 'A' type fire with suitable medium.

I Practical Significance

It is essential to observe safety while working with electrical installation, appliance, panel etc. The knowledge of safety accessories & procedures to be followed while performing the electrical work is essential for human life as well as the quality & life of machine/equipment/wires & cables.

II Industry/Employer Expected Outcome (s)

Carry out wiring and maintenance activities using relevant materials, tools and safety practices.

III Course Level Learning Outcome (s)

Follow safe working practices when undertaking electrical work.

IV Laboratory Learning Outcome (s)

LLO Douse the class 'A' type fire with suitable medium.

V Relevant Affective Domain related outcome (s)

Follow safety electrical rules for safe practices.

VI Relevant Theoretical Background (With diagrams if required)

A fire extinguisher is a handheld active fire protection device usually filled with a dry or wet chemical used to extinguish or control small fires, often in emergencies. It is not intended for use on an out-of-control fire, such as one which has reached the ceiling, endangers the user (i.e., no escape route, smoke, explosion hazard, etc.), or otherwise requires the equipment, personnel, resources or expertise of a fire brigade. Typically, a fire extinguisher consists of a hand-held cylindrical pressure vessel containing an agent that can be discharged to extinguish a fire. Fire extinguishers manufactured with non-cylindrical pressure vessels also exist but are less common.

The different classes of fire extinguisher rating are listed below together with the some of the most suitable types of fire extinguisher for use on each class of fire:

Class A - Suitable for paper, wood & textiles.
Type of fire extinguisher - Water, Foam, Dry Powder, Wet Chemical

Class B - Suitable for flammable liquids.
Type of fire extinguisher - Foam, Dry Powder, Carbon Dioxide (CO_2)

Class C - Suitable for flammable gasses.
Type of fire extinguisher - Dry Powder

Class F - Suitable for cooking oil and fat.
Type of fire extinguisher - Wet Chemical

There are four different types of water extinguishers: water jet, water spray, water with additives and water mist or fog. Water jet extinguishers work by spraying a jet of water at the burning materials, cooling them and preventing re-ignition. They should not be used on live electrical equipment.

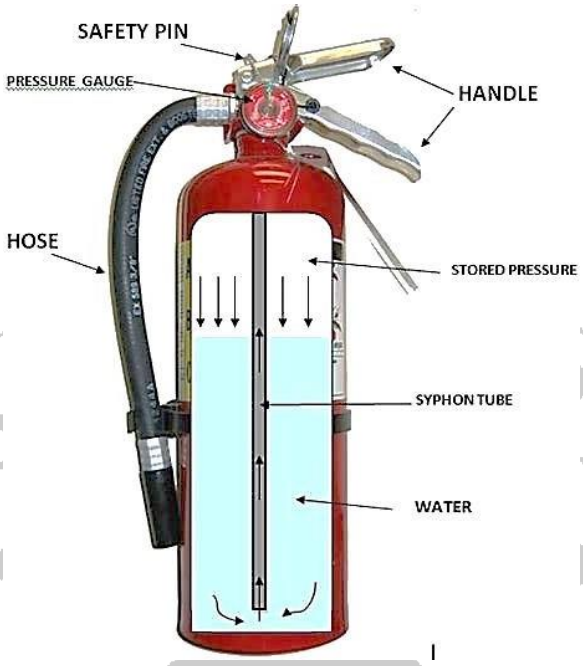

Fig 2.1 Details of fire extinguisher

How to use a fire extinguisher

Fire extinguishers should ideally only be used by someone who has been trained to do so.

The following four-step technique can be memorized more easily with the acronym **PASS, to help you use a fire extinguisher:**

1. **Pull**: Pull the pin to break the tamper seal.
2. **Aim**: Aim low, pointing the nozzle or hose at the base of the fire. (Do not touch the horn on a CO_2 extinguisher since it becomes very cold and can damage skin.
3. **Squeeze**: Squeeze the handle to release the extinguishing agent.
4. **Sweep**: Sweep from side to side at the base of the fire – the fuel source – until the fire is extinguished.

Suitable for use on Class A solid combustible fires (wood, paper, fabrics, coal), water fire extinguishers penetrate burning materials, creating a cooling effect and preventing re-ignition.

VII Actual Circuit diagram used in laboratory with equipment Specifications:

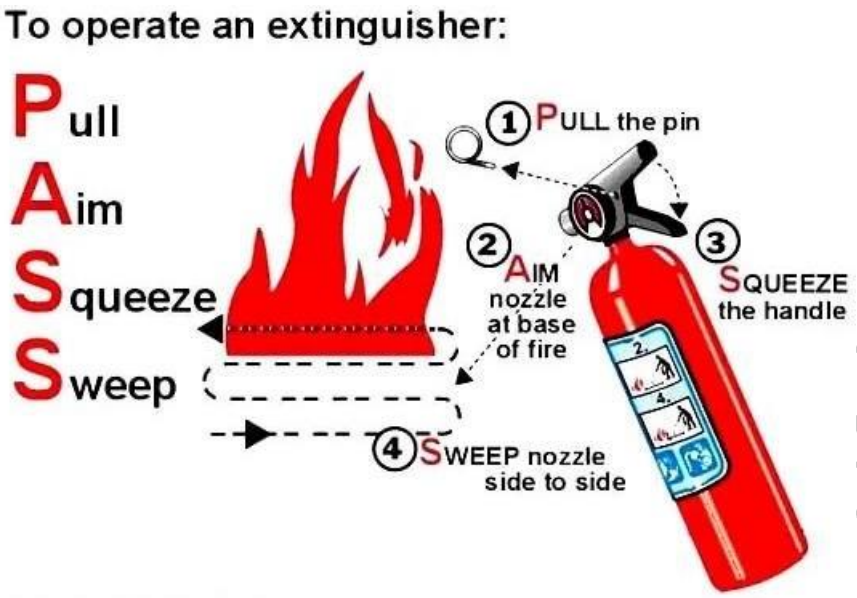

Fig. 2.2 Operation of Fire Extinguisher

VIII Required Resources/apparatus/equipment with specification:

S. No.	Name of Resource	Suggested Broad Specification	Quantity
1	Bucket filled with water	-	1 No.
2	Class 'A' type fire extinguisher (Any one)	-	1 No.
3	Recommendations on Safety Procedures and Practices in Electrical Work, Part I: General	IS 5216 (Part 1)	1 No.
4	Rubber Insulated Electrical Gloves	Working potential: 7,500V	1 No.
5	Electrical Shock Proof Safety Shoes	Insulation range- 15 to 30 KV	1 No.
6	Safety Jacket	Standard	1 No.
7	Safety Helmet	Standard	1 No.
8	Safety Belt	Standard	1 No.
9	Safety Goggles	Standard	1 No.

IX Precautions to be followed:

1. Never use a fire extinguisher on flames from a fire involving escaping gas.
2. Only tackle a fire in its earliest stages
3. Do not move forward unless it is safe, and you should always remain at least one meter from the fire.
4. Do not use more than one fire extinguisher to tackle a fire

X Procedure

1. For plain water extinguishers: check that there is no live electrical equipment in the area.
2. Pull the safety pin.
3. Squeeze the lever to start discharging the extinguisher.
4. Aiming the extinguisher nozzle.
5. As the fire starts to diminish carefully move closer to it.

XI Result(s)

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XII Interpretation of results

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XIII Conclusion and recommendation

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XIV Practical related questions (Provide space for answers)

(Teacher should provide various questions related to practical- sample given)

1. What are the causes of electrical fire?
2. List the types of fire extinguisher with application.
3. How does fire Extinguisher work?
4. What is PASS technique when using fire extinguisher?

XV References/Suggestions for further reading

1. https://www.mtu.edu/ehs/programs/electrical-safety/,assessed on 11th April, 2018.
2. https://www.electrical4u.com/safety-precautions-for-electrical-system/, assessed on 11th April, 2018.
3. https://archive.org/details/gov.in.is.sp.30.2011, ,assessed on 11th April, 2018
4. https://ia801005.us.archive.org/4/items/gov.in.is.5216.1.1982/is.5216.1.1982.pdf, assessed on 11th April, 2018.

XVI Suggested Assessment Scheme

Performance Indicators		Weightage
Process Related : 30 Marks		**60 %**
1	Handling of the components	10%
2	Identification of components	20%
3	Measuring value using suitable instrument	20%
4	Working in teams	10%
Product Related: 20 Marks		**40%**
5	Calculated theoretical values of given component	10%
6	Interpretation of result	05%
7	Conclusions	05%
8	Practical related questions	15%
9	Submitting the journal in time	05%
Total (50 Marks)		**100 %**

Marks Obtained			Dated signature of teacher
Process Related (30)	**Product Related (20)**	**Total (50)**	

Practical No. 3: Rescue a person and practice artificial respiration.

I Practical Significance

It is essential to observe safety while working with electrical installation, appliance, panel etc. The knowledge of safety accessories & procedures to be followed while performing the electrical work is essential for human life as well as the quality & life of machine/equipment/wires & cables.

II Industry/Employer Expected Outcome(s)

Carry out wiring and maintenance activities using relevant materials, tools and safety practices.

III Course Level Learning Outcome(s)

Follow safe working practices when undertaking electrical work.

IV Laboratory Learning Outcome(s)

LLO Rescue a person and apply respiratory methods.

V Relevant Affective Domain related outcome(s)

Follow safety electrical rules for safe practices.

VI Relevant Theoretical Background (With diagrams if required)

What is electric shock?

Electric shock occurs when a person is exposed to an electrical energy source. This condition causes physical responses to the movement of electrical currents in the body. These reactions range from mild reactions to severe shocks that can affect tissues in the body, most importantly local damage, skin burns or cardiac arrhythmias, cardiac arrest and death. The degree of danger of electric shock depends on the level of the voltage, which part of the body is affected and the type of current.

Causes of electric shock

Some subjects are more at risk of electric shock than the general population. The majority are children, adolescents and adults who are exposed to a lot of electric current due to work. Low voltage usually does not cause serious injury to people. On the other hand, high voltage (more than 500 volts) can cause serious tissue damage. However, for children, significant injuries are still possible from exposure to low voltages of about 110 to 220 volts, which are found in common household electrical currents. Even children can be electrocuted right away by household appliances, extension cords and power cords.

Artificial respiration is the forcing of air into the lungs of someone who has stopped breathing, usually by blowing through their mouth or nose, in order to keep them alive and to start breathing again.

Artificial respiration: Different methods

1) Schaffer's Method.
2) Sylvester's method (Arm lift chest pressure method).
3) Nielson's Method (Arm lift back pressure method).
4) Mouth to mouth respiration.

Schaffer's Method

Schaffer's method is an outdated method of artificial respiration. In this method, the patient is made to sleep facing down, i.e., in prone position. The patient is then asked to bend hands at the elbow and place it next to the lower area of the chest. The head is kept in an outward position so that the patient can breathe through mouth and nose. The therapist kneels down near the patient and slowly presses on the loins of the patient by putting his body weight. As a result, pressure is created in the abdomen which pushes up the diaphragm and air is thrown out from the lungs. The process in which air is drawn from the lungs is also known as exhalation or expiration.

After this, the therapist releases pressure and gets back to his initial position. This also releases the pressure on the abdomen, the diaphragm goes down and air is inhaled. This process is termed as inhalation or inspiration. The steps are repeated for 12 times in a minute or as per the usual respiration rate. In Schaffer's method exhalation is for three seconds and inhalation continues for two seconds (approximately).

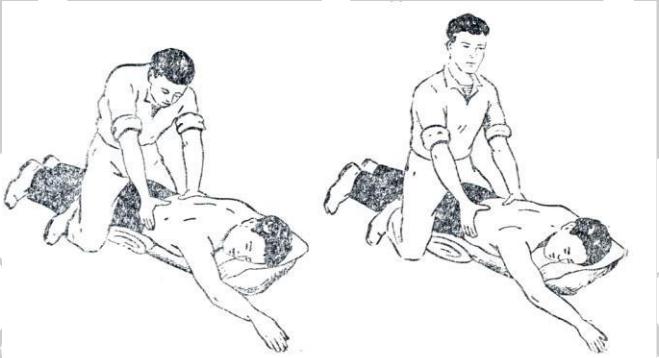

Fig 3.1 Schaffer's Method of Artificial Respiration

Advantages

- Schaffer's method is non-tiring procedure, which can be repeated easily and the patient can take this therapy as long as possible.
- As the patient is laid on abdomen, mucus or saliva cannot block his airways.

- Schaffer's method allows treatment of back and thorax in case of injuries.
- Due to prone position, obstructing material (mucus or saliva) present in the airway directly comes out. This clears the air passage and allows the patient to inhale and exhale properly.

Disadvantages

- This method cannot be used for the patients having abdominal injury.
- Passive inhalation – In this method, the process of inhalation occurs passively whereas exhalation occurs actively. But both of the processes are not physiological.

Sylvester's Method

In this method, the patient is laid on a surface facing upwards. The therapist stands near the head of the patient in order to hold the wrist. The first step is to pull the arms in upward direction, or towards the head. As a result, the process of inhalation takes place. After that, the therapist puts a heavy pressure on the patient's chest by folding hands over the chest. This action compresses the chest wall and results in the process of exhalation. In Sylvester's method of artificial breathing, inhalation should take place for three seconds and exhalation should take place for two seconds.

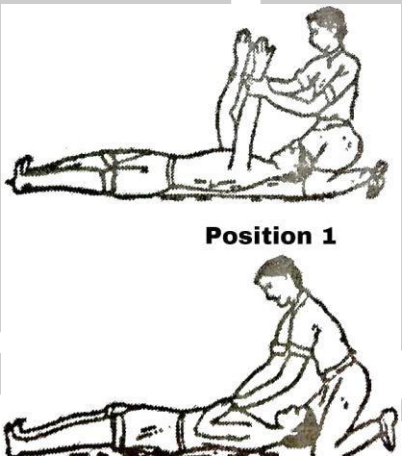

Fig. 3.2 Sylvester's Method of Artificial Respiration

Advantages

- This method is helpful in cases of accidents or in operation theatre.
- Sylvester's method of artificial breathing offers excellent ventilation.
- Both the processes, inspiration and expiration, are active in this method.

Disadvantages

- This method cannot be used in drowning cases as water cannot be drawn out of lungs because of supine position.
- Sylvester's method cannot be used for patients suffering from thorax or rib fracture.
- This method is exhausting in nature which may require assistance during the therapy.

Nielson's Method

This method is also called the arm lift back pressure method. In Holger-Nielson's method of artificial respiration the patient is laid on stomach facing downwards. The headrests on the hands. The therapist places his hands on both sides of the back. Spreading the fingers apart the therapist puts pressure on the back of patient. This pressure assists in exhalation. For inhalation the patient's arms are moved forward. The entire process is repeated roughly around ten to twelve times in a minute.

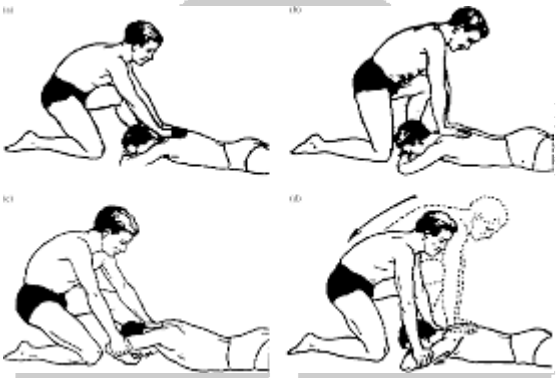

Fig. 3.3 Holger Neilson Method of Artificial Respiration

Mouth to mouth resuscitation is a form of artificial ventilation given to person who fainted or drowned. In this method the rescuer put's his mouth to the victim's mouth and blows air to his lungs through the mouth. This is done for a person who is not doing well with his or her breathing and fainted. Mouth to mouth resuscitation is usually done as a continuation of Cardio Pulmonary Resuscitation.

Fig. 3.4 Mouth to Mouth respiration

Mouth To Mouth Resuscitation on a Child below 8 or an Infant

- Place the victim on a hard or plain surface.
- Ensure that the mouth and throat are clean or clear for the air to pass.
- If something is stuck in the throat or mouth try to sweep it out with your fingers.
- If vomiting occurs, turn the child onto his or her side and sweep out the mouth with two fingers.
- Tilt the head back slightly to open the airway.
- Place your mouth tightly over the mouth. Blow two quick, shallow breaths (smaller breaths than you would give to an adult). Watch for the chest to rise.
- Remove your mouth. Look for the chest to fall as the child exhales.
- Listen for the sounds of breathing. Feel for the child's breath on your cheek. If breathing does not start on its own, repeat the procedure.

Mouth To Mouth Resuscitation for an Adult

- Make sure the person is lying on a hard, flat surface. Look into the mouth and throat to ensure that the airway is clear. If an object is present, try to sweep it out with your finger vomiting occurs, turn the person on his or her side and sweep out the mouth with two fingers. Do not place your finger in the mouth if the person is rigid or is having a seizure.
- Tilt the head back slightly to open the airway. Put upward pressure on the jaw to pull it forward.
- Pinch the nostrils closed with thumb and index finger. Place your mouth tightly over the person's mouth. Use a mouthpiece if one is available. Blow two quick breaths and watch for the person's chest to rise.
- Release the nostrils. Look for the person's chest to fall as he or she exhales. Listen for the sounds of breathing. Feel for the person's breath on your cheek. If the person does not start breathing on his or her own, repeat the procedure.

VII Required Resources/apparatus/equipment with specification

S. No.	Name of Resource	Suggested Broad Specification	Quantity
1	Wooden sticks	Standard	1 No.
2	Rubber Mat	Standard	1 No.
3	Recommendations on Safety Procedures and Practices in Electrical Work, Part I: General	IS 5216 (Part 1)	1 No.
4	Rubber Insulated Electrical Gloves	Working potential: 7,500V	1 No.
5	Electrical Shock Proof Safety Shoes	Insulation range- 15 to 30 KV	1 No.
6	Safety Jacket	Standard	1 No.
7	Safety Helmet	Standard	1 No.
8	Safety Belt	Standard	1 No.
9	Safety Goggles	Standard	1 No.
10	Chart of rescue procedure	Standard	1 No.

VIII Precautions to be followed:

1. Place yourself secured while working.
2. The procedure to start and to stop the work should be well defined.
3. Use insulated gloves and shoes.
4. Examine all safety appliances such as rubber gloves, mats etc.

IX Conclusion and recommendation

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X Practical related questions (Provide space for answers)

(Teacher should provide various questions related to practical- sample given)

1. What is mean by electrical shock?
2. What are the causes for electric shock?
3. List the various Method of Artificial Respiration.

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XI References/Suggestions for further reading:

1. https://www.mtu.edu/ehs/programs/electrical-safety/ assessed on 11th April, 2018.
2. https://www.electrical4u.com/safety-precautions-for-electrical-system/, assessed on 11th April, 2018.
3. https://archive.org/details/gov.in.is.sp.30.2011, ,assessed on 11th April, 2018
4. https://ia801005.us.archive.org/4/items/gov.in.is.5216.1.1982/is.5216.1.1982.pdf, assessed on 11th April, 2018.

XII Suggested Assessment Scheme

Performance Indicators		Weightage
Process Related : 30 Marks		**60 %**
1	Handling of the components	10%
2	Identification of components	20%
3	Measuring value using suitable instrument	20%
4	Working in teams	10%
Product Related: 20 Marks		**40%**
5	Calculated theoretical values of given component	10%
6	Interpretation of result	05%
7	Conclusions	05%
8	Practical related questions	15%
9	Submitting the journal in time	05%
Total (50 Marks)		**100 %**

Marks Obtained			Dated signature of teacher
Process Related (30)	**Product Related (20)**	**Total (50)**	

Practical No. 4: Use of different types of electrical/electronic tools.

I Practical Significance

While performing electrical wiring/maintenance work everybody should be aware of the proper tools required. Unavailability/ not using proper tool may lead to improper/ faulty work and may leads to an accident/injury.

II Industry/Employer Expected Outcome(s)

Use different types of electrical/electronic tools.

III Course Level Learning Outcome(s)

Follow safe working practices when undertaking electrical work.

IV Laboratory Learning Outcome(s)

LLO 1 Use different types of electrical/electronic tools.

V Relevant Affective Domain related outcome(s)

Follow safety electrical rules for safe practices.

VI Relevant Theoretical Background (With diagrams if required)

Electrical technician's kit is very simple and brief. The main tools in the kit are plier and screwdriver. The electrical technician can do much work only with these two tools, but for electrical wiring purpose, it requires a special kit consist of tools such as cutter, Scratch Awl, try square, hacksaw, hammer, drilling machines, test lamp, tester, soldering iron, de-soldering gun etc.

VII Actual Circuit diagram used in laboratory with equipment Specifications:

Fig. 4.1 Tool Kit and Electrical Technicians Main Tools

VIII Required Resources/apparatus/equipment with specification

S. No.	Name of Resource	Suggested Broad Specification	Quantity
1	Electricians tool kit	Standard	1 kit

IX Precautions to be followed

1. Use ISI mark tools.
2. Use proper tool for proper work (job).
3. Never carry pointed tools in packet.
4. Never use damaged/ broken tools.

X Procedure

1. Identify various electrical/electronic tool
   i. Observe the given tool (e.g. Screw driver).
   ii. Draw the free hand sketch of given tool.
   iii. Label the different parts.
   iv. Measure/observe and note down the size of tool and its specifications.
   v. Observe the make of tool and note down.
   vi. Note down the different applications of given tool.

2. Use various electrical/ electronic tools.
   i. Collect old/ broken switch boards/electronic circuits.
   ii. Remove the electrical accessories/ electronics components.
   iii. Use proper tools (Teacher should guide students as per the work allotted.)

3. Follow safety practices while working with tools.
   i. Follow the instruction given by teacher, while working with electrical/electronic tools.
   ii. Write safety precautions, in your own words, for any two tools.

