I

Name _____

Roll No. _____ Year 20____20____

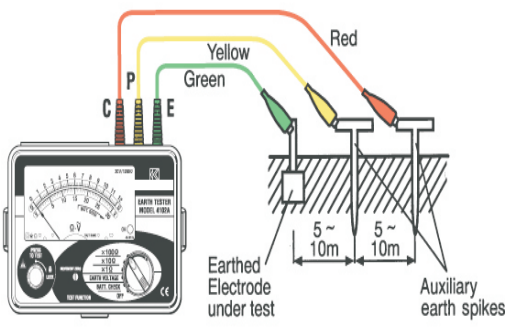
Exam Seat No. _____

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

A LABORATORY MANUAL

FOR

ELECTRICAL MATERIALS & WIRING PRACTICE (22328)



MAHARASHTRA STATE BOARD OF TECHNICAL EDUCATION, MUMBAI
(Autonomous) (ISO 9001 : 2015) (ISO / IEC 27001 : 2013)

VISION

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

MISSION

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

QUALITY POLICY

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

CORE VALUES

MSBTE believes in the followings:

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

A Laboratory Manual

for

Electrical Materials and Wiring Practice

(22328)

Semester-III

(EE/EP/EU)

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

Maharashtra State Board of Technical Education,
(Autonomous) (ISO : 9001 : 2015) (ISO/IEC 27001 : 2013)
4th Floor, Government Polytechnic Building, 49, Kherwadi,
Bandra (East), Mumbai - 400051.
(Printed on June, 2018)

MAHARASHTRA STATE

BOARD OF TECHNICAL EDUCATION

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 Materials and Wiring Practice (22328)** for the academic year 20…….. to 20…….. as prescribed in the curriculum.

Place: …… Enrollment No:.……

Date: …… Exam. Seat No: ……

Subject Teacher **Head of the Department** **Principal**

Seal of Institution

Preface

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

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

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

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

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.

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

Following POs and PSO are expected to be achieved through the practicals of the Electrical Materials and Wiring Practice course.

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

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

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

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

Program Specific Outcomes (PSOs)

PSO 1. Electrical Equipment: Maintain various types of rotating and static electrical equipment.
PSO 2. Electrical Power Systems: Maintain different types of electrical power systems.

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List of Industry Relevant Skills

The following industry relevant skills of the competency 'Plan wiring/cabling activities using relevant materials following safe practices' are expected to be developed in you by undertaking the practicals of this practical manual.

1. Identify various electrical accessories
2. Use wiring tools.
3. Use various measuring and testing instruments.
4. Test electrical installations.
5. Investigate cable faults

Practical- Course Outcome matrix

Course Outcomes (COs):– >

a. Follow safe practices when undertaking electrical works.
b. Select relevant conductors and electromagnetic/magnetic materials.
c. Select relevant insulating materials.
d. Perform different types of electrical wiring/cabling activities.
e. Implement relevant earthing systems.

S. No.	Practical Outcome	CO a.	CO b.	CO c.	CO d.	CO e.
1.	Use different electrical safety accessories and practices.	√	-	-	-	-
2.	Use different types of electrical/electronic tools.	√	-	-	-	-
3.	Test the working of the given components: i) single pole one way and two way switches and ii) MCB using relevant tools and instruments.	√	-	-	-	-
4.	Test the working of the given components: i) RCB and ii) ELCB using relevant tools and instruments.	√	-	-	-	-
5.	Measure conductor resistance of cables using Kelvin's double bridge.	-	√	-	-	-
6.	Use the Megger to measure insulation resistance of cables.	-	-	√	√	-
7.	Use the Wheatstone's bridge to measure resistance of a conductor bundle (to determine per unit length resistance).	-	√	-	-	-
8.	Use Wheatstone's bridge to measure resistance of conductor bundles (to determine per unit length resistance) (two specimens of different cross sections area).	-	√	-	-	-
9.	Select and place relevant fuses in different lighting circuits.	√	-	-	-	-
10.	Use the coil over core arrangement to determine the iron losses per unit weight of first electromagnetic specimen.	-	√	-	-	-
11.	Use the coil over core arrangement to determine the iron losses per unit weight of second electromagnetic specimen.	-	√	-	-	-
12.	Select insulating materials for specific applications from given samples (at least five).	-	-	√	-	-
13.	Investigate (and record observations) a cable failure by insulation breakdown (1^{st} case).	√	-	-	√	-
14.	Investigate (and record observations) a cable failure by insulation breakdown (2^{nd} case).	√	-	-	√	-