XI Observations and calculations

Identify various electrical/electronic tool

1) Name of tool:

Free hand sketch

Size:

Specifications:

Make:

Applications:

Precautions:

2) Name of tool:

Free hand sketch

Size:

Specifications:

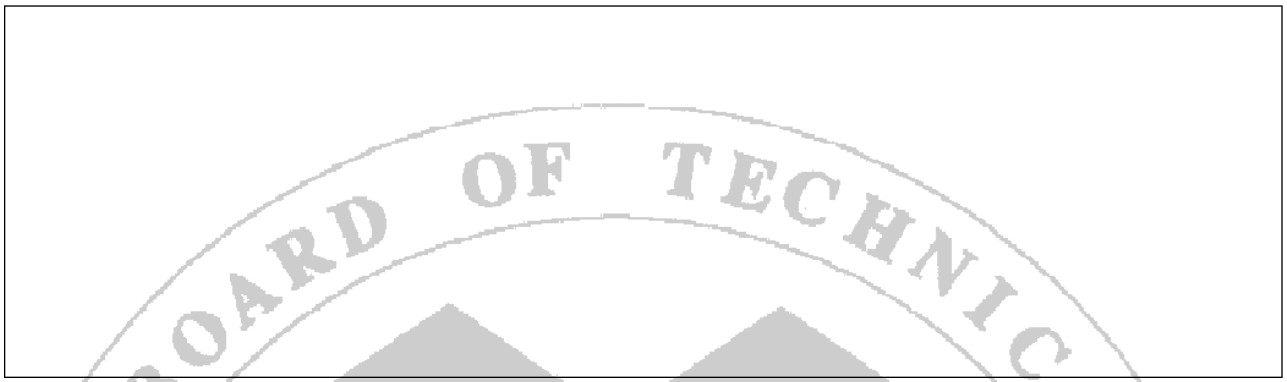
Make:

Applications:

Precautions:

3) Name of tool:

Free hand sketch



Size:

Specifications:

Make:

Applications:

Precautions:

4) Name of tool:

Free hand sketch

Size:

Specifications:

Make:

Applications:

Precautions:

XII Result(s)

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XIII Interpretation of results

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XIV Conclusion and recommendation

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XV Practical related questions (Provide space for answers)

(Teacher should provide various questions related to practical- sample given)

1. Prepare a list of tools required for wiring (with specification) for calling quotation from different suppliers.
2. Name the tools used for followings.

a) Established vertical line on a wall

b) Established horizontal line on a wall

c) Cut PVC conduit

d) Put a hole in wall using hammer

e) Put a pilot hole for fixing screw on board

f) State any two precautions while working with electricians screw driver.

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XVI References/Suggestions for further reading:

1. http://www.tapariatools.com/screw_driver.html#second ,assessed on 11th April, 2018
2. httr//homediyelectronics.com/tools/electronicstoolkitessentials.php ,assessed on11th April, 2018

XVII Suggested Assessment Scheme

	Performance Indicators	Weightage
	Process Related : 30 Marks	**60 %**
1	Handling of the components	10%
2	Identification of components	20%
3	Measuring value using suitable instrument	20%
4	Working in teams	10%
	Product Related: 20 Marks	**40%**
5	Calculated theoretical values of given component	10%
6	Interpretation of result	05%
7	Conclusions	05%
8	Practical related questions	15%
9	Submitting the journal in time	05%
	Total (50 Marks)	**100 %**

Marks Obtained			**Dated signature of teacher**
Process Related (30)	**Product Related (20)**	**Total (50)**	

Practical No. 5: Testing of single pole one way, two way switches and MCB using relevant tools and instruments

I Practical Significance:

The switches and MCBs are the most important components of an electrical installation. They provide the safety & ease in smooth operation of the installation. It is essential to know the working of these components in an electrical installation.

II Industry/Employer Expected Outcome(s)

Carry out wiring and maintenance activities using relevant materials, tools and safety practices.

III Course Level Learning Outcome(s)

Follow safe working practices when undertaking electrical work.

IV Laboratory Learning Outcome(s)

Test the working of single pole one way and two way switches and MCB.

V Relevant Affective Domain related outcome(s)

Follow safety electrical rules for safe practices.

VI Relevant Theoretical Background (With diagrams if required)

Switches: All the switches are specified in accordance with their function, location , type of mounting, current capacity and working voltage. Various types of switches according to their function and place of use are : Single pole-one way switch, Single pole-two way switch, Intermediate switch, Bell push or push-button switch, Pull or ceiling switch, Double pole switch (D.P. Switches), Double pole - iron clad (D.P.I.C.) switch, Three pole- iron clad (T.P.I.C.) switch.

Miniature Circuit Breaker (MCB): MCB switches "OFF" the electrical circuit during overload and short circuits. MCBs have current ratings ranging from 0.5 A to 100 A and, as their name implies, they have a compact size. There are three main types of MCBs, classified according to the current range at which they trip instantly.

- Type B - Trips at 3 to 5 times rated current, suitable for resistive or slightly inductive loads.
- Type C - Trips at 5 to 10 times rated current, suitable for moderate inductive loads.
- Type D - Trips a t 10 to 20 times rated current, suitable for loads with a high inductive component.

VII Actual Circuit diagram used in laboratory with equipment Specifications:

1. Test working of single pole one way switch.

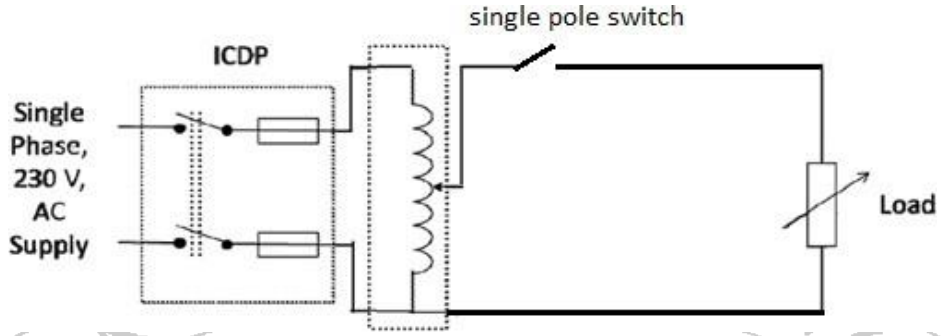

Fig. 5.1 Testing and working of one way switch.

2. Test working of two way switch.

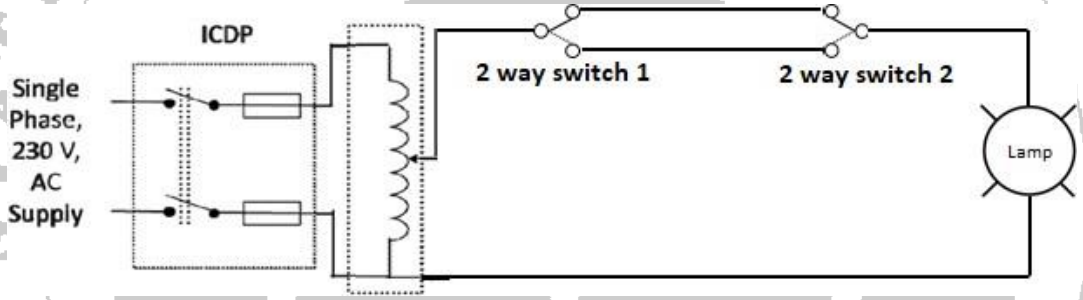

Fig. 5.2 Test working of two way switch.

3. Test working of MCB overload condition.

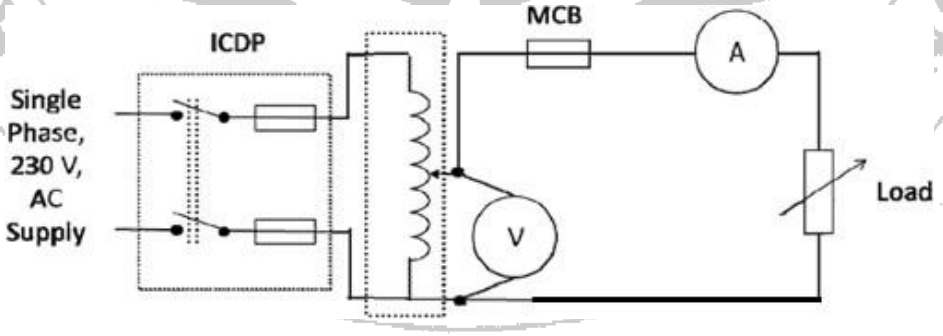

Fig. 5.3 Testing and working of MCB overload condition.

4. Test working of MCB short circuit condition

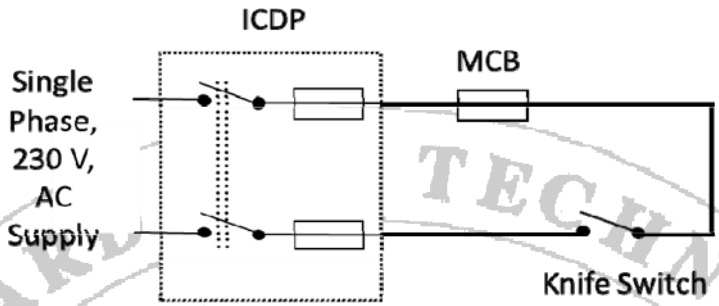

Fig. 5.4 Testing and working of MCB short circuit condition

VIII Required Resources/apparatus/equipment with specification:

S. No.	Name of Resource	Suggested Broad Specification	Quantity
1	Single pole, one-way switch	Piano type 240 V, 6A	1 No.
2	Single pole, two-way switch	Piano type 240 V, 6A	1 No.
3	Single pole MCB	1 Amp, Type B, 6kA, 240 V	1 No.
4	Digital Multi-meter	Standard	1 No.
5	Auto transformer (Dimmer)	Single-phase 0-270 V, 4A	1 No.
6	Ammeter	MI multi-range- 0-5-10 A	1 No.
7	Resistive load / lamp load	Suitable size	1 No.

IX Precautions to be followed:

1. Please read carefully the following precautions before operating Digital Multi• meter (DMM).
   a. Check test leads for broken insulation before working.
   b. Don't use ohmmeter section on live system.
   c. Don't use ammeter section parallel to voltage source.
   d. Don't touch the test lead terminals while connecting live circuits; otherwise it will give a shock.
   e. Disconnect the test leads immediately after the testing.
2. While testing MCB proper ratings of fuses should be used in ICDP.

X Procedure

1. Test working of single pole switch.
   i. Connect the circuit as shown if fig. 1.
   ii. Switch on the switch.
   iii. Switch on the lamp load.
   iv. Observe whether lamp is ON or OFF.

2. Test working of single pole switch.
   i. Connect the circuit as shown if fig. 2.
   ii. Switch on the switch 1 and 2.
   iii. Observe whether lamp is ON or OFF.

3. Test working of MCB.
   i. Connect the circuit as shown in fig.3
   ii. Switch on the supply.
   iii. Increase voltage in steps by varying variac and set at voltage rating of MCB.
   iv. Observe Ammeter.
   v. Switch on lamp load and increase the load up to 3 times current rating of MCB.
   vi. Observe Ammeter
   vii. Wait and record the tripping time of MCB and ammeter reading in observation table.

4. Working of MCB on short circuit.
   i. Connect ICDP, MCB, and knife switch (should be open) as shown in the fig.4
   ii. Switch on the supply.
   iii. Close the knife switch.
   iv. Observe the working of MCB.

XI Observations and calculations

Sr. No.	Current through circuit in Amperes	Tripping Time of MCB in seconds
1		
2		

XII Result(s)

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XIII Interpretation of results

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XIV Conclusion and recommendation

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XV Practical related questions (Provide space for answers)

(Teacher should provide various questions related to practical- sample given)

1. State the specifications of the followings.
   a. Single pole switch
   b. Two way switch
   c. Miniature circuit breaker.
2. What is kA rating of MCB?
3. State, how will you select rating of MCB used in residential installation?

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XVI References/Suggestions for further reading:

1. https://www.youtube.com/watch?v=T3NoJ_x8oiA, assessed on 3rd April, 2018
2. https://www.youtube.com/watch?v=aPh96GOBh-4, assessed on 3rd April, 2018
3. http://www.studyelectrical.com/2014/07/miniature-circuit-breakers-mcb-types• characteristic-curves.html , assessed on 3rd April, 2018
4. https://thegrid.rexel.com/en-us/product_faqs/w/wiki/881/what-are-miniature•circuit-breakers-mcb, assessed on 3rd April, 2018

XVII Suggested Assessment Scheme

	Performance Indicators	Weightage
	Process Related : 30 Marks	**60 %**
1	Handling of the components	10%
2	Identification of components	20%
3	Measuring value using suitable instrument	20%
4	Working in teams	10%
	Product Related: 20 Marks	**40%**
5	Calculated theoretical values of given component	10%
6	Interpretation of result	05%
7	Conclusions	05%
8	Practical related questions	15%
9	Submitting the journal in time	05%
	Total (50 Marks)	**100 %**

Marks Obtained			**Dated signature of teacher**
Process Related (30)	**Product Related (20)**	**Total (50)**	

Practical No. 6: Demonstration of MCCB

I Practical Significance

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

II Industry/Employer Expected Outcome(s)

Carry out wiring and maintenance activities using relevant materials, tools and safety practices.

III Course Level Learning Outcome(s)

Follow safe working practices when undertaking electrical work.

IV Laboratory Learning Outcome(s)

Operate the MCCB

V Relevant Affective Domain related outcome(s)

Follow safety electrical rules for safe practices.

VI Relevant Theoretical Background (With diagrams if required)

Molded case circuit breaker is a circuit breaker and trip device assembled in a molded case. It can automatically cut off electric supply 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 etc. It's also called an MCCB, which is the abbreviation for molded case circuit breaker

The term "molded case" refers to the plastic casing that encloses the breaker. The casing serves to protect the breaker by keeping away external elements as well as offering thermal and mechanical protection.

More importantly, the molded case breaker housing provides the much-needed insulation for safety, as the breaker operates in higher voltage and higher current situations than the regular MCB.

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VII Actual Circuit diagram used in laboratory with equipment Specifications

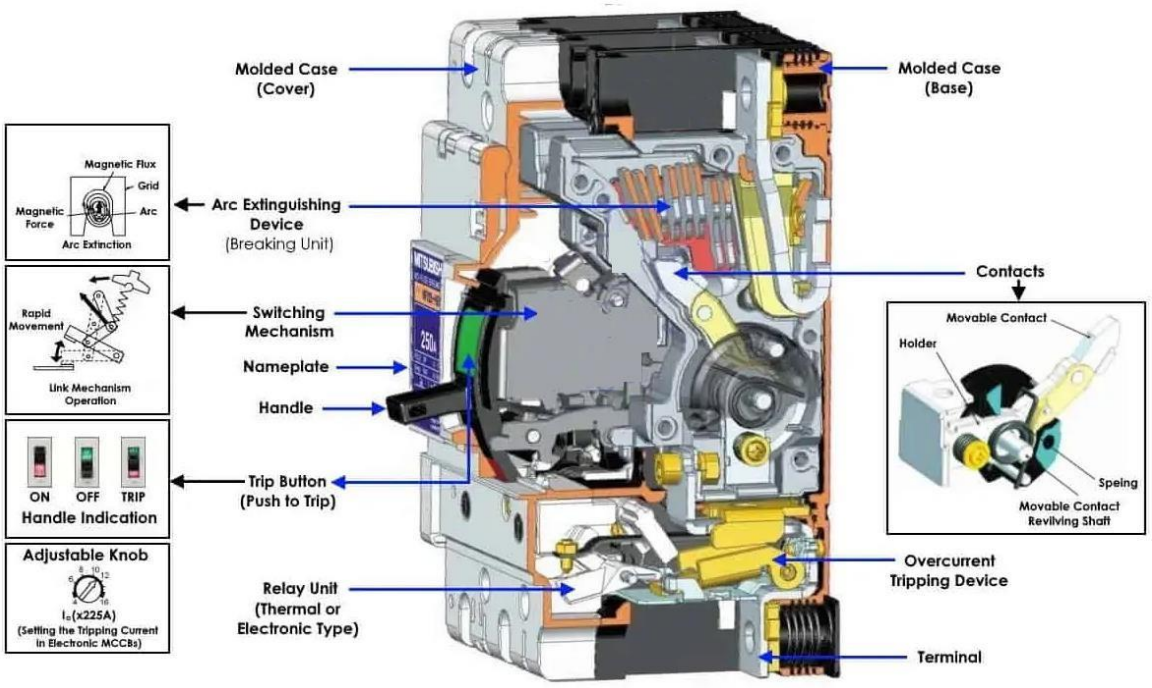

Fig. 6.1 Construction of MCCB

VIII Required Resources/apparatus/equipment with specification:

S. No.	Name of Resource	Suggested Broad Specification	Quantity
1	MCCB	Suitable rating	1No.
2	Hammer		1No.
3	Screw driver		1No.

IX Precautions to be followed

1. Use screwdriver carefully.
2. Follow electrical safety practices

X Procedure

1. Observe the external parts such as outgoing terminal and incoming terminals.
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 Observations and calculations

Sr. No.	Name of part	Material used	Function

XII Result(s)

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XIII Interpretation of results

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XIV Conclusion and recommendation

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XV Practical related questions (Provide space for answers)

(Teacher should provide various questions related to practical- sample given)

1. Give specification of MCCB.
2. Compare MCB and MCCB.
3. State whether MCCB operates on earth faults. Give reason.

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XVI References/Suggestions for further reading

1. https://www.electricaltechnology.org/2021/07/mccb-molded-case-circuit-breaker.html
2. https://www.electrical4u.net/basic-accessories/what-is-mccb-molded-case-circuit-breaker-working-types-of-mccb-included/
3. https://www.youtube.com/watch?v=zfi4Go8bQTY

XVII Suggested Assessment Scheme

Performance Indicators		Weightage
Process Related : 30 Marks		**60 %**
1	Handling of the components	10%
2	Identification of components	20%
3	Measuring value using suitable instrument	20%
4	Working in teams	10%
Product Related: 20 Marks		**40%**
5	Calculated theoretical values of given component	10%
6	Interpretation of result	05%
7	Conclusions	05%
8	Practical related questions	15%
9	Submitting the journal in time	05%
Total (50 Marks)		**100 %**

Marks Obtained			Dated signature of teacher
Process Related (30)	**Product Related (20)**	**Total (50)**	

Practical No. 7: Testing of rewirable fuse

I Practical Significance

The fuse is one of the most important component of an electrical installation. Fuse provide the safety and ease in smooth operation in the installation. It is essential to know the construction and working of fuse.

II Industry/Employer Expected Outcome(s)

Carry out wiring and maintenance activities using relevant materials, tools and safety practices.

III Course Level Learning Outcome(s)

Follow safe working practices when undertaking electrical work

IV Laboratory Learning Outcome(s)

LLO Test the working of fuse

V Relevant Affective Domain related outcome(s)

Follow safety electrical rules for safe practices.

VI Relevant Theoretical Background (With diagrams if required)

A fuse is a safety device having a short length of a thin metal wire having low melting point, which melts and breaks the circuit if the current exceeds a safe value. A fuse wire is connected in series in the electric circuits. The thickness and length of the fuse wire depends on the maximum current allowed through the circuit. An electric fuse works on the heating effect of current. The fuse for protecting a domestic wiring is fitted just above our main switch on the switch board. The fuse in domestic wiring consists of a porcelain fuse holder H having two brass terminals in it. This is connected in the live wire. The other part of the fuse is a removable fuse grip G which is also made of porcelain. The fuse grip has a fuse wire fixed in it. When fuse grip is inserted in the fuse holder as shown in figure 7.1 then the circuit is completed so, under normal circumstances when the current is within limit, the fuse wire is intact and electric current is available in our wiring

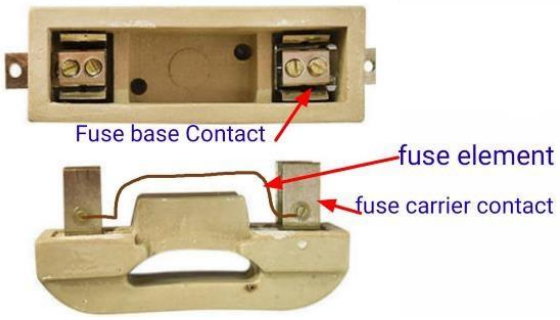

Fig. 7.1 Construction of fuse

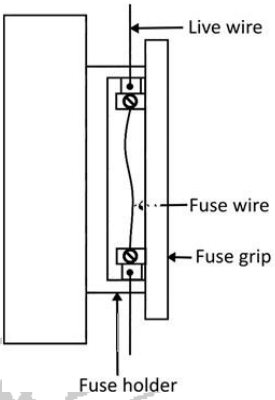

Fig. 7.2 Normal condition

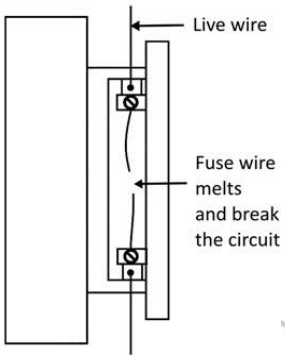

Fig. 7.3 Overload or short circuit condition

When a short circuit takes place, or when overloading takes place, the current becomes large and heats the fuse wire too much. Since the melting point of fuse wire is much lower than copper wires, the fuse wire melts and breaks the circuit as shown in Figure 7.3. When the fuse wire breaks, electricity supply automatically switched off before any damage can be done to the rest of the electrical appliances being used.