15.	Dielectric strength test of one insulating oil sample.	√	-	√	-	-
16.	Dielectric strength test of two different insulating oil samples of varied usages.	√	-	√	-	-
17.	Prepare staircase wiring and test it.	-	-	-	√	-
18.	Prepare godown wiring and test it.	-	-	-	√	-
19.	Prepare switch board containing four switch four socket arrangements (with fuse, indicator, internal wiring etc.).	-	-	-	√	-
20.	Prepare fluorescent tube light fixture wiring and test it.	-	-	-	√	-
21.	Perform cable laying from incoming bus to a machine installation.	-	-	-	√	-
22.	Perform cable laying from incoming main to a residential unit.	-	-	-	√	-
23.	Trace laid down cables and identify the path.	-	-	-	√	-
24.	Prepare cable joints (different joints).	-	-	-	√	-
25.	Perform lug crimping for cable leads of a specific size.	-	-	-	√	-
26.	Perform lug crimping for cable leads of a size other than above.	-	-	-	√	-
27.	Perform compound filling and water proof taping of cable joint	-	-	-	√	-
28.	Perform plate earthing for a machine laboratory.	√	-	-	-	√
29.	Perform plate earthing for a computer centre.	√	-	-	-	√
30.	Perform plate earthing for a building.	√	-	-	-	√
31.	Test / measure earthing system resistance of a computer centre.	√	-	-	-	√
32.	Test / measure earthing system resistance of a building.	√	-	-	-	√

Guidelines to Teachers

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

Instructions for Students

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

Content Page

List of Practicals and Progressive Assessment Sheet

S. No	Practical Outcome	Page No.	Date of performance	Date of submission	Assessment marks (50)	Dated sign. of teacher	Remarks (if any)
14.	Investigate (and record observations) a cable failure by insulation breakdown (2^{nd} case).	54					
15.	Dielectric strength test of one insulating oil sample.	59					
16.	Dielectric strength test of two different insulating oil samples of varied usages.	59					
17.	Prepare staircase wiring and test it.	64					
18.	Prepare godown wiring and test it.	72					
19.	Prepare switch board containing four switch four socket arrangements (with fuse, indicator, internal wiring etc.).	79					
20.	Prepare fluorescent tube light fixture wiring and test it.	84					
21.	Perform cable laying from incoming bus to a machine installation.	90					
22.	Perform cable laying from incoming main to a residential unit.	94					
23.	Trace laid down cables and identify the path.	98					
24.	Prepare cable joints (different joints).	102					
25.	Perform lug crimping for cable leads of a specific size.	107					
26.	Perform lug crimping for cable leads of a size other than above.	107					
27.	Perform compound filling and water proof taping of cable joint	112					
28.	Perform plate earthing for a machine laboratory.	118					
29.	Perform plate earthing for a computer centre.	118					
30.	Perform plate earthing for a building.	118					
31.	Test / measure earthing system resistance of a computer centre.	123					
32.	Test / measure earthing system resistance of a building.	123					
Total							

Note: To be transferred to Proforma of CIAAN-2017.

Practical No. 1: Safety 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 Relevant Program Outcomes (POs)

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

III Competency and Practical Skills

This practical is expected to develop the following skills for the industry identified competency: **'Plan wiring/cabling activities using relevant materials following safe practices'**

i. Use various electrical safety accessories.
ii. Follow electrical safety practices.