The thin wire is used as a fuse wire and not a thick wire. Thin wire is used in a fuse because it has a much greater resistance. Due to its high resistance, the heating effect of current will be much more in the fuse wire than anywhere else in the circuit. This will melt the fuse wire whereas other wiring will remain safe. We should not use a thick wire as a fuse wire because it will have a low resistance and hence it will not get heated to its melting point easily

VII Actual Circuit diagram used in laboratory with equipment Specifications:

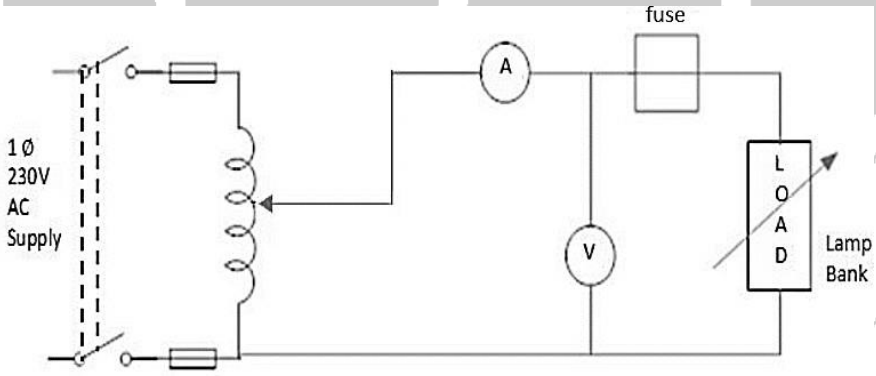

Fig. 7.4 Circuit diagram

VIII Required Resources/apparatus/equipment with specification

S. No.	Name of Resource	Suggested Broad Specification	Quantity
1	Rewirable kitkat fuse	Range 1-5 Amp	1 No.
2	Lamp bank	230V, 10A	1 No.
3	AC ammeter	0-10Amp	1 No.
4	AC voltmeter	0-300V	1 No.
5	Autotransformer	0-270V, 10A, 10Kva	1 No.

IX Precautions to be followed:

1. Connection should not be loose
2. Ensure that proper rating of fuse is selected
3. Follow electrical safety rules

X Procedure

1. Make connections as per the circuit diagram.
2. Switch on the supply and adjust the rated load current.
3. Gradually increase the load current and note down the time of operation till fuse blows.
4. Disconnect the load.
5. Switch off the supply.
6. Replace fuse element with different current rating.
7. Repeat the procedure and note down the readings.

XI Observations and calculations

Sr. No.	Current through fuse in ampere	Time of fuse operation in seconds

XII Result(s)

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XIII Interpretation of results

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XIV Conclusion and recommendation

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XV Practical related questions (Provide space for answers)

(Teacher should provide various questions related to practical- sample given)

1. Define fuse, fuse element, fusing current.
2. State the types of fuses.
3. State the applications of fuse.

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XVI References/Suggestions for further reading

1. https://discover.hubpages.com/technology/Rewirable-fuses-Electric
2. K.B. Raina, S. K. Bhattacharya, "Electrical Design Estimation and Costing", New Age International Publishers, Reprint 2010, ISBN(l0): 81-224-0363-8; ISBN(l3): 978-81-224-0363-3

XVII Suggested Assessment Scheme

Performance Indicators		Weightage
Process Related : 30 Marks		**60 %**
1	Handling of the components	10%
2	Identification of components	20%
3	Measuring value using suitable instrument	20%
4	Working in teams	10%
Product Related: 20 Marks		**40%**
5	Calculated theoretical values of given component	10%
6	Interpretation of result	05%
7	Conclusions	05%
8	Practical related questions	15%
9	Submitting the journal in time	05%
Total (50 Marks)		**100 %**

Marks Obtained			Dated signature of teacher
Process Related (30)	**Product Related (20)**	**Total (50)**	

Practical No. 8: Preparation of series lamp test board with 2 meter wire extension.

I Practical Significance

Testing of electric circuit plays an important role in electrical and electronic equipments. Testing of components such as choke coils motor, generators, household equipments etc. is necessary for fault finding, satisfactory performance of equipments, safety of operator, life of equipment etc.

II Industry/Employer Expected Outcome(s)

Carry out wiring and maintenance activities using relevant materials, tools and safety practices.

III Course Level Learning Outcome(s)

Follow safe working practices when undertaking electrical work.

IV Laboratory Learning Outcome(s)

Prepare series lamp test board with 2 meter wire extension.

V Relevant Affective Domain related outcome(s)

Follow safety electrical rules for safe practices.

VI Relevant Theoretical Background (With diagrams if required)

A series test lamp can be used to find the open circuit and short circuit in electrical circuit. Series test lamp can be used to check the continuity of the supply in electrical circuits. Series test lamp is connected in series with the circuit to check open circuit or short circuit.

If series lamp does not glow it indicates there is open circuit.

If lamp glows with more brightness it indicates that there is short circuit.

If lamp glows with normal brightness it indicates that circuit is in good condition.

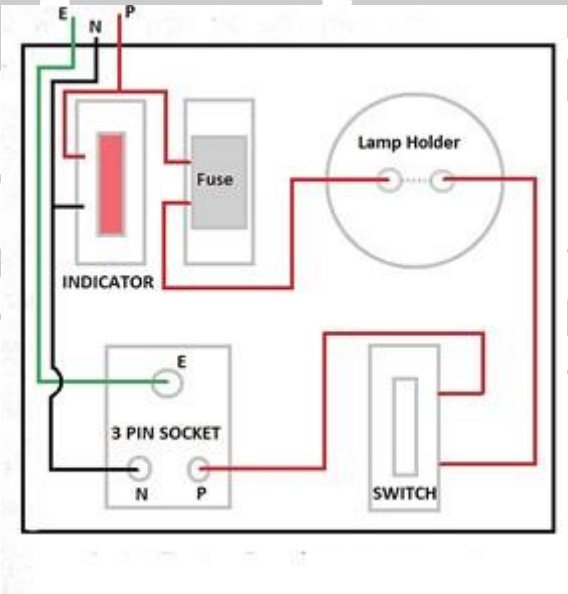

Fig. 8.1Series test lamp board

VII Actual Circuit diagram used in laboratory with equipment Specifications

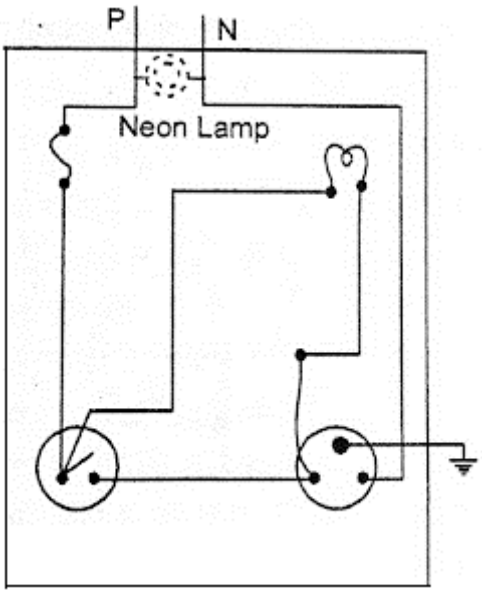

Fig. 8.2 Circuit diagram of series test lamp board

VIII Required Resources/apparatus/equipment with specification

S. No.	Name of Resource	Suggested Broad Specification	Quantity
1	Wooden board/ PVC board	Standard size	1 No.
2	Batten Lamp holder	240V, 6A	1 No.
3	Lamp	40 watt	1 No.
4	Switch	240V, 6A	1 No.
5	Socket	5 Pin, 240V, 6A	1 No.
6	Indicator	240V	1 No.
7	Fuse	6A	1 No.
8	PVC Wire of red, black and green color	2 mm^2	2 meter

IX Precautions to be followed

1. All electrical connections should be neat and tight.
2. Check the power supply before connection.
3. Follow safe practices.

X Procedure

1. Prepare the test board as per circuit diagram.
2. Connect the equipment to be tested.
3. Switch on the supply and observe brightness of the lamp.
4. Depending upon the condition of the lamp note down the observations

XI Observations and calculations

Sr. No.	Lamp brightness (Dim/Bright/No)	Remark whether equipment is open circuit/short circuit/not faulty

XII Result(s)

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XIII Interpretation of results

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XIV Conclusion and recommendation

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XV Practical related questions (Provide space for answers)

(Teacher should provide various questions related to practical- sample given)

1. Write necessary conditions for using test series lamp for testing.
2. Draw a diagram for testing choke coil using series test lamp
3. Write meaning of SERIES in series test lamp.

XVI References/Suggestions for further reading

1. www.electical4u.com
2. www.howstuffworks.com
3. www.electricaltechnology.org

XVII Suggested Assessment Scheme

Performance Indicators		Weightage
Process Related : 30 Marks		**60 %**
1	Handling of the components	10%
2	Identification of components	20%
3	Measuring value using suitable instrument	20%
4	Working in teams	10%
Product Related: 20 Marks		**40%**
5	Calculated theoretical values of given component	10%
6	Interpretation of result	05%
7	Conclusions	05%
8	Practical related questions	15%
9	Submitting the journal in time	05%
Total (50 Marks)		**100 %**

Marks Obtained			Dated signature of teacher
Process Related (30)	**Product Related (20)**	**Total (50)**	

Practical No. 9: Testing of the RCCB

I Practical Significance

RCCB is a life saving device which is designed to prevent human life from electric shocks. This device provides the safety in an electrical installation, therefore it is essential to know the working of RCCB

II Industry/Employer Expected Outcome(s)

Carry out wiring and maintenance activities using relevant materials, tools and safety practices.

III Course Level Learning Outcome(s)

Follow safe working practices when undertaking electrical work.

IV Laboratory Learning Outcome(s)

LLO Test the performance of RCCB.

V Relevant Affective Domain related outcome(s)

Follow safety electrical rules for safe practices.

VI Relevant Theoretical Background (With diagrams if required)

An Earth leakage circuit breaker (ELCB) is a safety device used in electrical installations. It protects operator, instruments as well as circuit while earth leakage. There are two types of ELCB voltage operated and current operated. Voltage operated ELCB are old ones, they are not used now in new installations. However current operated ELCB are widely used, this current operated ELCB is called as Residual Current Circuit Breaker (RCCB). A Residual Current Circuit Breaker (RCCB) is an electrical device that provides protection against electric shocks, electrical fires, and other dangerous electrical hazards. It is designed to detect and quickly disconnect the electricity supply when an imbalance in the electrical current is detected. RCCB works on the principle of incoming current is equal to outgoing current. Residual current is a difference between line current and neutral current. At the event of earth leakage, current finds the earth path and hence imbalance occurs between line current and neutral current. The coil in toroidal transformer in RCCB senses residual current which is connected to relay.

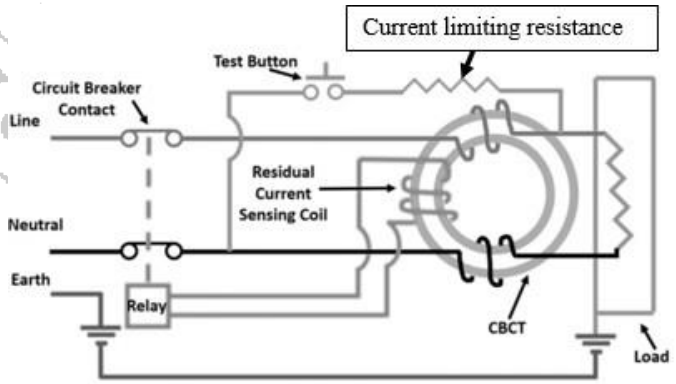

Fig. 9.1 RCCB construction

VII Actual Circuit diagram used in laboratory with equipment Specifications

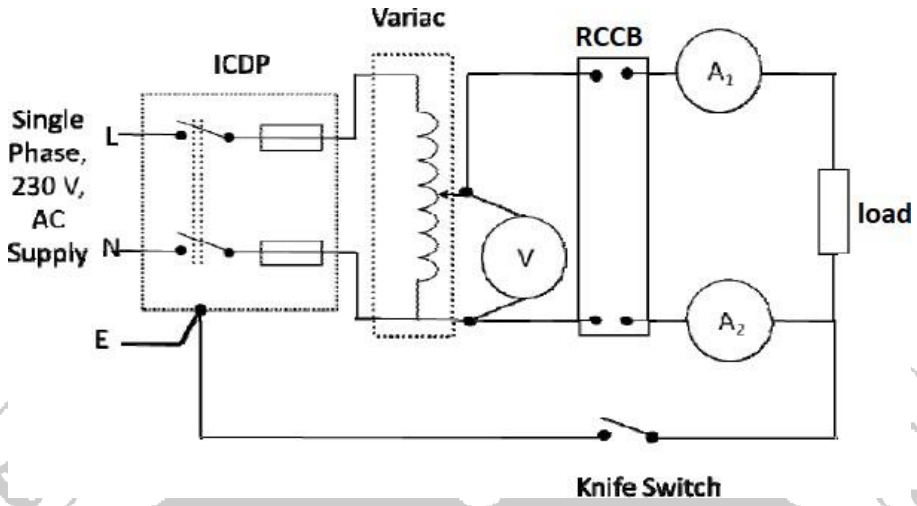

Fig. 9.2 circuit diagram for testing of RCCB

VIII Required Resources/apparatus/equipment with specification

S. No.	Name of Resource	Suggested Broad Specification	Quantity
1	RCCB	10A, double pole, sensitivity 30mA	1 No.
2	Digital multimeter		1 No.
3	Auto transformer	Single phase 0-270 V, 10A	1 No.
4	Ammeter	0-10A	2 No.
5	Voltmeter	0-300V	1 No.
6	Lamp bank	230V, 10A	1 No.
7	Knife switch	Single pole single throw	1 No.

IX Precautions to be followed:

1. While testing RCCB proper rating of fuses should be used in ICDP.
2. Precautions should be taken while operating knife switch.

X Procedure

1. Connect the circuit as shown in the diagram.
2. Apply rated voltage by using auto transformer.
3. Switch ON the load.
4. Measure current through live and neutral wire before closing the knife switch.
5. By operating knife switch create earth fault.
6. Measure current through live and neutral wire after closing the knife switch.
7. Note down the tripping time of RCCB.

XI Observations and calculations

Before operating knife switch

Sr. No.	Current through live wire	Current through neutral wire

After operating knife switch

Sr. No.	Current through live wire	Current through neutral wire

XII Result(s)

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XIII Interpretation of results

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XIV Conclusion and recommendation

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XV Practical related questions (Provide space for answers)

(Teacher should provide various questions related to practical- sample given)

1. State how RCCB differs from MCB.
2. Is RCCB trips in the event of short circuit in an electric circuit?
3. State the different parts of RCCB and write the function of each part.

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XVI References/Suggestions for further reading:

1. http://www.idconline.com/control/Working_Principle_of_ELCB_and_RCB.pdf, assessed on 11th April, 2018.
2. https://www.electrical4u.com/residual-current-circuit-breaker/, assessed on 11th April, 2018
3. http://www.studyelectrical.com/2015/05/residual-current-circuit-breakers-elcb-rccb- rebo-working-principle.html, assessed on 11th April, 2018
4. https://library.e.abb.com/public/d286e8468abe43dcc1256a93002c4169/GSK050070180 201.pdf, assessed on 11th April, 2018

XVII Suggested Assessment Scheme

Performance Indicators		Weightage
Process Related : 30 Marks		**60 %**
1	Handling of the components	10%
2	Identification of components	20%
3	Measuring value using suitable instrument	20%
4	Working in teams	10%
Product Related: 20 Marks		**40%**
5	Calculated theoretical values of given component	10%
6	Interpretation of result	05%
7	Conclusions	05%
8	Practical related questions	15%
9	Submitting the journal in time	05%
Total (50 Marks)		**100 %**

Marks Obtained			Dated signature of teacher
Process Related (30)	**Product Related (20)**	**Total (50)**	

Practical No. 10: Selection of fuse in different lighting circuits

I Practical Significance

Fuse prevents the electrical circuit in the event of over current and fault, hence to avoid the damage to an electrical circuit selection of correct rating of fuse is important.

II Industry/Employer Expected Outcome(s)

Carry out wiring and maintenance activities using relevant materials, tools and safety practices.

III Course Level Learning Outcome(s)

Select relevant conducting, electromagnetic and magnetic materials.

IV Laboratory Learning Outcome(s)

Choose the appropriate fuse rating and its location for the given circuit

V Relevant Affective Domain related outcome(s)

Follow safety electrical rules for safe practices.

VI Relevant Theoretical Background (With diagrams if required)

A fuse is a safety device used for purpose of protecting circuit against excess current. In the event of excessive current, the fuse element melts and opens up the circuit thereby protecting it from damage. In electrical installations, the fuses are always connected into live wires (L1, L2 and L3 as shown in Fig. 1) and never into the neutral (N) or the protective earth line (PE).

Following are the types of fuses used in domestic wiring.

1. Rewirable type (up to 200 A)
2. Cartridge type (up to 1250 A)

Some important terms related to fuse are as follows:

1. Current Rating: Safe maximum current that can be passed continuously without overheating.
2. Fusing Current: The current at which the fuse element melts.
3. Fusing Factor: It is a ratio of minimum fusing current and current rating.

The fusing factor for rewirable fuse varies between 1.4 and 1.7 and may go up to 2.0, but for HRC fuse it is 1.1. However, a fuse selected for overcurrent protection should not have a fusing factor more than 1.25.

VII Actual Circuit diagram used in laboratory with equipment Specifications

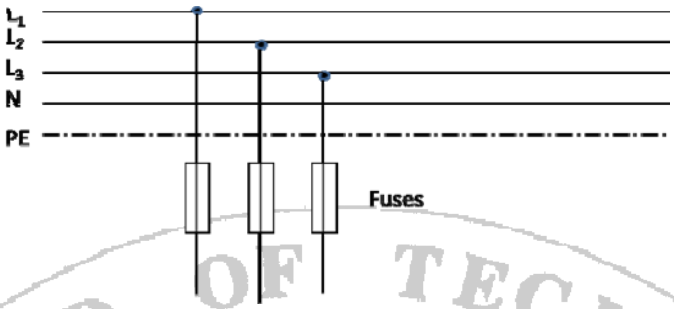

Fig. 10.1 Fuse Placement

VIII Required Resources/apparatus/equipment with specification

S. No.	Name of Resource	Suggested Broad Specification	Quantity
1	Lighting circuit connected to DB		1 No.
2	Fuse wire	Various fuse rating	As required
3	Electricians Screw driver	150mm	1 No.
4	Insulated Combination Plier	200mm	1 No.
5	Test lamp		1 No.

IX Precautions to be followed

1. Follow electrical safety rules.
2. Use insulated tools while working on installation.
3. Insure that the supply in "OFF" while replacing the fuse

X Procedure

1. Identify any electrical circuit in the department.
2. Identify the number of sub-circuits.
3. Calculate the connected load in the sub- circuit.
4. Calculate total load on a circuit.
5. Calculate individual current rating of circuit.
6. Select proper current rating of fuses for the sub-circuits and main switch.
7. Switch "OFF" the main switch.
8. Test the supply at incoming and outgoing terminals of the main switch with the help of test lamp.

9. Test the supply at DB.
10. Replace the old fuse element in DB and main switch using new fuse element of proper rating.

XI Observations and calculations:

1. No. of light sub-circuits.....
2. No. of power sub-circuits (if any).....

Sr. No.	Sub circuit no.	Description	Total connected load	Total current	Fuse current rating

XII Result(s)

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XII Interpretation of results

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XIV Conclusion and recommendation

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XV Practical related questions (Provide space for answers)

(Teacher should provide various questions related to practical- sample given)

1. State the rule for no. of points and total wattage in lighting sub-circuit.
2. State the rule for no. of points and total wattage in power sub-circuit.
3. State, how will you select the fuse rating for **1** HP, water pump?
4. Name other device which can be used in residential unit instead of fuse.

XVI References/Suggestions for further reading

1. K.B. Raina, S.K.Bhattacharya, "Electrical Design Estimation and Costing", New Age International Publishers, Reprint 2010, ISBN(l0): 81-224-0363-8; ISBN(l3): 978-81-224-0363-3

XVII Suggested Assessment Scheme

Performance Indicators		Weightage
Process Related : 30 Marks		**60 %**
1	Handling of the components	10%
2	Identification of components	20%
3	Measuring value using suitable instrument	20%
4	Working in teams	10%
Product Related: 20 Marks		**40%**
5	Calculated theoretical values of given component	10%
6	Interpretation of result	05%
7	Conclusions	05%
8	Practical related questions	15%
9	Submitting the journal in time	05%
Total (50 Marks)		**100 %**

Marks Obtained			Dated signature of teacher
Process Related (30)	**Product Related (20)**	**Total (50)**	

Practical No. 11: Measurement of insulation resistance of cable using insulation tester

I Practical Significance

Many a times it is essential to measure insulation resistance of cable before installation as well as whenever power breakdown in a shop or section of industry occurs. The value of insulation resistance measured decides the condition of cable. It is essential to know the procedure & interpretation of value of insulation resistance.

II Industry/Employer Expected Outcome(s)

Carry out wiring and maintenance activities using relevant materials, tools and safety practices.

III Course Level Learning Outcome(s)

Select relevant insulating materials.

IV Laboratory Learning Outcome(s)

Measure insulation resistance of cable using insulation tester.

V Relevant Affective Domain related outcome(s)

Follow safety electrical rules for safe practices.

VI Relevant Theoretical Background (With diagrams if required):

Insulation resistance quality of an electrical system degrades with time, environment condition i.e. temperature, humidity, moisture and dust particles. It also get impacted negatively due to the presence of electrical and mechanical stress, so it becomes very necessary to check the IR (Insulation resistance) of equipment at a constant regular interval to avoid any major electrical shock. Megger is an instrument designed, to measure extremely high value of resistance. Megger measures the extremely high value of resistance, hence called mega• ohmmeter. It is also used for measurement of insulation resistance, hence called insulation tester.