IV Relevant Course Outcome(s)

- Follow safe practices when undertaking electrical works.

V Practical Outcome

1. Use different electrical safety accessories and practices.

VI Relevant Affective domain related Outcome(s)

a. Practice good housekeeping with safety measures.
b. Demonstrate working as a leader/a team member.
c. Maintain tools and equipment.
d. Follow ethical practices.

VII Minimum Theoretical Background

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.

VIII Practical set-up / Circuit diagram / Work Situation

Fig. 1 Electrical Safety Accessories

IX Resources Required

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: 7,500 V	1 Pair
4	Electrical Shock Proof Safety Shoes	Insulation Range-15 to 30 KV	1 Pair
5	Safety apron	Standard	1 No.
6	Safety helmet	Standard	1 No.
7	Safety belt	Standard	1 No.

X 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.

XI 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.

XII Resources Used

S. No	Name of Resource	Broad Specifications		Quantity	Remarks (If any)
		Make	Details		
1.					
2.					
3.					
4.					
5.					

XIII Actual Procedure followed (Use blank sheet provided if space not sufficient)

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XIV Observations and Calculations (Use blank sheet provided if space not sufficient)

…….Not Applicable…….

XV Results

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XVI Interpretation of Results (Give meaning of the above obtained results)

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XVII Conclusions (Actions/decisions to be taken based on the interpretation of results).

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XVIII Practical Related Questions: (Use separate sheet for answer)

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

1. For a new building earthing is to be done but the soil at that place is having high resistance. What are the different methods to reduce earth resistance?
2. In an electrical installations where three terminal pin (Phase, Neutral and earth) is used. Out of these three, earth terminal is having larger cross section area compared with other two. State the reason for this.
3. Give the values of earth resistances for power station, large sub-station, HT line, LT line and residential installation.

[Space for answers]

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XIX 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.

XX Suggested Assessment Scheme

Performance indicators		Weightage
Process related: 30 Marks		**60%**
1	Handling of the instruments	10 %
2	Identification of component/dial/scale	20 %
3	Measuring value using suitable instrument	20 %
4	Working in team	10 %
Product related: 20 Marks		**40%**
5	Writing result	10 %
6	Interpretation of result	05 %
7	Conclusions	05 %
8	Practical related questions	15 %
9	Submitting the journal in time	05%
Total		**100 %**

Names of Student Team Members

1. ……
2. ……...
3. ……

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

Practical No. 2: 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 Relevant Program Outcomes (POs)

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

III Competency and Practical Skills

This practical is expected to develop the following skills for the industry identified competency: **'Plan wiring/cabling activities using relevant materials following safe practices'**

- Identify various electrical / electronic tools.
- Use various electrical / electronic tools.
- Follow safety practices while working with tools.

IV Relevant Course Outcome(s)

- Follow safe practices when undertaking electrical works.

V Practical Outcome

1. Use different types of electrical/electronic tools.

VI Relevant Affective domain related Outcome(s)

- Practice good housekeeping with safety measures.
- Demonstrate working as a leader/a team member.
- Maintain tools and equipment.
- Follow ethical practices.

VII Minimum Theoretical Background

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.

VIII Practical set-up / Circuit diagram / Work Situation

Fig. 1 Tool Kit and Electrical Technicians Main Tools

IX Resources Required

S. No.	Name of Resource	Suggested Broad Specification	Quantity
1	Electricians tool kit	Standard	1 kit
2	Steel rule	150 mm	1 No.

X Precautions to be followed

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

XI Procedure

- 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. (Refer Manufactures Catalogue)
  v. Observe the make of tool and note down.
  vi. Note down the different applications of given tool.
  vii. Repeat above instructions for other tools.