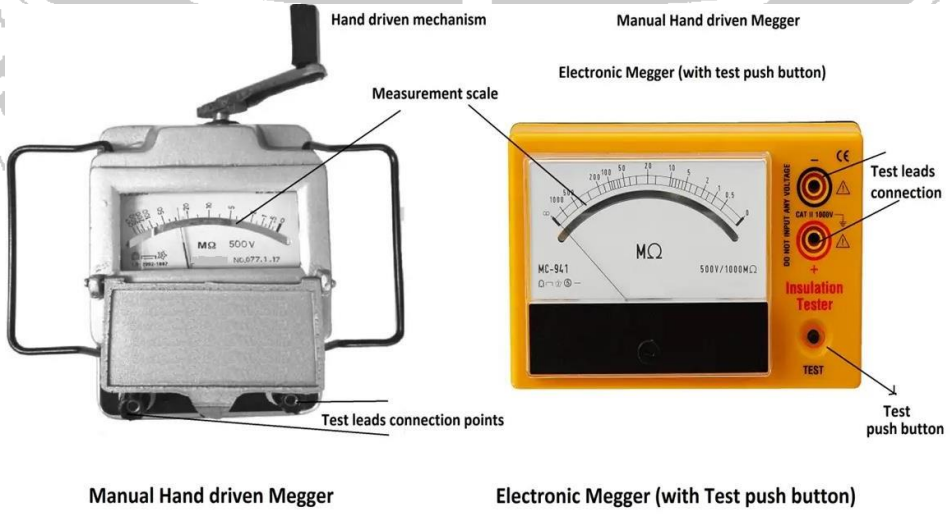

Fig 11.1 Types of megger

VII Actual Circuit diagram used in laboratory with equipment Specifications

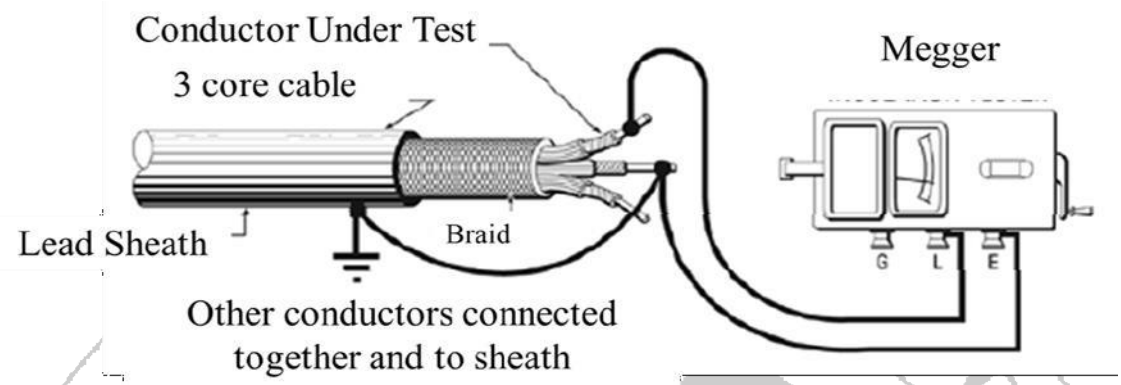

Figure 11.2: Insulation Resistance test of Cable

VIII Required Resources/apparatus/equipment with specification

S. No.	Name of Resource	Suggested Broad Specification	Quantity
1	Megger	500 V Hand Driven	1 No.
2	Test cable	Suitable size	1 No.

IX Precautions to be followed

1. The megger should not be used on live system.
2. The handle of the rnegger should be rotated in clockwise direction.
3. Don't touch the terminals of rnegger while conducting a test; otherwise it will give an electric shock.
4. Rotate the handle of rnegger at its rated speed.
5. Keep the rnegger in horizontal position while operation.

X Procedure

1. Connect the L terminal of megger to conductor under test as shown in Fig. 2.
2. Connect the E terminal of megger to other conductors connected together and to sheath.
3. Rotate the handle of megger at its rated speed.
4. Observe the reading.
5. Note down the reading in observation table.
6. Repeat the steps for other conductors.

XI Observations and calculations

Sr. No.	Connection Description	Readings	Remarks

XII Result(s)

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XIII Interpretation of results

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XIV Conclusion and recommendation

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XV Practical related questions (Provide space for answers)

(Teacher should provide various questions related to practical- sample given)

1. Does the cranking affect the megger reading
2. State the meaning of zero and infinity reading of megger.
3. State the purpose of measuring insulation resistance of cable.

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XVI References/Suggestions for further reading

1. http://www.techni-tool.com/site/ARTICLE_LIBRARY/Megger%20%20The%20Complete%20Guide%2oto%20Electrical%20Insulation%20Testing.pdf, assessed on 12th April, 2018
2. https://www.electrical4u.com/megger-working-principle-types-history-uses-of•megger/, assessed on 12th April, 2018

XVII Suggested Assessment Scheme

	Performance Indicators	Weightage
	Process Related : 30 Marks	**60 %**
1	Handling of the components	10%
2	Identification of components	20%
3	Measuring value using suitable instrument	20%
4	Working in teams	10%
	Product Related: 20 Marks	**40%**
5	Calculated theoretical values of given component	10%
6	Interpretation of result	05%
7	Conclusions	05%
8	Practical related questions	15%
9	Submitting the journal in time	05%
	Total (50 Marks)	**100 %**

Marks Obtained			Dated signature of teacher
Process Related (30)	**Product Related (20)**	**Total (50)**	

Practical No. 12: Selection of insulating materials for specific applications from given samples

I Practical Significance

The identification and selection of proper insulating materials is required for safe working of electrical appliances. The insulating material separates the electrical conductors to safeguard individuals from electrically energized parts.

II Industry/Employer Expected Outcome(s)

Carry out wiring and maintenance activities using relevant materials, tools and safety practices.

III Course Level Learning Outcome(s)

Select relevant insulating material.

IV Laboratory Learning Outcome(s)

Select insulating materials for specific applications.

V Relevant Affective Domain related outcome(s)

Follow safety electrical rules for safe practices.

VI Relevant Theoretical Background (With diagrams if required)

Insulating material is generally used as a protective coating on electrical conductor and cables. e.g. polyethylene, cross linked polyethylene-XLPE, polyvinyl chloride-PVC, Teflon, silicone etc. Bushings are made insulating material like glass, porcelain, or composite polymer materials. Transformer oil is widely used as an insulator to prevent arcing in transformers, stabilizers, circuit breakers, etc. The insulating oil can withstand insulating properties up to a specified electrical breakdown voltage. Vacuum, gas (sulfur hexafluoride), and ceramic or glass wire are other methods of insulation in high voltage systems. Small transformers, power generators, and electrical motors contain insulation on the wire coils by the means of polymer varnish. Fiberglass insulating tape is also used as a winding coil separator. All domestic electrical appliances are insulated to prevent their user from electrical shock hazard. Mica, fiberglass, porcelain, backelite etc. are used in domestic appliances. Insulation table made of PVC, nylon, fiberglass cloth are used to insulate wires and cables.

.VII Actual Circuit diagram used in laboratory with equipment Specifications:

---------- Not applicable----------

VIII Required Resources/apparatus/equipment with specification

S. No.	Name of Resource	Suggested Broad Specification	Quantity
1	Insulating Material Samples		As required

IX Precautions to be followed

1. Observe the samples carefully.
2. In case of any doubt, ask teacher.

X Procedure

1. Pick any one sample of insulating material.
2. Observe the sample carefully.
3. Identify the material.
4. Write its properties. (As mentioned in references).
5. Select the material for proper application and write the application in observation space.

XI Observations and calculations

Sr. No.	Sample	Identification	Specifications	Applications
1	Sample 1			
2	Sample 2			
3	Sample 3			
4	Sample 4			
5	Sample 5			

XII Result(s)

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XIII Interpretation of results

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XIV Conclusion and recommendation

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XV Practical related questions (Provide space for answers)

(Teacher should provide various questions related to practical- sample given)

1. Name various liquid insulating materials.
2. Name various solid insulating materials.
3. Name various gaseous insulating materials.
4. State any one application of PVC, HDPE, Mica and Porcelain.

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XVI References/Suggestions for further reading:

1. https://www.brighthubengineering.com/commercial-electrical- applications/ 124315-common-insulating-materials-used-in-electrical-engineering/ , assessed on 15th April, 2018
2. K B. Raina, S.K. Bhattacharya, T. Joneja, "Electrical Engineering Material & Electronics Components", S.K. Kataria & Sons, 2013, ISBN: 9789350144176

XVII Suggested Assessment Scheme

	Performance Indicators	Weightage
	Process Related : 30 Marks	**60 %**
1	Handling of the components	10%
2	Identification of components	20%
3	Measuring value using suitable instrument	20%
4	Working in teams	10%
	Product Related: 20 Marks	**40%**
5	Calculated theoretical values of given component	10%
6	Interpretation of result	05%
7	Conclusions	05%
8	Practical related questions	15%
9	Submitting the journal in time	05%
	Total (50 Marks)	**100 %**

Marks Obtained			**Dated signature of teacher**
Process Related (30)	**Product Related (20)**	**Total (50)**	

Practical No. 13: Insulation resistance test on electrical installation.

I Practical Significance:

Many a times it is essential to measure insulation resistance of electrical installation before supply is given to the installation. The value of insulation resistance measured decides the condition of insulation of electrical installation. It is essential to know the procedure & interpretation of value of insulation resistance.

II Industry/Employer Expected Outcome(s)

Carry out wiring and maintenance activities using the relevant materials, tools and safety practices.

III Course Level Learning Outcome(s)

Select relevant insulating materials.

IV Laboratory Learning Outcome(s)

LLO Measure insulation resistance of electrical installation using insulation tester.

V Relevant Affective Domain related outcome(s)

Follow safety electrical rules for safe practices.

VI Relevant Theoretical Background (With diagrams if required

The resistance offered to the leakage from conductors to earth is known as insulation resistance between the wiring and earth. The value of insulation resistance is very high and it is in mega ohms. Megger or insulation tester is used to measure the insulation resistance. Insulation resistance is measured to know whether the wires or cables using in electrical installation are sufficiently insulated to avoid leakage of current.

VII Actual Circuit diagram used in laboratory with equipment Specifications:

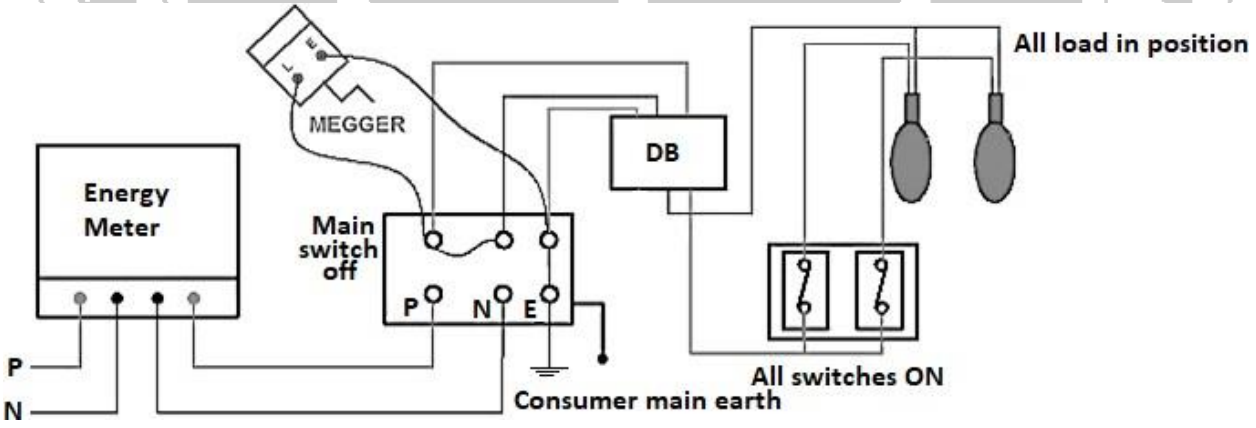

Fig. 13.1 Insulation resistance between wiring (conductor) and earth

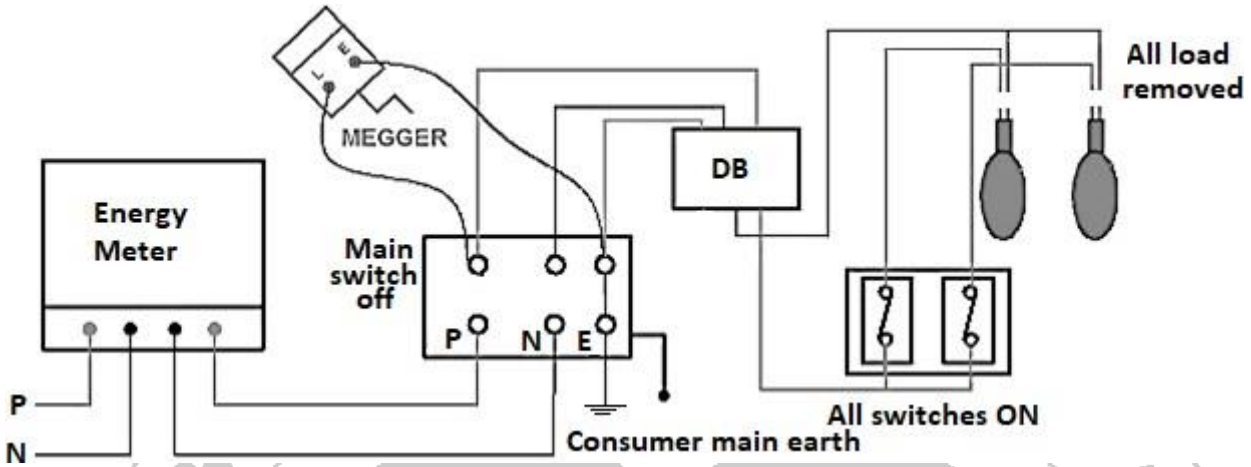

Fig. 13.2 Insulation resistance between wiring (conductor)

VIII Required Resources/apparatus/equipment with specification

S. No.	Name of Resource	Suggested Broad Specification	Quantity
1	Megger	500 V or 1000V Hand Driven	1 No.

IX Precautions to be followed

1. The megger should not be used on live system.
2. The handle of the megger should be rotated in clockwise direction.
3. Don't touch the terminals of megger while conducting a test; otherwise it will give an electric shock.
4. Rotate the handle of megger at its rated speed.
5. Keep the megger in horizontal position while operation.

X Procedure

a) Insulation resistance between wiring and earth

1. Keep the main switch in OFF position.
2. Take out the main fuse.
3. Keep all other fuses in position.
4. Keep all the switches in ON position.
5. All the lamp should be connected or the lamp holders should be short circuited

6. Short the line and neutral terminal of the electrical installation
7. Connect the L terminal of megger to conductor under test as shown in Fig.
8. Connect the E terminal of megger to earth.
9. Rotate the handle of megger at its rated speed.
10. Observe the reading.
11. Note down the reading in observation table.
12. Repeat the steps for other conductors.

b) Insulation resistance between conductors

1. Keep the main switch in OFF position.
2. Take out the main fuse.
3. Keep all other fuses in position.
4. Keep all the switches in ON position.
5. Remove Short circuit between the line and neutral terminal of the electrical installation
6. All the lamp should be removed
7. Connect the L terminal of megger to conductor under test as shown in Fig.
8. Connect the E terminal of megger to earth.
9. Rotate the handle of megger at its rated speed.
10. Observe the reading.
11. Note down the reading in observation table.
12. Repeat the steps for other conductors.

XI Observations and calculations

S.N.	Connection Description	Readings	Remarks
1.			
2.			

XII Result(s)

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XIII Interpretation of results

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XIV Conclusion and recommendation

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XV Practical related questions (Provide space for answers)

(Teacher should provide various questions related to practical- sample given)

1. Define insulation resistance.
2. State the purpose of measuring insulation resistance of installation.
3. What is the value of insulation resistance?
4. Does the cranking affect the megger reading
5. State the meaning of zero and infinity reading of megger

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XVI References/Suggestions for further reading

1. A course in Electrical Installation Estimation and Costing J. B. Gupta

XVII Suggested Assessment Scheme

	Performance Indicators	Weightage
	Process Related : 30 Marks	**60 %**
1	Handling of the components	10%
2	Identification of components	20%
3	Measuring value using suitable instrument	20%
4	Working in teams	10%
	Product Related: 20 Marks	**40%**
5	Calculated theoretical values of given component	10%
6	Interpretation of result	05%
7	Conclusions	05%
8	Practical related questions	15%
9	Submitting the journal in time	05%
	Total (50 Marks)	**100 %**

Marks Obtained			**Dated signature of teacher**
Process Related (30)	**Product Related (20)**	**Total (50)**	

Practical No. 14: Dielectric strength test of given insulating oil sample

I Practical Significance

Oil in the transformer is revealed to mechanical and electrical stress after some years. And also absorbs moisture, dirt, and dust from environment. Due to prolong service of transformer, oil tends to deteriorate. Therefore, regular testing of transformer oil is essential to avoid breakdown and to extend the service of transformer

II Industry/Employer Expected Outcome(s)

Carry out wiring and maintenance activities using relevant materials, tools and safety practices.

III Course Level Learning Outcome(s)

Select relevant insulating material.

IV Laboratory Learning Outcome(s)

Test insulating oil for its dielectric strength.

V Relevant Affective Domain related outcome(s)

Follow safety electrical rules for safe practices.

VI Relevant Theoretical Background (With diagrams if required):

Insulating oil is used in transformers, oil immersed switch gear, circuit breakers, oil filled capacitors, tap changers, and fuses as insulating/cooling/dielectric/arc quenching medium. The important properties of insulating oil are Low viscosity, Low pour point, High flash point, excellent chemical stability and high dielectric strength. High dielectric strength ensures good insulation of electrical conductors and prevention of arcing between electrodes under the voltage stresses encountered in normal insulating oil service. Low dielectric strength may result in many causes, the most common of which is foreign particles or fibers and water in combination. Individually their effect may be relatively small, but together a contamination of only a few parts in a million can cause considerable lowering of the breakdown voltage of the oil. High acidity, sludge and free water should not be tolerated, but will not necessarily reduce the dielectric strength below acceptable or specified levels. Dielectric strength of oil is measured in kV/mm using oil testing kit shown in Fig. 14.1, whose circuit diagram is shown in Fig. 14.2. Indian standard IS. 6792: 1972 covers a method for determination of electric strength of insulating oils.

VII Actual Circuit diagram used in laboratory with equipment Specifications

Fig. 14.1 Oil Testing Kit

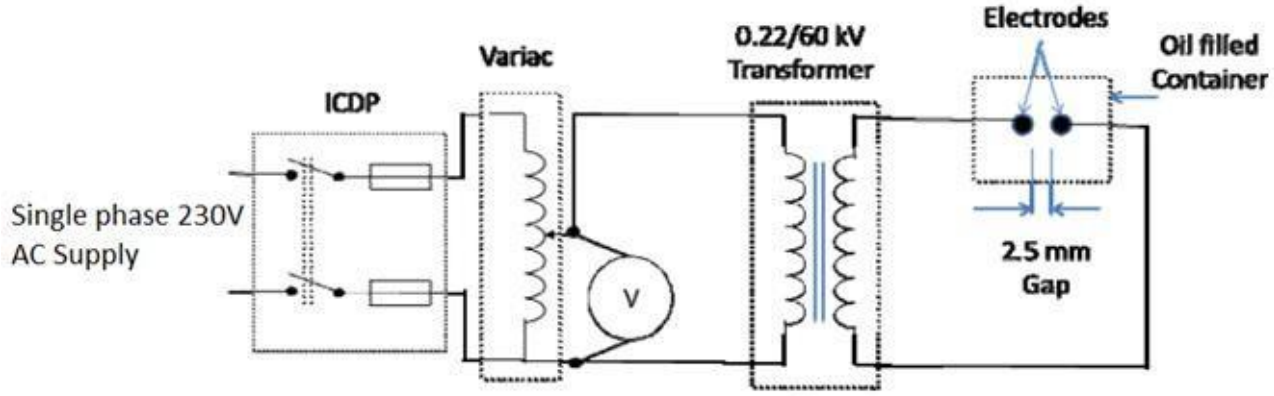

Fig. 14.2 Circuit Diagram for Oil Testing

VIII Required Resources/apparatus/equipment with specification

S. No.	Name of Resource	Suggested Broad Specification	Quantity
1	Oil testing kit	Standard	1 No.
2	Oil samples		As required

IX Precautions to be followed

1. Read the instruction manual before using kit.
2. Follow instruction given by manufacturer.
3. Don't use a dusty or fibrous cloth for cleaning the test cell as it may have loose dust or fibres.
4. Pour test oil into the test cell slowly to avoid formation air bubbles.
5. The test should be carried out in a dry place free from dust.

X Procedure

1. Fill the test cell with sample of oil to be tested. The quantity will be as recommended by the manufacturer.
2. Stir the oil properly if bubbles are present in oil.
3. Put the test cell inside the testing unit.
4. Switch "ON" the kit.
5. Raise the voltage uniformly till the breakdown of oil occurs.
6. Record that voltage of breakdown.
7. Repeat the above procedure for three to six times (with fresh sample every time).
8. Repeat the above procedure for various oil samples.
9. The testing shall be done as per as per IS. 6792: 1972
10. Switch off the test kit.
11. Calculate the average value.

XI Observations and calculations

Oil Sample for test	Dielectric Strength (kV)	Average Reading
Sample 1 sample taken from	1.	
	2.	
	3.	
	4.	
	5.	
Sample 2 sample taken from	1.	
	2.	
	3.	
	4.	
	5.	

XII Result(s)

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XIII Interpretation of results

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XIV Conclusion and recommendation

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XV Practical related questions (Provide space for answers)

(Teacher should provide various questions related to practical- sample given)

1. State the effect of temperature on dielectric strength of oil.
2. State the desirable properties of transformer oil
3. How will you identify good transformer oil from physical appearance?
4. Compare the physical appearance of Transformer oil before and after testing

[Space for answers]

XVI References/Suggestions for further reading

1. http://questin.org/sites/default/files/standards/is.6792.1992 0.pdf, assessed on 15th April, 2018
2. https://www.electrical4u.com/transformer-insulating-oil-and-types-of-transformer• oil/ , assessed on 15th April, 2018

XVII Suggested Assessment Scheme

	Performance Indicators	Weightage
	Process Related : 30 Marks	**60 %**
1	Handling of the components	10%
2	Identification of components	20%
3	Measuring value using suitable instrument	20%
4	Working in teams	10%
	Product Related: 20 Marks	**40%**
5	Calculated theoretical values of given component	10%
6	Interpretation of result	05%
7	Conclusions	05%
8	Practical related questions	15%
9	Submitting the journal in time	05%
	Total (50 Marks)	**100 %**

Marks Obtained			Dated signature of teacher
Process Related (30)	**Product Related (20)**	**Total (50)**	

Practical No. 15: Preparation of staircase wiring and its testing.

I Practical Significance

Properly installed electrical wiring provides long service, less maintenance and safety. Therefore, it is necessary to perform wiring practice.

II Industry/Employer Expected Outcome(s)

Carry out wiring and maintenance activities using relevant materials, tools and safety practices.

III Course Level Learning Outcome(s)

Perform different types of electrical wiring and cabling activities.

IV Laboratory Learning Outcome(s):

LLO1: Carry out staircase wiring.

LLO2: Test the working of staircase wiring.

V Relevant Affective Domain related outcome(s)

Follow safety electrical rules for safe practices.

VI Relevant Theoretical Background (With diagrams if required)

Staircase wiring refers to the arrangement and installation of electrical wiring and switches in a staircase area. It enables the control of lights at different floors or levels of a building from multiple switch locations, ensuring ease of use and energy efficiency. With staircase wiring, users can conveniently switch on or off the lights at various points along the staircase, avoiding the need to traverse the entire staircases to control the lighting.

VII Actual Circuit diagram used in laboratory with equipment Specifications:

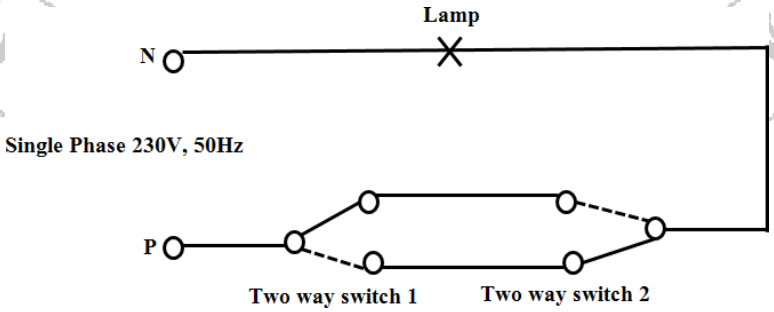

Fig. 15.1 Circuit Diagram

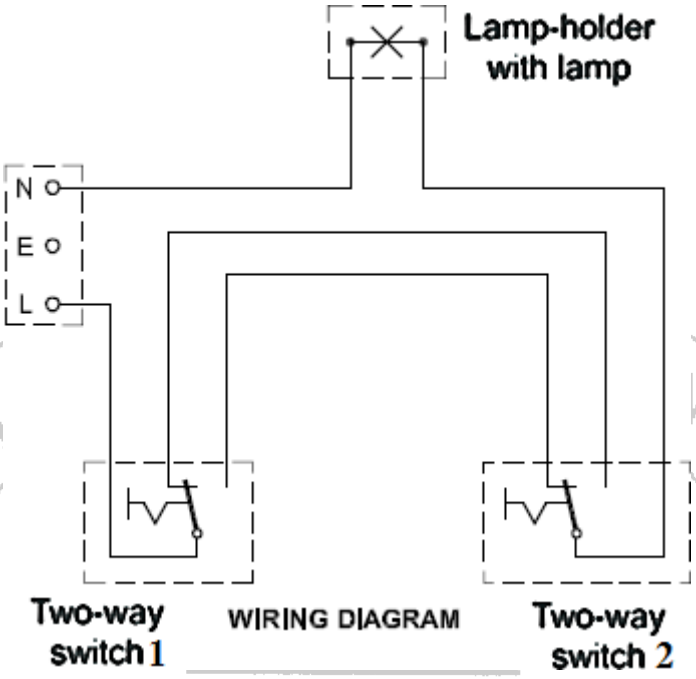

Fig. 15.2 Wiring Diagram

VIII Required Resources/apparatus/equipment with specification

S. No.	Name of Resource	Suggested Broad Specification	Quantity
1	Wooden / PVC board	Standard	1 Nos.
2	Two way switches	6A, 230V	2 Nos.
3	Lamp holder	6A, 230V	1 Nos.
4	Lamp	40 Watts	1 Nos.
5	Combination pliers	200 mm	1 Nos.
6	Screwdriver	200 x 5 mm	1 Nos.
7	Wire	1.5 mm^2	2 meter

IX Precautions to be followed

1. Select proper switches.
2. Handle tools carefully.
3. Make sure all connection should be tight.

X Procedure:

1. Mark the layout on the wiring board.
2. Position the accessories on the top cover of modular box close the open holes with strips (if any)
3. Prepare the end termination of the wires as per the wiring diagram.
4. Terminate the cables in the batten holders and fix them.
5. Terminate the cables of the switches in the switch, and fix them.
6. Connect the supply wires in the supply terminals available.
7. Test the circuit after approval by the teacher.

XI Observations and calculations

Sr. No.	Position of Switch1	Position of Switch2	Condition of lamp
1	1	1	ON
2	1	2	OFF
3	2	1	OFF
4	2	2	ON

XII Result(s)

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XIII Interpretation of results

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XIV Conclusion and recommendation

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XV Practical related questions (Provide space for answers)

1. What are the various components required for two-lamp control from two different places?
2. Draw the wiring diagram and circuit diagram for Three-Lamp control from three different places.

(Teacher should provide various questions related to practical- sample given)

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XVI References/Suggestions for further reading

1. K.B. Raina, S.K.Bhattacharya, "Electrical Design Estimation and Costing", New Age International Publishers, Reprint 2010, ISBN(l0): 81-224-0363-8; ISBN(l3): 978-81-224-0363-3
2. Gupta J. B., "Electrical Estimating and Costing", S. K. Kataria & Sons, New Delhi,2012, ISBN:978-93-5014-279-0

XVII Suggested Assessment Scheme

	Performance Indicators	Weightage
	Process Related : 30 Marks	**60 %**
1	Handling of the components	10%
2	Identification of components	20%
3	Measuring value using suitable instrument	20%
4	Working in teams	10%
	Product Related: 20 Marks	**40%**
5	Calculated theoretical values of given component	10%
6	Interpretation of result	05%
7	Conclusions	05%
8	Practical related questions	15%
9	Submitting the journal in time	05%
	Total (50 Marks)	**100 %**

Marks Obtained			Dated signature of teacher
Process Related (30)	**Product Related (20)**	**Total (50)**	

Practical No. 16: Preparation of godown wiring and its testing.

I Practical Significance

Properly installed electrical wiring provides long service, less maintenance and safety. Therefore, it is necessary to perform wiring practice.

II Industry/Employer Expected Outcome(s)

Carry out wiring and maintenance activities using relevant materials, tools and safety practices.

III Course Level Learning Outcome(s)

Perform different types of electrical wiring and cabling activities

IV Laboratory Learning Outcome(s)

LLO 1: Carry out godown wiring

LLO 2: test the working of godown wiring

V Relevant Affective Domain related outcome(s)

Follow safety electrical rules for safe practices.

VI Relevant Theoretical Background (With diagrams if required)

Godown is a big hall having numbers of compartments. Fig. 16.1 shows the three compartment godown having three lamps in each compartment, which are to be controlled such that as a person moves from one compartment to other in either direction the switch ON one lamp after the other and lamp switch ON earlier is switched off. Such an arrangement is called as godown wiring. In godown wiring one single pole switch at entrance is required. The two way switches required are number of compartment minus one.

VII Actual Circuit diagram used in laboratory with equipment Specifications:

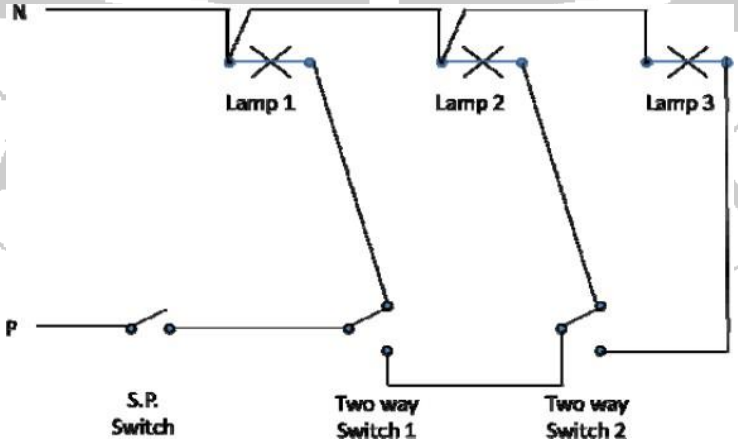

Fig. 16.1 Godown Wiring Circuit Diagram

VIII Required Resources/apparatus/equipment with specification

S. No.	Name of Resource	Suggested Broad Specification	Quantity
1	Wooden / PVC board	Standard	1 Nos.
2	One way switch	6A, 230V	1 Nos.
3	Two way switches	6A, 230V	2 Nos.
4	Lamp holder	6A, 230V	3 Nos.
5	Lamp	40 Watts	3 Nos.
6	Combination pliers	200 mm	1 Nos.
7	Screwdriver	200 x 5 mm	1 Nos.
8	Wire	1.5 mm^2	2 meter

IX Precautions to be followed:

1. Select proper switches.
2. Handle tools carefully.
3. Make sure all connection should be tight.

X Procedure

1. Mark the layout on the wiring board.
2. Position the accessories on the top cover of modular box close the open holes with strips (if any)
3. Prepare the end termination of the wires as per the wiring diagram.
4. Terminate the cables in the batten holders and fix them.
5. Terminate the cables of the switches in the switch, and fix them.
6. Connect the supply wires in the supply terminals available.
7. Test the circuit after approval by the teacher.

XI Observations and calculations

Sr. No.	Switch 1	Switch 2	Switch 3	Lamp 1	Lamp 2	Lamp 3
1	**OFF**	**OFF**	**OFF**			
2	**ON**	**OFF**	**OFF**			
3	**ON**	**ON**	**OFF**			
4	**ON**	**ON**	**ON**			

XII Result(s)

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XIII Interpretation of results

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XIV Conclusion and recommendation

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XV Practical related questions (Provide space for answers)

(Teacher should provide various questions related to practical- sample given)

1. What are the various components required for 5 compartment godown wiring?
2. Draw the wiring diagram and circuit diagram for Three-Lamp control from Three different places.

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XVI References/Suggestions for further reading:

1. K.B. Raina, S.K.Bhattacharya, "Electrical Design Estimation and Costing", New Age International Publishers, Reprint 2010, ISBN(l0): 81-224-0363-8; ISBN(l3): 978-81-224-0363-3
2. Gupta J. B., "Electrical Estimating and Costing", S. K. Kataria & Sons, New Delhi,2012, ISBN:978-93-5014-279-0

XVII Suggested Assessment Scheme

	Performance Indicators	Weightage
	Process Related : 30 Marks	**60 %**
1	Handling of the components	10%
2	Identification of components	20%
3	Measuring value using suitable instrument	20%
4	Working in teams	10%
	Product Related: 20 Marks	**40%**
5	Calculated theoretical values of given component	10%
6	Interpretation of result	05%
7	Conclusions	05%
8	Practical related questions	15%
9	Submitting the journal in time	05%
	Total (50 Marks)	**100 %**

Marks Obtained			**Dated signature of teacher**
Process Related (30)	**Product Related (20)**	**Total (50)**	

Practical No. 17: Preparation of switch board containing four switch, four socket arrangement (with MCB, indicator etc.)

I Practical Significance

Switch board wiring is very important. Improper connections of neutral and live (phase) wire in a switch board is dangerous and leads to electric shock while maintenance work.

II Industry/Employer Expected Outcome(s)

Carry out wiring and maintenance activities using relevant materials, tools and safety practices.

III Course Level Learning Outcome(s)

Perform different types of electrical wiring and cabling activities.

IV Laboratory Learning Outcome(s):

LLO1: Carry out switch board wiring.

LLO2: Test the working of switch board.

V Relevant Affective Domain related outcome(s)

Follow safety electrical rules for safe practices.

VI Relevant Theoretical Background (With diagrams if required)

While specifying the boards for wiring installation, the following particulars shall be given.

1. Material of the board - wood, PVC or metal.
2. Size - length, breadth and height in mm.
3. Thickness of the material in mm.
4. Single or double (double-hinged or non-hinged type).
5. Additional information like type of finish on wooden boards, colour of PVC or metal boards, surface of flush mounting, etc.

Now a days wooden or sunmica boards are not used in wiring. Modular metal boards are used in concealed wiring; however PVC modular boards shown in Fig. are used in surface wiring.

Fig. 17.1 modular PVC board

Colour identification of cables.

The colour of the cables indicates their function. Every electrician should be able to identify the colour code used in electrical work and follow it meticulously to avoid hazards. Following table gives the colour code and the alpha-numeric notation as recommended by N.E. code.

Alpha-numeric notation and colours

Designation of conductors		**Identification by**	
		Alpha-numeric notation	**Colour**
Supply AC System	Phase 1	L1	Red
	Phase 2	L2	Yellow
	Phase 3	L3	Blue
	Neutral	N	Black
Protective Conductor		E	Green

VII Actual Circuit diagram used in laboratory with equipment Specifications:

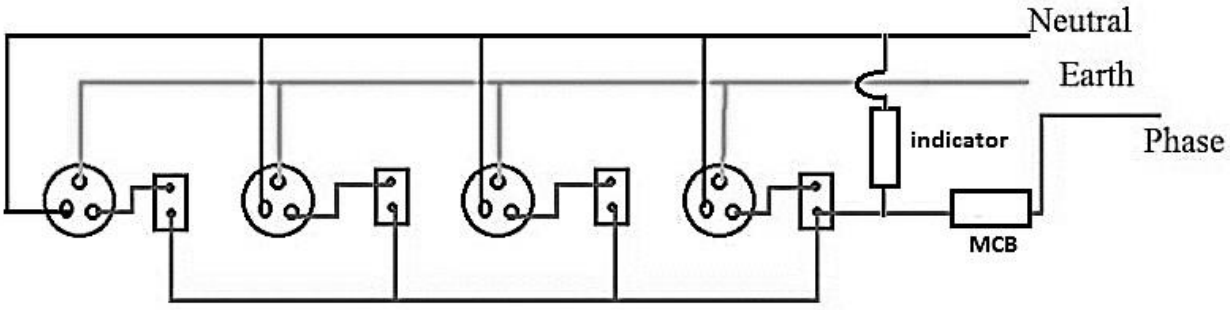

Fig17.2 Switch board wiring diagram

VIII Required Resources/apparatus/equipment with specification

S. No.	Name of Resource	Suggested Broad Specification	Quantity
1	Wooden / PVC modular board	Standard	1 Nos.
2	Single pole switch	6A, 240V	4 Nos.
3	Socket 5 pin	6A, 240V	4 Nos.
4	MCB	2A, 240V	1 Nos.
5	Indicator	240V	1 Nos.
6	Combination pliers	200 mm	1 Nos.
7	Screwdriver	200 x 5 mm	1 Nos.
8	PVC wire of red, black and green colour	1.5 mm^2	3 meter

IX Precautions to be followed:

1 Always place fuse in incoming live wire.

2 Switch should be connected in live wire.

3 Always connect a neutral in a socket at our left hand side terminal

4 Make sure all connection should be tight.

5 Follow colour code of wires.

X Procedure

1. Select proper module board as per requirement. (One module is required for switch, fuse and indicator and two modules are required for 6 A socket outlet).
2. Fix the accessories on the board.
3. Close remaining holes with modular board strips.
4. Measure and cut cables for connections according to requirement. Use the BIS recommended colour code for cable connections with in the board.
5. Wire up the board.
6. Connect the earth wire with socket outlets.
7. Complete the board.
8. Check the connection and approved the board from teacher.
9. Connect upper plate to the box with screws.
10. Test the board with test lamp.

XI Observations and calculations

Draw the wiring diagram

XII Result(s)

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XIII Interpretation of results

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XIV Conclusion and recommendation

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XV Practical related questions (Provide space for answers)

(Teacher should provide various questions related to practical- sample given)

1. State the function of Neon lamp on board.
2. State the function of MCB on board

XVI References/Suggestions for further reading

1. K.B. Raina, S.K.Bhattacharya, "Electrical Design Estimation and Costing", New Age International Publishers, Reprint 2010, ISBN(l0): 81-224-0363-8; ISBN(l3): 978-81-224-0363-3
2. Gupta J. B., "Electrical Estimating and Costing", S. K. Kataria & Sons, New Delhi,2012, ISBN:978-93-5014-279-0

XVII Suggested Assessment Scheme

	Performance Indicators	Weightage
	Process Related : 30 Marks	**60 %**
1	Handling of the components	10%
2	Identification of components	20%
3	Measuring value using suitable instrument	20%
4	Working in teams	10%
	Product Related: 20 Marks	**40%**
5	Calculated theoretical values of given component	10%
6	Interpretation of result	05%
7	Conclusions	05%
8	Practical related questions	15%
9	Submitting the journal in time	05%
	Total (50 Marks)	**100 %**

Marks Obtained			**Dated signature of teacher**
Process Related (30)	**Product Related (20)**	**Total (50)**	

Practical No. 18: LED tube light mounting, testing and fault finding.

I Practical Significance:

It is essential to observe safety while working with electrical installation, appliance, panel etc. The knowledge of safety accessories & procedures to be followed while performing the electrical work is essential for human life as well as the quality & life of machine/equipment/wires & cables.

II Industry/Employer Expected Outcome(s)

Carry out wiring and maintenance activities using relevant materials, tools and safety practices.

III Course Level Learning Outcome(s)

Perform different types of electrical wiring and cabling activities.

IV Laboratory Learning Outcome(s)

LLO Fix and test LED tube.

V Relevant Affective Domain related outcome(s)

Follow safety electrical rules for safe practices.

VI Relevant Theoretical Background (With diagrams if required)

What is an LED Tube light?

An LED tube light is a modern lighting solution that utilizes Light Emitting Diodes (LEDs) to produce light. LED tube lights offer enhanced energy efficiency, longevity, and superior lighting quality. These lights are composed of small semiconductor diodes that emit light when an electrical current passes through them. LED tube lights come in various sizes and configurations, providing flexibility in brightness levels and colour temperatures.

How to Install an LED Tube Light?

Here are the steps you need to follow to install an LED tube light:

Step 1: Turn off power

Before starting the installation, ensure safety by turning off the circuit breaker. Once the power is off, carefully remove the existing fluorescent tube by gently twisting it out of the fixture. Set it aside safely, and then inspect the fixture for any loose wires.

Step 2: Remove the tube light fixture if you are replacing a fluorescent tube light

LED battens do not operate on fluorescent tube light fixtures. Remove the fixture and clear the space for the LED tube to function optimally. You can do it by disconnecting the power wires from the fixture and remove the fixture by detaching any screws or clips.

Step 3: Wiring the LED tube light

Wiring process for single-ended and double-ended LED tubes:

Single-ended tubes: These have one powered end. Connect the live and neutral wires from the fixture to the corresponding end of the LED tube. The other end remains unpowered.

Double-ended tubes: Both ends of these tubes are powered. Connect live and neutral wires from one end of the fixture to one end of the LED tube and repeat for the other end.

Step 4: Install the LED tube

Now, fix the LED batten onto the wall by aligning the pins on each end. Ensure it is properly seated and secure. Inspect the wiring to confirm that all connections are secure and correctly aligned.

Step 5: Do the final checks

Once the installation is complete, turn the circuit breaker back on to restore power to the fixture. Test the newly installed LED tube by switching it on. Ensure that it lights up without flickering. If any problems arise, revisit the installation steps to identify and rectify the issue.

Advantages of switching to LED tube lights

Switching to LED tube lights presents a range of compelling advantages. These lights are significantly more energy-efficient as they consume less power while emitting brighter light. Their extended lifespan far surpasses traditional fluorescent tubes, reducing maintenance and replacement costs.

Testing and fault finding

- **Internal Wiring and Connections:** HQTS will inspect the internal wiring and connections within the LED light. Loose or poorly connected wires can lead to performance issues and safety concerns.
- **Voltage check:** During the inspection we will measure the voltage stability of the LED light during operation. Fluctuations in voltage can lead to flickering or premature failure. Ensure that the LED light operates within the specified voltage range.
- **Overcharge Check (if applicable):** For LED lights with rechargeable batteries, HQTS will check if they have overcharge protection mechanisms in place. Overcharging can reduce battery lifespan and pose safety risks.
- **Luminosity and Brightness:** Measure the luminosity and brightness of the LED light. Ensure it meets the specified lumen output and maintains consistent brightness without flickering.
- **Color Temperature:** Verify that the LED light emits light at the correct color temperature, adhering to the manufacturer's specifications.

- **Dimming Performance:** Test LED light's dimming capabilities, if applicable. Ensure smooth and flicker-free dimming across the entire range.
- **Color Consistency:** Check for color consistency across multiple LED lights of the same model.
- **Flickering Test:** Observe that the LED light for any flickering or pulsing during operation, especially at different dimming levels and temperatures.

VII Actual Circuit diagram used in laboratory with equipment Specifications:

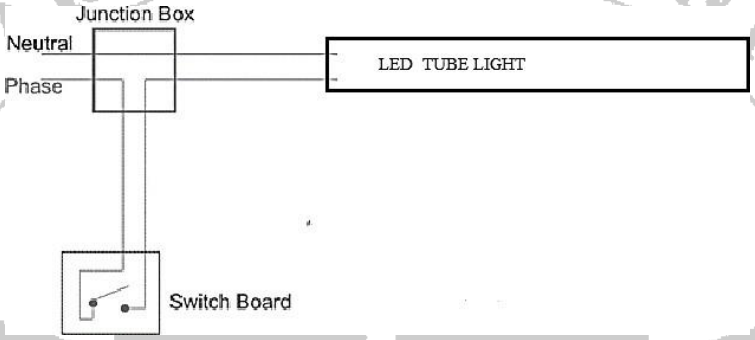

Fig. 18.1 LED tube light connection

VIII Required Resources/apparatus/equipment with specification:

S. No.	Name of Resource	Suggested Broad Specification	Quantity
1	LED tube with mounting brackets and screws	18/20 Watt, 230V	1 No.
2	Recommendations on Safety Procedures and Practices in Electrical Work, Part I: General	IS 5216 (Part 1)	1 No.
3	Rubber Insulated Electrical Gloves	Working potential: 7,500V	1 No.
4	Electrical Shock Proof Safety Shoes	Insulation range- 15 to 30 KV	1 No.
5	Safety Jacket	Standard	1 No.
6	Safety Helmet	Standard	1 No.
7	Safety Belt	Standard	1 No.
8	Safety Goggles	Standard	1 No.