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

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

XII Resources Used

S. No	Name of Resource	Broad Specifications		Quantity	Remarks (If any)
		Make	Details		
1					
2					
3					
4					
5					

XIII Actual Procedure followed (Use blank sheet provided if space not sufficient)

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XIV Observations and Calculations (use blank sheet provided if space not sufficient)

a. Identify various electrical/electronic tool

a) Name of tool: -

Free hand sketch :-

Size: -

Specifications: -

Make: -

Applications: -

Precautions: -

b) Name of tool: -

Free hand sketch :-

Size: -

Specifications: -

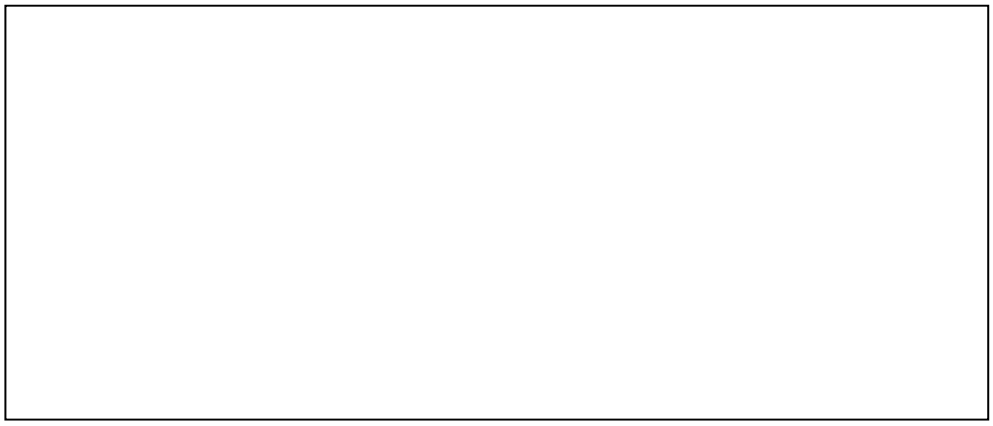
Make: -

Applications: -

Precautions: -

c) Name of tool: -

Free hand sketch :-

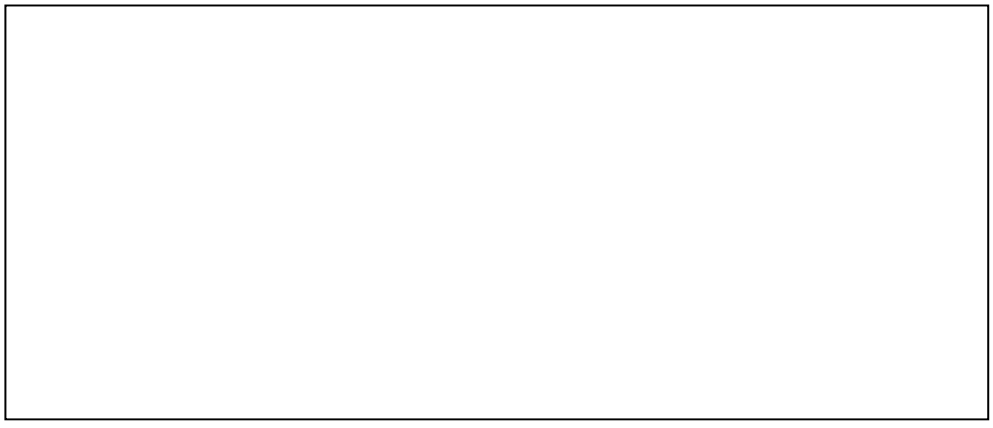


Size: -
Specifications: -

Make: -
Applications: -

Precautions: -

d) Name of tool: -
Free hand sketch :-



Size: -
Specifications: -

Make: -
Applications: -

Precautions: -

XV Results

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XVI Interpretation of Results (Give meaning of the above obtained results)

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XVII Conclusions (Actions/decisions to be taken based on the interpretation of results).