IX Precautions to be followed:

1. Make sure the power is off at the breaker before you start and use a voltage tester to verify that.
2. Make sure you have all the appropriate tools, including pliers, wire cutters, cable & wire stripper, fish & colored tape, voltage tester, continuity tester.

X Procedure

For fixing the LED tube light

1. Remove the LED cover.
2. Drill appropriate mounting holes in the wall.
3. Secure the lights onto the wall using screws.
4. Connect the wires carefully, ensuring safety and proper insulation.
5. Switch on the supply and check LED tube light glows without any problem.

For replacing the LED tube light

1. To replace LED tubes, follow these simple steps:
2. Switch off the circuit breaker to ensure safety.
3. For most LED tubes, gently pull out the tube from the fixture sockets.
4. Insert the new LED tube into the fixture sockets, aligning the pins with the sockets, and ensuring a secure fit.

XI Observations and calculations

Sr. No.	Faults in LED tube light	Causes of faults

XII Result(s)

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XIII Interpretation of results

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XIV Conclusion and recommendation

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XV Practical related questions (Provide space for answers)

(Teacher should provide various questions related to practical- sample given)

1. Write construction and working of LED tube light.
2. Write different faults and their causes in LED tube lights.
3. Write different types of LED tube light testing.

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XVI References/Suggestions for further reading:

1. https://www.tutorialspoint.com/what-is-led-lamp-construction-working-advantages-and-applications

XVII Suggested Assessment Scheme

	Performance Indicators	Weightage
	Process Related : 30 Marks	**60 %**
1	Handling of the components	10%
2	Identification of components	20%
3	Measuring value using suitable instrument	20%
4	Working in teams	10%
	Product Related: 20 Marks	**40%**
5	Calculated theoretical values of given component	10%
6	Interpretation of result	05%
7	Conclusions	05%
8	Practical related questions	15%
9	Submitting the journal in time	05%
	Total (50 Marks)	**100 %**

Marks Obtained			Dated signature of teacher
Process Related (30)	**Product Related (20)**	**Total (50)**	

Practical No. 19: Power cable tracing (for machine installation in laboratory)

I Practical Significance

Every residential installation is having service connection. At the event of supply failure, knowledge of service connection and their rout is necessary to restore the electric supply.

II Industry/Employer Expected Outcome(s)

Carry out wiring and maintenance activities using relevant materials, tool and safety practices.

III Course Level Learning Outcome(s)

Perform different types of electrical wiring and cabling activities.

IV Laboratory Learning Outcome(s): Trace cable laying.

V Relevant Affective Domain related outcome(s)

Follow safety electrical rules for safe practices.

VI Relevant Theoretical Background (With diagrams if required)

The line, bringing electric power from supplier's low voltage distributor up to the energy meter installed at the consumer's premises is called the service connection. There are two types of service connection: Overhead service connection and Underground service connection. Selection of type of service connection depends on various factor i.e. aesthetic, installation cost and safety.

VII Actual Circuit diagram used in laboratory with equipment Specifications

Draw single line drawing showing the cable rout from LT substation of your college to your laboratory and details of service connection on A4 size sheet

VIII Required Resources/apparatus/equipment with specification:

S. No.	Name of Resource	Suggested Broad Specification	Quantity
1	Drawing instruments		1 No.
2	Drawing sheet	A4 size	1 No.

IX Precautions to be followed:

Don't touch any live parts while physical verification of service connection

X Procedure

1. Identify the type of service connection at home.
2. Trace the cable rout.
3. Measure the length of cable rout.
4. Identify and list various components and accessories.
5. Draw single line drawing showing the cable rout from service pole to energy meter and details of service connection on A4 size sheet.

XI Observations and calculations

List the materials used in service connection.

XII Result(s)

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XIII Interpretation of results

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XIV Conclusion and recommendation

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XV Practical related questions (Provide space for answers)

(Teacher should provide various questions related to practical- sample given)

1. List the types of service connection.
2. List the materials used in road crossing of service connection.
3. State the difference between overhead and underground service connection.

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XVI References/Suggestions for further reading:

1. http://www.lburgus.com/elec/specs/docs/single_phase_underground_service.pd[, assessed on 10th April, 2018
2. http://www.graysonrecc.com/content/service-diagrams, assessed on 10th April, 2018

XVII Suggested Assessment Scheme

	Performance Indicators	Weightage
	Process Related : 30 Marks	**60 %**
1	Handling of the components	10%
2	Identification of components	20%
3	Measuring value using suitable instrument	20%
4	Working in teams	10%
	Product Related: 20 Marks	**40%**
5	Calculated theoretical values of given component	10%
6	Interpretation of result	05%
7	Conclusions	05%
8	Practical related questions	15%
9	Submitting the journal in time	05%
	Total (50 Marks)	**100 %**

Marks Obtained			Dated signature of teacher
Process Related (30)	**Product Related (20)**	**Total (50)**	

Practical No. 20: Electrical installation testing.

I Practical Significance

It is necessary that switches are placed in live (Phase) so that by making switch off the circuit can be disconnected from the supply. To ensure that all the switches are connected in phase wire and not in neutral wire polarity test is conducted

II Industry/Employer Expected Outcome(s)

Carry out wiring and maintenance activities using relevant materials, tools and safety practices.

III Course Level Learning Outcome(s)

Perform different types of electrical wiring and cabling activities.

IV Laboratory Learning Outcome(s)

Carry out polarity test of the electrical installation of machine laboratory.

V Relevant Affective Domain related outcome(s)

Follow safety electrical rules for safe practices.

VI Relevant Theoretical Background (With diagrams if required)

It is necessary that switches are placed in live (Phase) so that by making switch off the circuit can be disconnected from the supply. If the switch is connected in neutral wire then lamp or fan will be the part of wiring and will remain alive even when the switch is in OFF position, which may lead to the accidents. As a result, a person who touches it may face a life threat as a result of some electric shock. As such, from a safety point of view, single-phase switches should always be fitted along a phase wire instead of a neutral wire. It should be remembered that apart from single phase switches, this electricity rule also applies to fuses as well as circuit breakers. To ensure that all the switches are connected in phase wire and not in neutral wire polarity test is conducted.

In polarity test all loads (e.g., fans and lamps, etc.) are disconnected from the circuit, switches are turned ON. The main switch is turned ON by fitting the main fuses. Now one end of the test lamp is connected with the neutral terminal of the main switch, whereas its other end is connected turn by turn with any one terminal of every switch as shown in figure 1. If the test lamp glows it indicates that the switch is connected in the phase wire. If the lamp does not glows it means that it is installed on the neutral instead of a phase wire.

A multimeter finds the voltage at different terminals. The multimeter has two probes, including red and black. The red probe is embedded to the line and the other to the neutral if the pointer gives any deflection, we can assume it as a Line (L). If not, check by attaching the probes to the other terminals one after the other and recognize the deflection. The multimeter type method of finding the polarity is presented in the figure below.

VII Actual Circuit diagram used in laboratory with equipment Specifications:

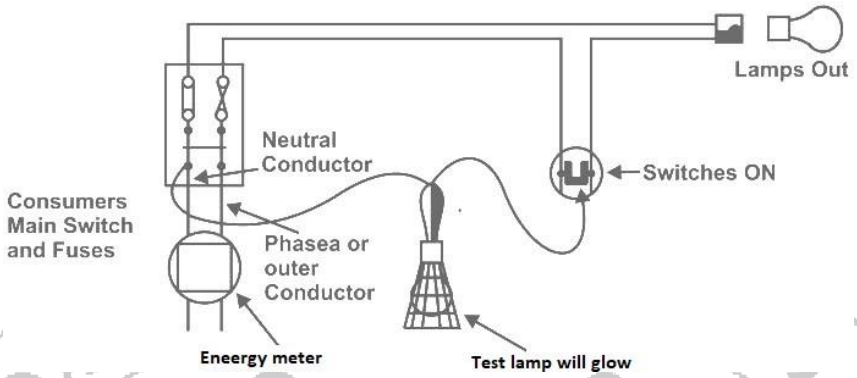

Fig. 20.1 Polarity test using test lamp

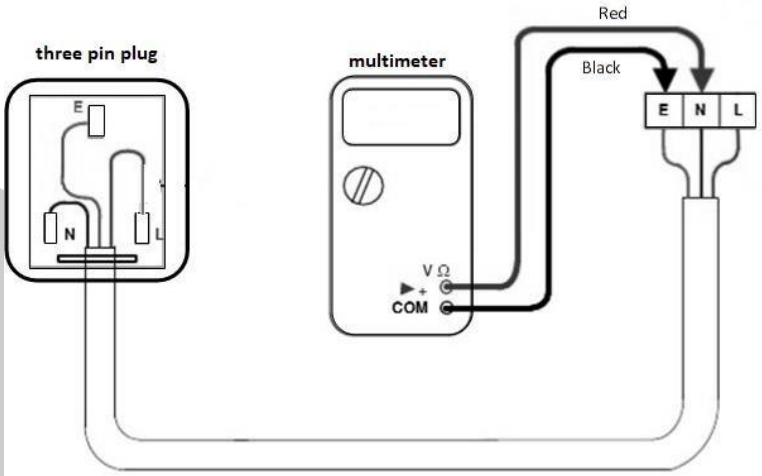

Fig. 20.2 Polarity test using multimeter

Student should draw the circuit diagram for polarity test using tester under the guidance of teacher.

VIII Required Resources/apparatus/equipment with specification

S. No.	Name of Resource	Suggested Broad Specification	Quantity
1	Test lamp		1 No.
2	Electric tester		1 No.
3	Multimeter		1 No.

IX Precautions to be followed

1. Disconnect all the connected lamps fans etc.
2. Follow safe and ethical practices

X Procedure to check polarity by using test lamp

1. Disconnect all the loads from the circuit.
2. Switches are turned ON.
3. The main switch is turned ON by fitting the main fuses.
4. One end of the test lamp is connected to neutral terminal of the main switch.
5. Other end of connected turn by turn with any one terminal of every switch.
6. Observe the test lamp
7. Note down the observation.
8. Depending upon test lamp condition comment whether switch is connected in phase or neutral

Procedure to check polarity by using multimeter

1. Set multimeter to “Voltmeter” mode.
2. Take the probes of the multimeter.
3. Insert the red probe into the outlet opening, which has a live 230V connection. Insert the black one into neutral conductor connection. If the readings appear on the screen indicating full voltage, the system is connected as per the polarity.
4. Insert the red probe into the outlet opening, which has a live 230V connection. Insert the black one into the earthing connection. If the readings appear on the screen indicating full voltage again, the system is connected as per the polarity..
5. Similarly, insert the red probe into the outlet opening, which has a earthing connection. Insert the black one into neutral terminal. If no reading appears on the screen, it is appropriately connected.

Student should develop the procedure for polarity test using tester under the guidance of teacher

XI Observations and calculations

Observation table for test lamp

Sr. No.	Connection of test lamp	Does lamp glows	Whether switch is connected in phase or neutral

Observation table for multimeter

Sr. No.	Connection of multimeter	Reading on multimeter	Comment as per readings of multimeter

Observation table for multimeter

Sr. No.	Connection of test tester	Does lamp glows	Comment whether tester is connected to phase neutral or earth

XII Result(s)

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XIII Interpretation of results

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XIV Conclusion and recommendation

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XV Practical related questions (Provide space for answers)

(Teacher should provide various questions related to practical- sample given)

1. Why polarity test is conducted?
2. Why switch is never connected in neutral?
3. What are the other methods to test the polarity?

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XVI References/Suggestions for further reading

1. K.B. Raina, S.K.Bhattacharya, "Electrical Design Estimation and Costing", New Age International Publishers, Reprint 2010, ISBN(l0): 81-224-0363-8; ISBN(l3): 978-81-224-0363-3
2. Gupta J. B., "Electrical Estimating and Costing", S. K. Kataria & Sons, New Delhi,2012, ISBN:978-93-5014-279-0

XVII Suggested Assessment Scheme

	Performance Indicators	Weightage
	Process Related : 30 Marks	**60 %**
1	Handling of the components	10%
2	Identification of components	20%
3	Measuring value using suitable instrument	20%
4	Working in teams	10%
	Product Related: 20 Marks	**40%**
5	Calculated theoretical values of given component	10%
6	Interpretation of result	05%
7	Conclusions	05%
8	Practical related questions	15%
9	Submitting the journal in time	05%
	Total (50 Marks)	**100 %**

Marks Obtained			Dated signature of teacher
Process Related (30)	**Product Related (20)**	**Total (50)**	

Practical No. 21: LT cable tracing (from LT substation transformer of your college to your laboratory)

I Practical Significance

Every installation is having service connection. At the event of supply failure, knowledge of service connection and their rout is necessary to restore the electric supply.

II Industry/Employer Expected Outcome(s)

Carry out wiring and maintenance activities using relevant materials, tool and safety practices.

III Course Level Learning Outcome(s)

Perform different types of electrical wiring and cabling activities.

IV Laboratory Learning Outcome(s)

Draw and trace LT cable

V Relevant Affective Domain related outcome(s)

Follow safety electrical rules for safe practices.

VI Relevant Theoretical Background (With diagrams if required)

The line, bringing electric power from supplier's low voltage distributor up to the energy meter installed at the consumer's premises is called the service connection. There are two types of service connection: Overhead service connection and Underground service connection. Selection of type of service connection depends on various factor i.e. aesthetic, installation cost and safety.

VII Actual Circuit diagram used in laboratory with equipment Specifications:

Draw single line drawing showing the cable route from LT substation of your college to your laboratory and details of service connection on A4 size sheet.

VIII Required Resources/apparatus/equipment with specification:

S. No.	Name of Resource	Suggested Broad Specification	Quantity
1	Drawing instruments		1 No.
2	Drawing sheet	A4 size	1 No.

IX Precautions to be followed:

Don't touch any live parts while physical verification of service connection

X Procedure

1. Identify the type of service connection at home.
2. Trace the cable route.
3. Measure the length of cable rout.
4. Identify and list various components and accessories.
5. Draw single line drawing showing the cable rout from service pole to energy meter and details of service connection on A4 size sheet.

XI Observations and calculations

List the materials used in service connection.

XII Result(s)

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XIII Interpretation of results

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XIV Conclusion and recommendation

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XV Practical related questions (Provide space for answers)

(Teacher should provide various questions related to practical- sample given)

1. List the types of service connection.
2. List the materials used in road crossing of service connection.
3. State the difference between overhead and underground service connection.

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XVI References/Suggestions for further reading:

1. K.B. Raina, S.K.Bhattacharya, "Electrical Design Estimation and Costing", New Age International Publishers, Reprint 2010, ISBN(l0): 81-224-0363-8; ISBN(l3): 978-81-224-0363-3
2. Gupta J. B., "Electrical Estimating and Costing", S. K. Kataria & Sons, New Delhi,2012, ISBN:978-93-5014-279-0

XVII Suggested Assessment Scheme

	Performance Indicators	Weightage
	Process Related : 30 Marks	**60 %**
1	Handling of the components	10%
2	Identification of components	20%
3	Measuring value using suitable instrument	20%
4	Working in teams	10%
	Product Related: 20 Marks	**40%**
5	Calculated theoretical values of given component	10%
6	Interpretation of result	05%
7	Conclusions	05%
8	Practical related questions	15%
9	Submitting the journal in time	05%
	Total (50 Marks)	**100 %**

Marks Obtained			**Dated signature of teacher**
Process Related (30)	**Product Related (20)**	**Total (50)**	

Practical No. 22: Preparation of electrical wire joints (simple twist, married, Tee and western union joints)

I Practical Significance

Joints in electrical conductors are necessary to extend the cables, overhead lines, and also to tap the electricity to other branch loads wherever required.

II Industry/Employer Expected Outcome(s)

Use different electrical safety accessories and follow safe practices

III Course Level Learning Outcome(s)

Perform different types of electrical wiring and cabling activities.

IV Laboratory Learning Outcome(s)

LLO Carry out electrical joints

V Relevant Affective Domain related outcome(s)

Follow safety electrical rules for safe practices.

VI Relevant Theoretical Background (With diagrams if required)

A joint in an electrical conductor means connecting/tying or interlaying together of two or more conductors such that union/junction becomes secured both electrically and mechanically. In electrical work, different types of joints are used, based on the requirement. The service to be performed by a joint determines the type to be used. Some commonly used joints are, pig-tail or rat-tail or twisted joint, married joint, tee joint, Britannia straight joint, Britannia tee joint, western union joint, scarfed joint and tap joint in single stranded conductor.

VII Actual Circuit diagram used in laboratory with equipment Specifications:

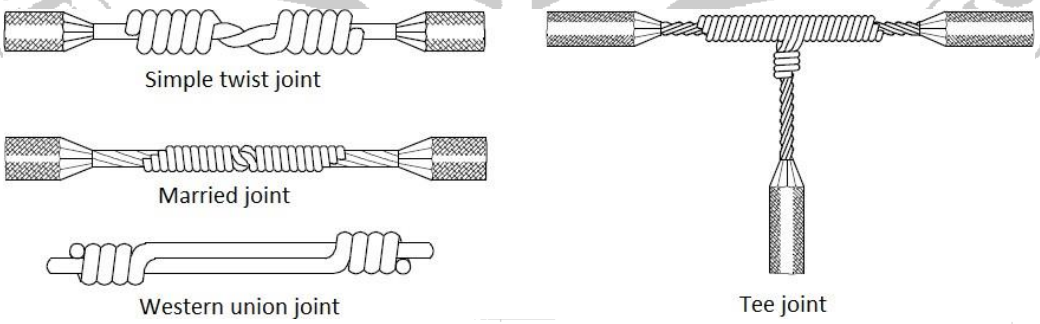

Fig. 22.1 Different types of joints

VIII Required Resources/apparatus/equipment with specification:

S. No.	Name of Resource	Suggested Broad Specification	Quantity
1	Stranded conductor	Various sizes	As required
2	Bare conductor	Various sizes	As required
3	Single stranded conductor	Various sizes	As required
4	Combination Plier	200mm	**1** No.
5	Wire stripper / electrician knife	Standard size	1 No.
6	Long nose plier	200mm	**1** No.
7	Soldering iron	Standard size	1 No.
8	Soldering wire and flux		As required
9	Insulation Tape	PVC	As required
10	Steel rule	150mm	1 No.

IX Precautions to be followed:

Handle tools carefully.

X Procedure

1. Remove insulation over the wire using electrician knife or wire stripper (for insulated wire joints).
2. Prepare joint.
3. Solder joint properly.
4. Insulate joint using insulation tape (for insulated wire joints).

XI Observations and calculations

Draw neat sketch of different types of joints.

XII Result(s)

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XIII Interpretation of results

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XIV Conclusion and recommendation

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XV Practical related questions (Provide space for answers)

(Teacher should provide various questions related to practical- sample given)

1. State necessity of wire joints.
2. State where following simple twist joint, married joint, Tee joint and Western union joint are used.
3. State the necessity of soldering the joint.

XVI References/Suggestions for further reading:

1. Gupta J.B., "Electrical Estimating and Costing", S. K. Kataria & Sons, New Delhi,2012, ISBN:978-93-5014-279-0

XVII Suggested Assessment Scheme

Performance Indicators		Weightage
Process Related : 30 Marks		**60 %**
1	Handling of the components	10%
2	Identification of components	20%
3	Measuring value using suitable instrument	20%
4	Working in teams	10%
Product Related: 20 Marks		**40%**
5	Calculated theoretical values of given component	10%
6	Interpretation of result	05%
7	Conclusions	05%
8	Practical related questions	15%
9	Submitting the journal in time	05%
Total (50 Marks)		**100 %**

Marks Obtained			Dated signature of teacher
Process Related (30)	**Product Related (20)**	**Total (50)**	

Practical No. 23: Preparation of electrical wire joints (Britannia straight, Britannia tee and rat tail joints)

I Practical Significance

Joints in electrical conductors are necessary to extend the cables, overhead lines, and also to tap the electricity to other branch loads wherever required.

II Industry/Employer Expected Outcome(s)

Use different electrical safety accessories and follow safe practices.

III Course Level Learning Outcome(s)

Perform different types of electrical wiring and cabling activities

IV Laboratory Learning Outcome(s)

LLO Carry out electrical joints

V Relevant Affective Domain related outcome(s)

Follow safety electrical rules for safe practices.

VI Relevant Theoretical Background (With diagrams if required)

A joint in an electrical conductor means connecting/tying or interlaying together of two or more conductors such that union/junction becomes secured both electrically and mechanically. In electrical work, different types of joints are used, based on the requirement. The service to be performed by a joint determines the type to be used. Some commonly used joints are, rat-tail or twisted joint, Britannia straight joint, Britannia tee joint.

VII Actual Circuit diagram used in laboratory with equipment Specifications:

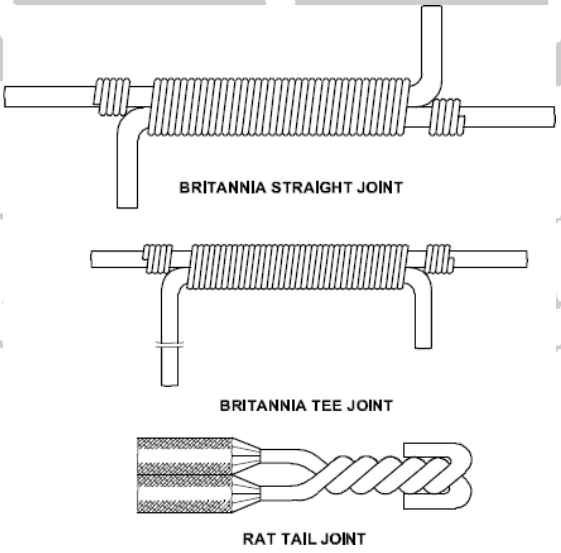

Fig 23.1 Different types of joints

VIII Required Resources/apparatus/equipment with specification

S. No.	Name of Resource	Suggested Broad Specification	Quantity
1	Stranded conductor	Various sizes	As required
2	Bare conductor	Various sizes	As required
3	Single stranded conductor	Various sizes	As required
4	Combination Plier	200mm	**1** No.
5	Wire stripper / electrician knife	Standard size	1 No.
6	Long nose plier	200mm	**1** No.
7	Soldering iron	Standard size	1 No.
8	Soldering wire and flux		As required
9	Insulation Tape	PVC	As required
10	Steel rule	150mm	1 No.

IX Precautions to be followed

1. Handle tools carefully.

X Procedure

1. Remove insulation over the wire using electrician knife or wire stripper (for insulated wire joints).
2. Prepare joint.
3. Solder joint properly.
4. Insulate joint using insulation tape (for insulated wire joints).

XI Observations and calculations

Draw neat sketch of different types of joints

XII Result(s)

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XIII Interpretation of results

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XIV Conclusion and recommendation

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XV Practical related questions (Provide space for answers)

(Teacher should provide various questions related to practical- sample given)

1. State different types of joints.
2. State where following Britannia straight joint, Britannia tee and rat tail joints are used.
3. State the necessity of soldering the joint.

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XVI References/Suggestions for further reading:

1. Gupta J.B., "Electrical Estimating and Costing", S. K. Kataria & Sons, New Delhi,2012, ISBN:978-93-5014-279-0

XVII Suggested Assessment Scheme

Performance Indicators		Weightage
Process Related : 30 Marks		**60 %**
1	Handling of the components	10%
2	Identification of components	20%
3	Measuring value using suitable instrument	20%
4	Working in teams	10%
Product Related: 20 Marks		**40%**
5	Calculated theoretical values of given component	10%
6	Interpretation of result	05%
7	Conclusions	05%
8	Practical related questions	15%
9	Submitting the journal in time	05%
Total (50 Marks)		**100 %**

Marks Obtained			Dated signature of teacher
Process Related (30)	**Product Related (20)**	**Total (50)**	

Practical No. 24: Lug crimping for cable leads

I Practical Significance

Lugs or connectors are used at the cable ends, when permanent, direct fastening methods are not feasible or necessary. Cables are connected to bus bars with the help of lugs and nut-bolts.

II Industry/Employer Expected Outcome(s)

Use different electrical safety accessories and follow safe practices.

III Course Level Learning Outcome(s)

Perform different types of electrical wiring and cabling activities.

IV Laboratory Learning Outcome(s)

Carry out lug crimping for cable.

V Relevant Affective Domain related outcome(s)

Follow safety electrical rules for safe practices.

VI Relevant Theoretical Background (With diagrams if required)

The word crimping in this context means to join two pieces of metal together by deforming one or both of them to hold the other. The deformity is called the crimp. The cable conductors are joined to bus bar or distribution box using a special connector known as cable lug. Stripped wire (often stranded) is inserted through the correctly sized opening of the connector, and a crimper is used to tightly squeeze the opening against the wire. Depending on the type of connector used, it may be attached to a metal plate by a separate screw or bolt or it could be simply screwed on using the connector. An electrical connector is a device for joining electrical circuits together using a mechanical assembly. The connection may be temporary or serve as a permanent electrical joint between two wires. There are hundreds of types of electrical connectors. Connectors may join two lengths of wire together or connect a wire to an electrical terminal.

VII Actual Circuit diagram used in laboratory with equipment Specifications:

Fig. 24.1 Various types of Lugs

Fig 24.2 Crimping tool

VIII Required Resources/apparatus/equipment with specification:

S. No.	Name of Resource	Suggested Broad Specification	Quantity
1	Measurement tape	3 m size	1 No.
2	Electricians Knife	Regular size	5 No.
3	Cable/wire Pieces	Various sizes	As required
4	Hand Crimp tool kit	For cable size of 2.5 to 16 sqmm	1 set
5	Lugs/ Connector of different size	Various sizes as per cable size	As required

IX Precautions to be followed:

1. Take care to prevent cutting of wire conductors, uneven stripping length and insufficient cutting of the insulation.
2. Ensure the strands do not spray come apart.
3. Do not excessively twist the strands.
4. Use proper size of the lug according to size of cable

X Procedure

1. Select the cable of appropriate size.
2. Select the lug of the proper size.
3. Measure the dimensions of cable and lug.
4. Remove the insulation of the cable as per the measured dimension.
5. Both cable conductor and compression crimp should be cleaned down using cable cleaning wipes.
6. Check size, shape and metal (copper or aluminum) must be correct for the cable conductor.
7. Select correct crimp die set.
8. Check cable conductor is be fully inserted into the crimp connector

Note: The correct compression or crimping sequence must be followed and the full compression pressure applied.

XI Observations and calculations

Not applicable

XII Result(s)

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XIII Interpretation of results

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XIV Conclusion and recommendation

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XV Practical related questions (Provide space for answers)

(Teacher should provide various questions related to practical- sample given)

1. List various types of lugs.
2. State precautions while crimping process.
3. Name the materials used to make connectors.
4. What will happen when connector is loosely tighten?

XVI References/Suggestions for further reading:

1. www.electrical4u.com
2. www.howstuffworks.com
3. www.electricaltechnology.org
4. www.electrical-installation.org

XVII Suggested Assessment Scheme

Performance Indicators		Weightage
Process Related : 30 Marks		**60 %**
1	Handling of the components	10%
2	Identification of components	20%
3	Measuring value using suitable instrument	20%
4	Working in teams	10%
Product Related: 20 Marks		**40%**
5	Calculated theoretical values of given component	10%
6	Interpretation of result	05%
7	Conclusions	05%
8	Practical related questions	15%
9	Submitting the journal in time	05%
Total (50 Marks)		**100 %**

Marks Obtained			Dated signature of teacher
Process Related (30)	**Product Related (20)**	**Total (50)**	

Practical No. 25: Preparation of PVC casing capping conduit wiring for minimum four points of 3 m length

I Practical Significance

Properly installed electrical wiring provides long service, less maintenance and safety. Therefore, it is necessary to perform wiring practice.

II Industry/Employer Expected Outcome(s)

Carry out wiring and maintenance activities using relevant materials, tools and safety practices

III Course Level Learning Outcome(s)

Perform different types of electrical wiring and cabling activities.

IV Laboratory Learning Outcome(s)

LLO Carry out PVC casing capping and conduit wiring

V Relevant Affective Domain related outcome(s)

Follow safety electrical rules for safe practices.

VI Relevant Theoretical Background (With diagrams if required)

One of the oldest and most commonly seen wiring in use today is casing capping wiring. PVC-insulated wires are encased in plastic casings and protected with a cap in this approach to electrical wiring. The casing capping wiring is generally recommended for low-voltage wiring in homes, offices, and devices, as well as for wire distribution and protection.

VII Actual Circuit diagram used in laboratory with equipment Specifications

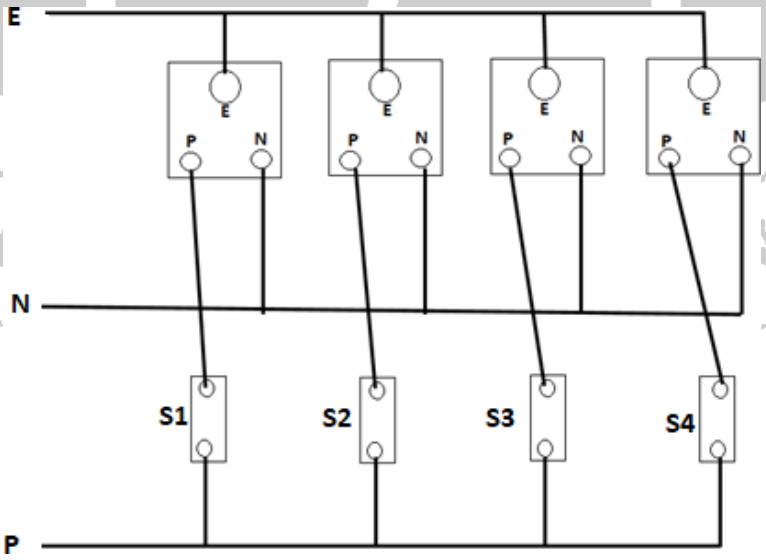

Fig. 25.1 Circuit diagram

VIII Required Resources/apparatus/equipment with specification:

S. No.	Name of Resource	Suggested Broad Specification	Quantity
1	PVC casing capping		3 meter
2	PVC conduit		3 meter
3	Wire	1mm²	5 meter
4	Wooden / PVC board		1 No.
5	Switches	6A	4
6	Sockets	6A	4

IX Precautions to be followed:

1. Mark layout on wiring board before fixing conduit.
2. Make sure all connection should be tight.

X Procedure

1. Mark the layout on the wiring board.
2. Cut the PVC casing capping as per the layout.
3. Fix the casing as per the layout and installation plan.
4. Fix the socket on the wiring board with the help of square box as per the plan.
5. Cut the wires according to the route.
6. Insert the required wires in the appropriate casing and accessories as per layout.
7. Take the modular boxes. Place them at the casing ends.
8. Cut the upper side of modular box by Hacksaw and remove the portion from it.
9. Position the accessories on the top cover of modular box close the open holes with strips.
10. Prepare the end termination of the cables as per the wiring diagram.
11. Insert the wires through the cable entry holes of junction box.
12. Terminate the wires in the socket and fix them.
13. Terminate the wires of the switches in the switch, and fix them.
14. Fix the boxes of the switches with wood screw on the wiring board.
15. Connect the supply wires in the supply terminals available.
16. Test the circuit after approval by the teacher

XI Observations and calculations

Draw the wiring diagram for 4 sockets and 4 switches.

XII Result(s)

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XIII Interpretation of results

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XIV Conclusion and recommendation

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XV Practical related questions (Provide space for answers)

(Teacher should provide various questions related to practical- sample given)

1. State the different wiring methods.
2. Compare casing capping and conduit wiring.
3. State the different conduit wiring accessories.

XVI References/Suggestions for further reading

1. K.B. Raina, S. K. Bhattacharya, "Electrical Design Estimation and Costing", New Age International Publishers, Reprint 2010, ISBN(l0): 81-224-0363-8; ISBN(l3): 978-81-224-0363-3
2. Gupta J. B., "Electrical Estimating and Costing", S. K. Kataria & Sons, New Delhi,2012, ISBN:978-93-5014-279-0

XVII Suggested Assessment Scheme

Performance Indicators		Weightage
Process Related : 30 Marks		**60 %**
1	Handling of the components	10%
2	Identification of components	20%
3	Measuring value using suitable instrument	20%
4	Working in teams	10%
Product Related: 20 Marks		**40%**
5	Calculated theoretical values of given component	10%
6	Interpretation of result	05%
7	Conclusions	05%
8	Practical related questions	15%
9	Submitting the journal in time	05%
Total (50 Marks)		**100 %**

Marks Obtained			Dated signature of teacher
Process Related (30)	**Product Related (20)**	**Total (50)**	

Practical No. 26: One lamp control from three and / or four different places.

I Practical Significance

Three-way switching or Four-way switching is used to control electrical appliances and equipment like fan, lighting points etc. from more than two places. The most common applications of this configuration is staircase wiring, hallway & corridor wiring, hostel wiring, hospital wiring, tunnel wiring, godown wiring etc. where a light bulb is controlled from two, three or even more places for ON and OFF operations.

II Industry/Employer Expected Outcome(s)

Use different electrical safety accessories and follow safe practices.

III Course Level Learning Outcome(s)

Perform different types of electrical wiring and cabling activities

IV Laboratory Learning Outcome(s)

Carry out wiring to control lamp from different places.

V Relevant Affective Domain related outcome(s)

Follow safety electrical rules for safe practices.

VI Relevant Theoretical Background (With diagrams if required)

Three-way switching or Four-way connection is used to control electrical appliances and equipment like fan, lighting points etc. from more than two places. The most common applications of this configuration is staircase wiring, hallway & corridor wiring, hostel wiring, hospital wiring, tunnel wiring, godown wiring etc. where a light bulb is controlled from two, three or even more places for ON and OFF operations

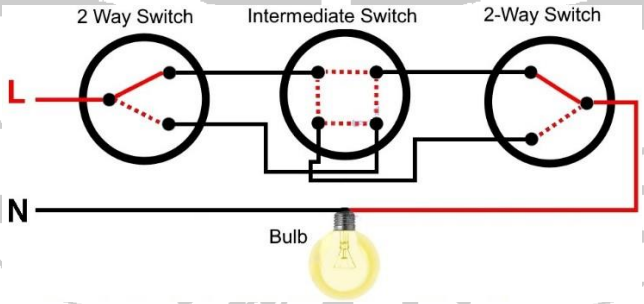

Fig. 26.1 One lamp control from three different places

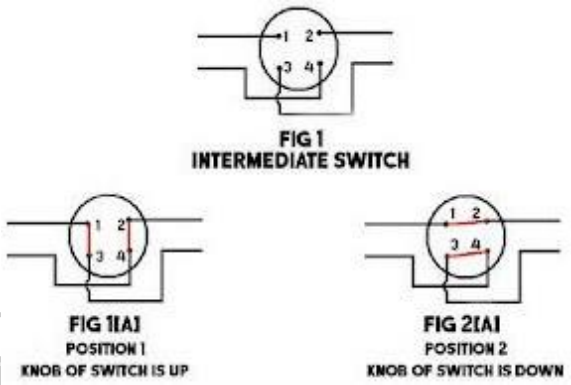

Fig. 26.2 positions of Intermediate switch

An intermediate switch have four terminals. Because of this terminals it is possible to change the flow of the current from one circuit to another circuit as shown as in figure 1(inside fig-A) In this figure there are ON and OFF the supply by two ways. The four terminals of intermediate switch is shown in fig 1. Sometimes, the terminal contacts of switch is connect terminal 1 with terminal 3 and terminal 2 with terminal 4 as shown in fig 1 a (position 1) and it can connect the terminal contacts of switch is connected with terminal 1 with 2 and terminal 3 with 4 as shown in fig 1 a (position 2).

When the knob of the switch is UP, then the vertical contacts 1 and 3 & 2 and 4 are connected as shown in fig 1[a] (position 1) And when the knob is DOWN, then the Horizontal contacts are 1 and 2 & 3 and 4 are connected as shown in fig 2[a] (position 2).

This kind of switch is used in a hall, go-downs, big rooms, where different lamps are required to turn on and off from different places and in a multistory building, the ground floor or car parking lights can be controlled from any floor. You can control a lamp from many more different places by adding intermediate switches.

VII Actual Circuit diagram used in laboratory with equipment Specifications

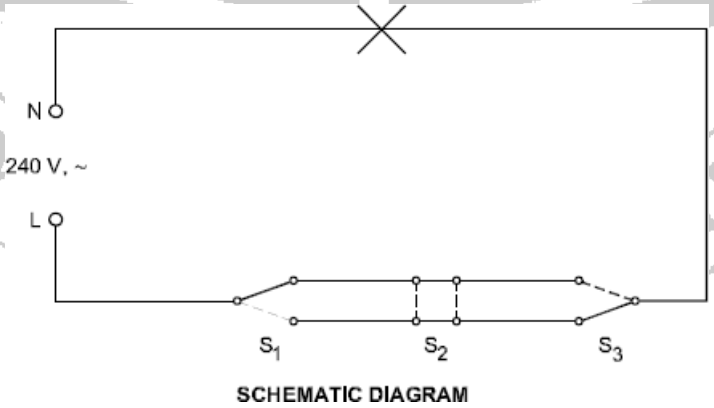

Fig. 26.3 Schematic Diagram

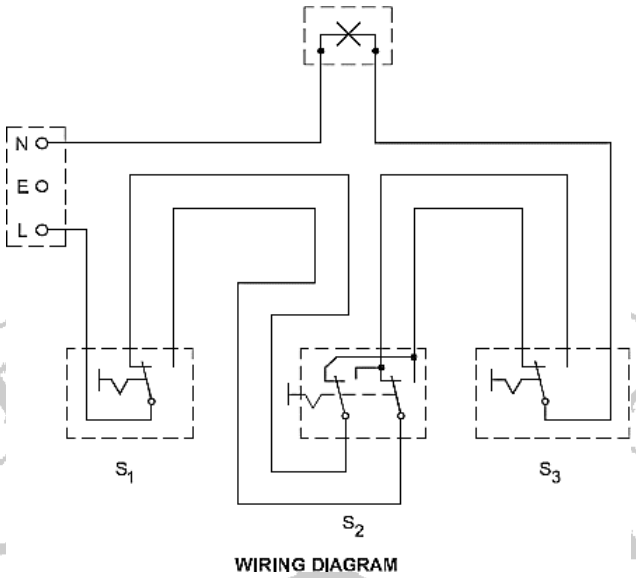

Fig 26.4 wiring diagram

VIII Required Resources/apparatus/equipment with specification:

S. No.	Name of Resource	Suggested Broad Specification	Quantity
1	Wooden board		1 No.
2	Lamp holder	240V, 6A	1
3	Lamp	40 watts	1
4	2 way switch	240V, 6A	2
5	Intermediate switch	240V, 6A	1
6	Wire pieces	1.5 Sq.mm	2 meter

IX Precautions to be followed

1. Select proper switches.
2. Handle tools carefully.
3. Make sure all connection should be tight.

X Procedure

1. Mark the layout on the board.
2. Position the accessories on the board
3. Prepare the end termination of the wires as per the wiring diagram.
4. Terminate the cables in the batten holders and fix them.
5. Terminate the cables of the switches in the switch, and fix them.
6. Connect the supply wires in the supply terminals available.
7. Test the circuit after approval by the teacher.

XI Observations and calculations

Sr. No.	Position of S1 knob	Position of S2 knob	Position of S3 knob	Condition of lamp
1	1	1	1	
2	2	1	1	
3	2	2	1	
4	2	2	2	
5	1	2	2	
6	1	1	2	
7	2	1	1	
8	2	1	2	

XII Result(s)

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XIII Interpretation of results

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XIV Conclusion and recommendation

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XV Practical related questions (Provide space for answers)

(Teacher should provide various questions related to practical- sample given)

1. What are the various components required for two-lamp control from two different places?
2. State the applications of 2 way switch and intermediate switch.

XVI References/Suggestions for further reading:

1. K.B. Raina, S. K. Bhattacharya, "Electrical Design Estimation and Costing", New Age International Publishers, Reprint 2010, ISBN(l0): 81-224-0363-8; ISBN(l3): 978-81-224-0363-3
2. Gupta J. B., "Electrical Estimating and Costing", S. K. Kataria & Sons, New Delhi,2012, ISBN:978-93-5014-279-0

XVII Suggested Assessment Scheme

	Performance Indicators	Weightage
	Process Related : 30 Marks	**60 %**
1	Handling of the components	10%
2	Identification of components	20%
3	Measuring value using suitable instrument	20%
4	Working in teams	10%
	Product Related: 20 Marks	**40%**
5	Calculated theoretical values of given component	10%
6	Interpretation of result	05%
7	Conclusions	05%
8	Practical related questions	15%
9	Submitting the journal in time	05%
	Total (50 Marks)	**100 %**

Marks Obtained			Dated signature of teacher
Process Related (30)	**Product Related (20)**	**Total (50)**	

Practical No. 27: Tracing of electrical schematic drawings of a panel of any electrical machine in your laboratory.

I Practical Significance

Every electrical machine laboratory have control panel for mounting the necessary devices required for satisfactory functioning of the electrical machines. At the event of supply failure knowledge of control panel and their rout is necessary to restore the electric supply.

II Industry/Employer Expected Outcome(s)

Carry out wiring and maintenance activities using relevant materials, tool and safety practices.

III Course Level Learning Outcome(s)

Perform different types of electrical wiring and cabling activities.

IV Laboratory Learning Outcome(s)

Trace and draw electrical schematic drawings of a panel.

V Relevant Affective Domain related outcome(s)

Follow safety electrical rules for safe practices.

VI Relevant Theoretical Background (With diagrams if required)

An electrical panel distributes the electricity to the various circuits. Its primary function is to receive electrical power from the utility provider and then distribute it to various circuits within the building. This distribution ensures that electricity reaches different outlets, appliances, and devices safely and efficiently. An electrical control panel is an enclosure, typically a metal box or plastic moulding which contains important electrical components that control the electrical machines. The electrical panel of electrical machines laboratory distributes electrical supply to individual machine. The electrical panel of individual machine consists of important electrical components which control the electrical machine. Electrical panel wiring diagrams are used to outline each device, as well as the connection between the devices found within an electrical panel.

VII Actual Circuit diagram used in laboratory with equipment Specifications

Draw single line drawing showing the details cable rout from main control panel of electrical machine laboratory to the individual machine. Also draw the block diagram of any electrical machine control panel.

VIII Required Resources/apparatus/equipment with specification

S. No.	Name of Resource	Suggested Broad Specification	Quantity
1	Drawing instruments		1 No.
2	Drawing sheet	A4 size	1 No.

IX Precautions to be followed

1. Don't touch any live parts while physical verification of service connection

X Procedure

1. Trace the cable rout.
2. Measure the length of cable rout.
3. Identify and list various components and accessories.
4. Draw single line drawing showing the cable rout from laboratory panel to electrical machine panel on A4 size sheet.
5. Also draw details of control panel of any one of the electrical machine

XI Observations and calculations

List the materials used in control panel.