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XVIII Practical Related Questions: (Use separate sheet for answer)

(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.
   i. Established vertical line on a wall
   ii. Established horizontal line on a wall
   iii. Cut PVC conduit
   iv. Put a hole in wall using hammer
   v. Put a pilot hole for fixing screw on board
3. State any two precautions while working with electricians screw driver.

[Space for answers]

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XIX References / Suggestions for further reading

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

XX Suggested Assessment Scheme

Performance indicators		Weightage
Process related: 30 Marks		**60%**
1	Handling of the instruments	10 %
2	Identification of component/dial/scale	20 %
3	Measuring value using suitable instrument	20 %
4	Working in team	10 %
Product related: 20 Marks		**40%**
5	Writing result	10 %
6	Interpretation of result	05 %
7	Conclusions	05 %
8	Practical related questions	15 %
9	Submitting the journal in time	05%
Total		**100 %**

Names of Student Team Members

1. ……..
2. …….
3. ……

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

Practical No. 3: Working of MCB

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 Relevant Program Outcomes (POs)

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

III Competency and Practical Skills

This practical is expected to develop the following skills for the industry identified competency: **'Plan wiring/cabling activities using relevant materials following safe practices'**

i. Test the continuity of switches and MCB using DMM.
ii. Use switches and MCBs in an electrical circuit.

IV Relevant Course Outcome(s)

- Follow safe practices when undertaking electrical works.

V Practical Outcome

1. Test the working of the given components: i) Single pole one way and two way switches and ii) MCB using relevant tools and instruments.

VI Relevant Affective domain related Outcome(s)

a. Practice good housekeeping with safety measures.
b. Demonstrate working as a leader/a team member.
c. Maintain tools and equipment.
d. Follow ethical practices.

VII Minimum Theoretical Background

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.

VIII Practical set-up / Circuit diagram / Work Situation

1. Test working of single pole switch and MCB.

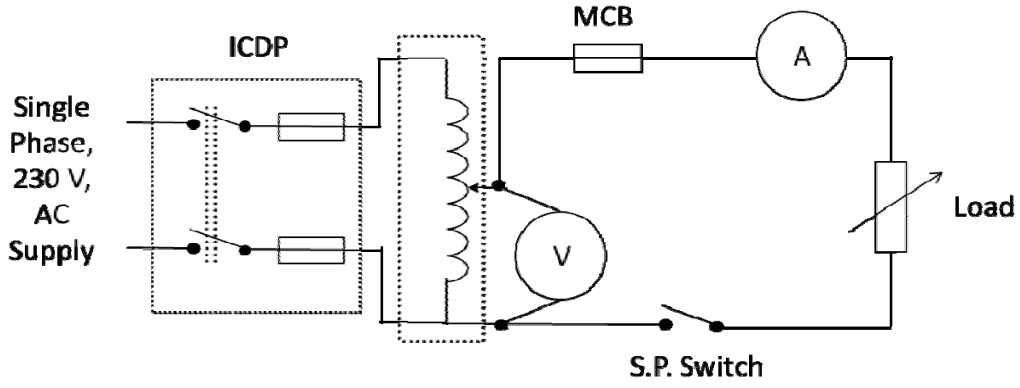

Fig. 1

2. Working of MCB on short circuit

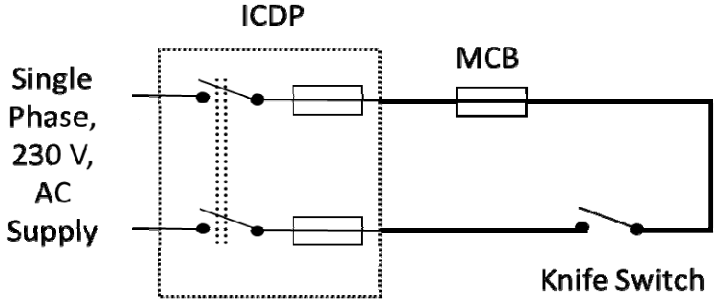

Fig. 2

Note: Students should write ratings of meters and equipment on circuit diagram.