XII Result(s)

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XIII Interpretation of results

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XIV Conclusion and recommendation

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XV Practical related questions (Provide space for answers)

(Teacher should provide various questions related to practical- sample given)

1. What is the need of control panel?
2. What are the safety devices used in the control panel?

XVI References/Suggestions for further reading

1. K.B. Raina, S.K.Bhattacharya, "Electrical Design Estimation and Costing", New Age International Publishers, Reprint 2010, ISBN(l0): 81-224-0363-8; ISBN(l3): 978-81-224-0363-3
2. Gupta J. B., "Electrical Estimating and Costing", S. K. Kataria & Sons, New Delhi,2012, ISBN:978-93-5014-279-0

XVII Suggested Assessment Scheme

	Performance Indicators	Weightage
	Process Related : 30 Marks	**60 %**
1	Handling of the components	10%
2	Identification of components	20%
3	Measuring value using suitable instrument	20%
4	Working in teams	10%
	Product Related: 20 Marks	**40%**
5	Calculated theoretical values of given component	10%
6	Interpretation of result	05%
7	Conclusions	05%
8	Practical related questions	15%
9	Submitting the journal in time	05%
	Total (50 Marks)	**100 %**

Marks Obtained			Dated signature of teacher
Process Related (30)	**Product Related (20)**	**Total (50)**	

Practical No. 28: Plate Earthing

I Practical Significance

Earthing System or Grounding System in an electrical network work as a safety measure to protect human life as well as equipment, the main objective of earthing system is to provide an alternative path for dangerous currents to flow so that accidents due to electric shock and damage to the equipment can be avoided.

II Industry/Employer Expected Outcome(s)

Use different electrical safety accessories and follow safe practices.

III Course Level Learning Outcome(s)

Implement relevant earthing system.

IV Laboratory Learning Outcome(s)

Carry out plate earthing.

V Relevant Affective Domain related outcome(s)

Follow safety electrical rules for safe practices.

VI Relevant Theoretical Background (With diagrams if required)

The resistance offered by the earth electrode to the flow of current into the ground is known as the earth resistance or resistance to earth. The electrical equipment mainly consists of two non-current carrying parts. These parts are neutral of the system or frame of the electrical equipment. From the earthing of these two non-current carrying parts of the electrical system earthing can be classified into two types neutral earthing and equipment earthing. Plate earthing is a type of earthing electrode where a plate (either copper or GI or even MS in some cases) are buried in the ground to serve as a grounding accessory for electrical system. Metallic parts of equipment are grounded or connected to the earth and if the equipment insulation fails for any reason, then the high voltages that can be present in the equipment covering or outer box need some path to get discharged. If the equipment is not earthed, these dangerous voltages can be transferred to anyone who touches it resulting in an electric shock.

VII Actual Circuit diagram used in laboratory with equipment Specifications

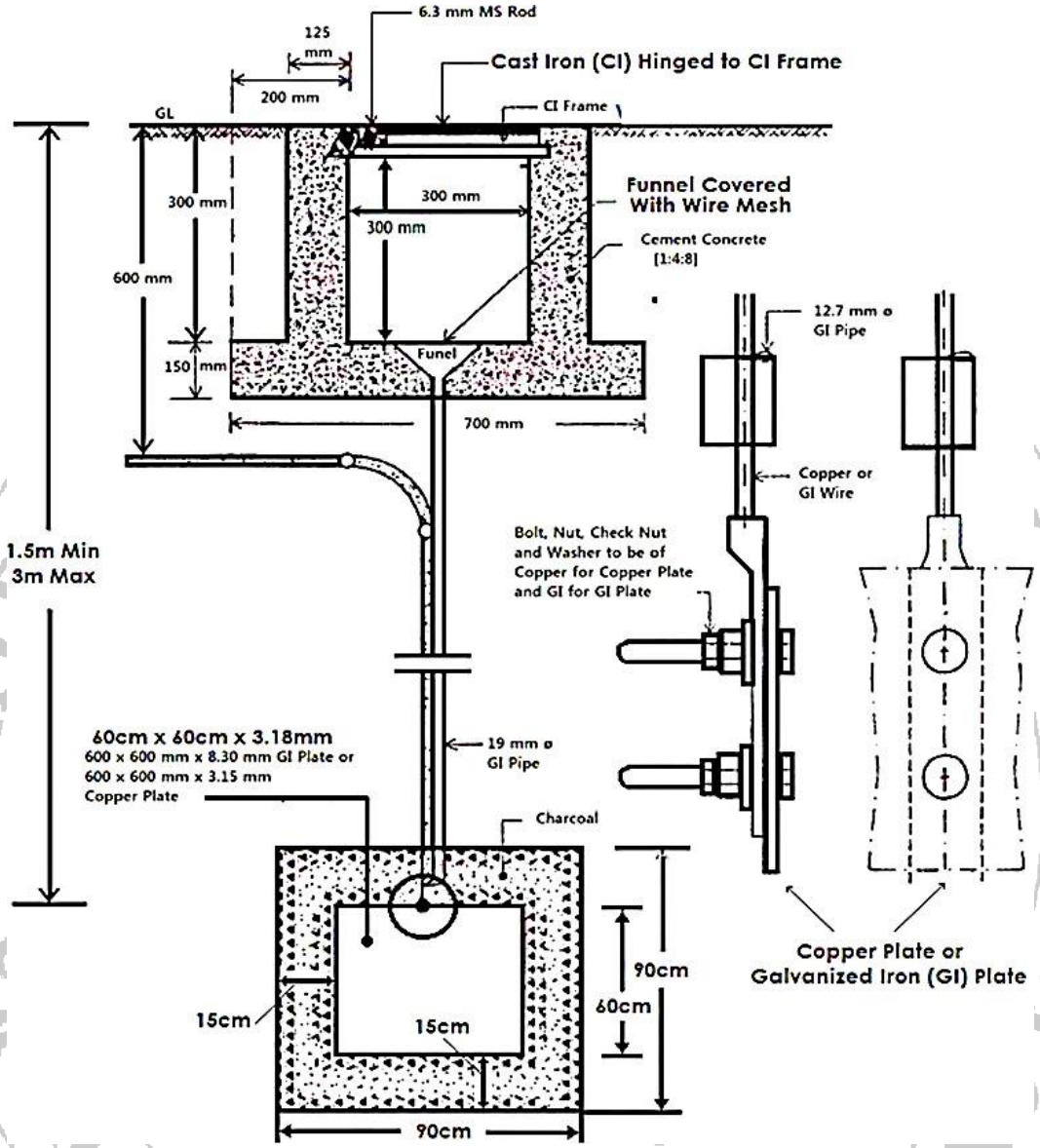

Fig. 28.1 Plate Earthing

VIII Required Resources/apparatus/equipment with specification

S. No.	Name of Resource	Suggested Broad Specification	Quantity
1	Copper/ GI Earthing Plate	Standard size	1 No.
2	Earthing pit materials		1 No.
3	Copper/ GI wire/Pipe	Standard size	1 No.
4	Pit digging equipment		As required

IX Precautions to be followed

1. Prepare proper size pit (depth and width).
2. Nut bolt should properly tighten.
3. Ensure that charcoal and salt material should be uniformly spread.
4. Plate should be place in vertical position.

X Procedure

1. Dig a 1.5x 1.5m pit having about 6-9 meters depth in the ground. (Note that, depth and width depends on the nature and structure of the ground)
2. Bury 600x600x300 mm copper plate or GI plate in pit in vertical position. Tight earth lead through nut bolts from two different places on earth plate.
3. Use two earth leads with each earth plate (in case of two earth plates) and tight them.
4. Apply grease around earth leads, to protect the joints from corrosion.
5. Collect all the wires in a metallic pipe from the earth electrode(s). Make sure the pipe is 300 mm above the surface of the ground.
6. Put a 300 mm layer of powdered charcoal (powdered wood coal) and salt mixture around the earth plate, to maintain the moisture condition around the earth plate.
7. Use thimble and nut bolts to connect tightly wires to the bed plates of machines. Each machine should be earthed from two different places. The minimum distance between two earth electrodes should be 3m.
8. Connect tightly, Earth continuity conductor which is connected to the body and metallic parts of all installation to earth lead.

XI Observations and calculations

Draw neat sketch of plate earthing on A4 paper

XII Result(s)

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XIII Interpretation of results

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XIV Conclusion and recommendation

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XV Practical related questions (Provide space for answers)

(Teacher should provide various questions related to practical- sample given)

1. List methods of equipment earthing
2. State the difference between system earthing and equipment earthing.
3. State why charcoal and salt is used in earthing.
4. List factors on which earth resistance depends.

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XVI References/Suggestions for further reading:

1. www.electrical4u.com
2. www.howstuffworks.com
3. www.electricaltechnology.org
4. www.electrical-installation.org

XVII Suggested Assessment Scheme

	Performance Indicators	Weightage
	Process Related : 30 Marks	**60 %**
1	Handling of the components	10%
2	Identification of components	20%
3	Measuring value using suitable instrument	20%
4	Working in teams	10%
	Product Related: 20 Marks	**40%**
5	Calculated theoretical values of given component	10%
6	Interpretation of result	05%
7	Conclusions	05%
8	Practical related questions	15%
9	Submitting the journal in time	05%
	Total (50 Marks)	**100 %**

Marks Obtained			Dated signature of teacher
Process Related (30)	**Product Related (20)**	**Total (50)**	

Practical No. 29: Chemical Earthing

I Practical Significance

Earthing System or Grounding System in an electrical network work as a safety measure to protect human life as well as equipment, the main objective of earthing system is to provide an alternative path for dangerous currents to flow so that accidents due to electric shock and damage to the equipment can be avoided.

II Industry/Employer Expected Outcome(s)

Use different electrical safety accessories and follow safe practices.

III Course Level Learning Outcome(s)

Implement relevant earthing system.

IV Laboratory Learning Outcome(s)

Carry out chemical earthing.

V Relevant Affective Domain related outcome(s)

Follow safety electrical rules for safe practices.

VI Relevant Theoretical Background (With diagrams if required)

Chemical Earthing is a branch of Electrical Earthing where we use chemical powder, coal, and salt material. In this chemical earthing not only coal and salt material but chemical powder is also used. In a general earthing salt and coal material is used on the electrode. But Chemical Earthing t Chemical Powder is uses on the Chemical Earthing. Carbon Powder and Bentonite Powder these are two types of chemical powder used in Chemical Earthing. Carbon Powder is black color powder whereas bentonite powder is brown in color. The use of Carbon Powder in normal places but bentonite powder is used in dry places. We can use Chemical earthing at home places, but there are some places where only chemical earthing should be done. In the hilly area chemical earthing will be done. Chemical Earthing Electrode is a type of GI Pipe. Inside the Chemical Earthing Electrode is completely filled with Chemicals. In Chemical Earthing electrode has a terminal on the top side that exits the two holes. Chemical Earthing Electrode is Maintenance Free, Completely filled with Chemicals, 5 Feet Long in Size and having the terminal at the top.

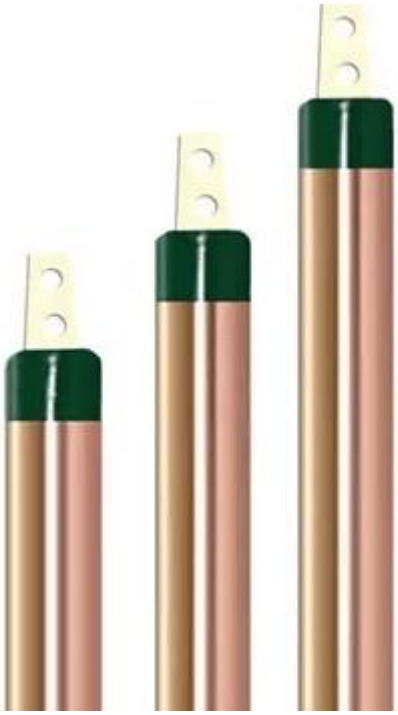

Fig. 29.1 Chemical Earthing Electrode

VII Actual Circuit diagram used in laboratory with equipment Specifications

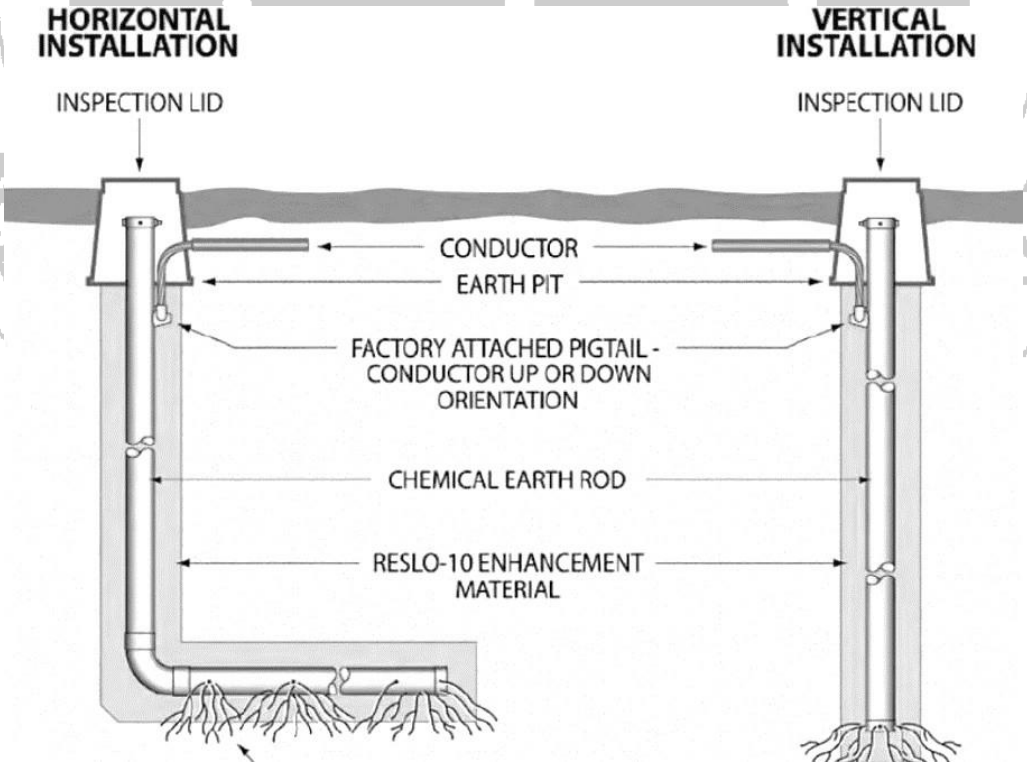

Fig. 29.1 Chemical Earthing

VIII Required Resources/apparatus/equipment with specification

S. No.	Name of Resource	Suggested Broad Specification	Quantity
1	Copper/ GI Earthing strip/conductor	Standard size	1 No.
2	Chemical electrode	Standard size	1 No.
3	Salt		As required
4	Charcoal		As required
6	Chemical mixture containing Bentonite		As required
6	Pit digging equipment		As required

IX Precautions to be followed

1. Prepare proper size pit (depth and width).
2. Nut bolt should properly tighten.
3. Ensure that chemical powder, charcoal and salt material should be uniformly spread.

X Procedure

1. Make an EarthPit 500*500*200 mm.
2. Make a hole with a center of 100mm diameter and 3.5 m depth.
3. Pour Chemical Powder with Water.
4. Place the electrode in the hole at an upright position till the end to top manners.
5. Fill the chemical earth pit with chemical compounds and water absorption.
6. Connect the earth wire with the earthing electrode

XI Observations and calculations

Not applicable

XII Result(s)

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XIII Interpretation of results

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XIV Conclusion and recommendation

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XV Practical related questions (Provide space for answers)

(Teacher should provide various questions related to practical- sample given)

1. Define chemical earthing
2. List methods of equipment earthing
3. State the difference between system earthing and equipment earthing.
4. State why charcoal and salt is used in earthing.
5. List factors on which earth resistance depends.

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XVI References/Suggestions for further reading

1. https://medium.com/@seotruepower/what-is-chemical-earthing-earthing-installation-process-1396f310077a

XVII Suggested Assessment Scheme

Performance Indicators		Weightage
Process Related : 30 Marks		**60 %**
1	Handling of the components	10%
2	Identification of components	20%
3	Measuring value using suitable instrument	20%
4	Working in teams	10%
Product Related: 20 Marks		**40%**
5	Calculated theoretical values of given component	10%
6	Interpretation of result	05%
7	Conclusions	05%
8	Practical related questions	15%
9	Submitting the journal in time	05%
Total (50 Marks)		**100 %**

Marks Obtained			Dated signature of teacher
Process Related (30)	**Product Related (20)**	**Total (50)**	

Practical No. 30: Testing and measurement of earthing resistance.

I Practical Significance

Earthing System or Grounding System is an electrical network work as a safety measure to protect human life as well as equipment. The main objective of the Earth testing is to measure the value of earth resistance and compare and maintain it with recommended value of earth system resistance.

II Industry/Employer Expected Outcome(s)

Use different electrical safety accessories and follow safe practices.

III Course Level Learning Outcome(s)

Implement relevant earthing system

IV Laboratory Learning Outcome(s)

LLO Test / measure earthing resistance of electrical installation

V Relevant Affective Domain related outcome(s)

Follow safety electrical rules for safe practices.

VI Relevant Theoretical Background (With diagrams if required)

The instrument used for measuring the resistance of the earth is known as earth tester. All the equipment of the power system is connected to the earth through the earth electrode. The earth protects the equipment and personnel from the fault current. The resistance of the earth is very low. The fault current through the earth electrode passes to the earth. Thus, protects the system from damage. As per Indian standard as well as international standard (IEEE and IEC), earthing resistance should not be more than following recommended value for various installations:

1. Household- 5 Ohm
2. Power station- 0.5 Ohm
3. Major substations- 1 Ohm
4. Minor substations- 2 Ohm

Earth tester is a special type of megger used for measurement of earth resistance having additional constructional features of rotating current reverser and rectifier. It has four terminals P1, P2 and C1, C2. Two terminals P1 and C1 are shorted to form a common point to be connected to the earth electrode. The other two terminals P_2 and C_2 are connected to auxiliary electrodes P and C respectively.

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VII Actual Circuit diagram used in laboratory with equipment Specifications

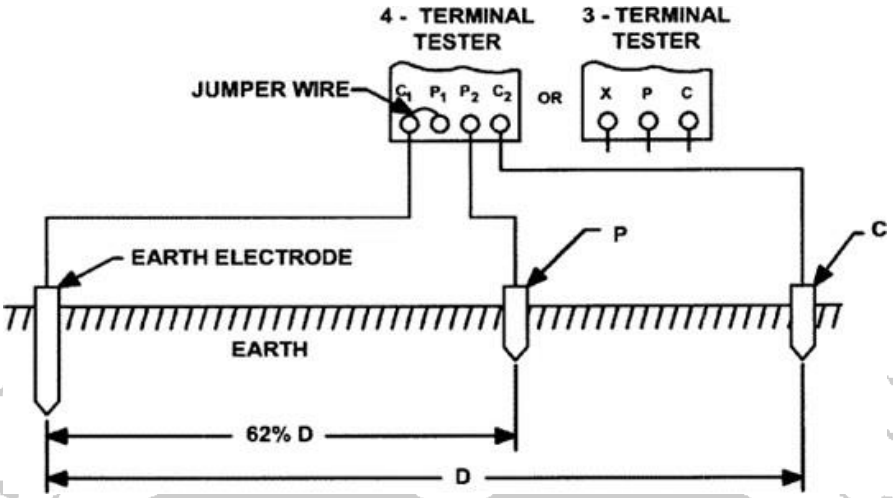

Fig. 30.1 Measurement of earth resistance.

Fig. 30.2 Four Terminal Analog and Digital Earth Tester

VIII Required Resources/apparatus/equipment with specification

S. No.	Name of Resource	Suggested Broad Specification	Quantity
1	Earth Tester with connecting cables	Analog or Digital type	1 Set.
2	Hammer ball peen	1 kg	1 No.
3	Combination plier	200mm	1 No.
4	Screw driver	300mm	1 No.
5	Earth Electrode (For Test)		1 No.

IX Precautions to be followed

1. Read carefully the instructions of the manufacturer.
2. All connection should be tight Select the proper range of tester
3. Handle rotation should be as per instruction given on instruments

X Procedure

1. Collect the earth tester and connecting cables.
2. Drive the current electrode at a distance of 30 meters from the main electrode.
3. Drive the potential electrode midway between the main and current electrodes.
4. Short the terminal C_1P_1 of the earth tester (if four terminals) and connect the terminals to the main electrode.
5. Connect the terminal P_2C_2 of the earth tester to the potential electrode and current electrodes respectively.
6. Rotate the earth tester at its rated speed (160 rpm).
7. Measure the resistance of the earth electrode directly in the tester and enter the value in observation table
8. Repeat the measurement by shifting the auxiliary electrode position as state in Sr. Nos. 2 to 4 of observation table.
9. Calculate average value of earth resistance.
10. If the value is found more than 5 Ohm, pour the water in funnel of earth electrode and measure the earth resistance.

XI Observations and calculations

Sr. No.	Position of electrodes	Earth resistance	Average earth resistance
1	Current electrode 30 m, Potential electrode 15 m (From the main electrode)		
2	Current electrode 40 m, Potential electrode 20 m (From the main electrode)		
3	Current electrode 36 m, Potential electrode 18 m (From the main electrode)		
4	Current electrode 24 m, Potential electrode 12 m (From the main electrode)		

XII Result(s)

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XIII Interpretation of results

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XIV Conclusion and recommendation

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XV Practical related questions (Provide space for answers)

(Teacher should provide various questions related to practical- sample given)

1. State the methods of reducing resistance of earth electrode.
2. What will happen, if two earth electrodes are joined together?
3. What will be the effect of change in the speed of rotation of earth tester?
4. State the causes of higher value of earth resistance.
5. State the operating principle of analog earth tester

XVI References/Suggestions for further reading

1. https://circuitglobe.com/earth-tester.html, assessed on 12th April, 2018
2. https://www.youtube.com/watch?v=tExa5bv2Kfo,, assessed on 12th April, 2018

XVII Suggested Assessment Scheme

Performance Indicators		Weightage
Process Related : 30 Marks		**60 %**
1	Handling of the components	10%
2	Identification of components	20%
3	Measuring value using suitable instrument	20%
4	Working in teams	10%
Product Related: 20 Marks		**40%**
5	Calculated theoretical values of given component	10%
6	Interpretation of result	05%
7	Conclusions	05%
8	Practical related questions	15%
9	Submitting the journal in time	05%
Total (50 Marks)		**100 %**

Marks Obtained			Dated signature of teacher
Process Related (30)	**Product Related (20)**	**Total (50)**	