IX Resources Required

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	3 ½ Digit Display	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.
8	Rheostat	Double tube, 4 A, 59 Ω	1 No.

X Precautions to be followed

1. Please read carefully the following precautions before operating **Digital Multi-meter (DMM)**.
   i. Check test leads for broken insulation before working.
   ii. Don't use ohmmeter section on live system.
   iii. Don't use ammeter section parallel to voltage source.
   iv. Don't touch the test lead terminals while connecting live circuits; otherwise it will give a shock.
   v. Disconnect the test leads immediately after the testing.

2. While testing MCB proper ratings of fuses should be used in ICDP.

XI Procedure

1 Test the continuity of switches and MCB using DMM
(Read the users manual provided with DMM before using it)

a) Test the continuity of single pole one-way switch.
   i. Turn the dial to Continuity Test mode ( ). (If required, press the continuity button.)
   ii. Insert the black test lead into the COM jack.
   iii. Insert the red lead into the V Ω jack. (When finished, remove the leads in reverse order: red first, then black.)
   iv. Keep switch in "OFF' position.
   v. Connect the test leads across then terminals of S.P. switch.
   vi. Observe the DMM.
      1. If DMM will not beep, the circuit is open.
      2. If DMM beeps, a complete path (continuity) is detected, means switch is short.
   vii. Keep switch in "ON' position.
   viii. Observe the DMM.
      1. If DMM will not beep, the circuit is open, means switch is faulty.
      2. If DMM beeps, a complete path (continuity) is detected.
   ix. Turn the DMM OFF.

b) Test the continuity of single pole two way switch.
Repeat the above procedure, on both two-way terminals of single pole two way switch.

c) Test the continuity of single pole MCB.
Repeat the procedure given in (a).

2 Test working of single pole switch and MCB.
   i. Connect ICDP, variac, MCB, load and S.P. switch as shown in the Fig. 1.
   ii. Connect DMM across variac.
   iii. Switch on the supply.
   iv. Increase voltage in steps by varying variac and set at voltage rating of MCB.
   v. Observe Ammeter.
   vi. Switch on one of switch of load.
   vii. Observe Ammeter.
   viii. Switch on single pole switch.

ix. Observe Ammeter.
x. Increase the load up to 3 times current rating of MCB.
xi. Observe Ammeter
xii. Wait for some time.
xiii. Record the tripping time of MCB and ammeter reading in observation table.
xiv. Switch on MCB.
xv. Increase the load up to 4 and 5 time's current rating of MCB.
xvi. Record the tripping time of MCB and ammeter readings in observation table.

3 Working of MCB on short circuit.
i. Connect ICDP, MCB, and knife switch (should be open) as shown in the Fig.2.
ii. Switch on the supply.
iii. Close the knife switch.
iv. Observe the working of MCB.

XII Resources Used

S. No	Name of Resource	Broad Specifications		Quantity	Remarks (If any)
		Make	Details		
1.					
2.					
3.					
4.					
5.					
6.					
7.					
8.					

XIII Actual Procedure followed (Use blank sheet provided if space not sufficient)

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XIV Observations and Calculations (Use blank sheet provided if space not sufficient)

S. No	Current through circuit	Tripping Time of MCB
1.		
2.		
3.		
4.		

XV Results

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XVI Interpretation of Results (Give meaning of the above obtained results)

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XVII Conclusions (Actions/decisions to be taken based on the interpretation of results).

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XVIII Practical Related Questions: (Use separate sheet for answer)

(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?

[Space for answers]

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XIX 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. https://library.e.abb.com/public/114371fcc8e0456096db42d614bead67/2CDC400002D0201_view.pdf , assessed on 3rd April, 2018
4. https://www.youtube.com/watch?v=AYbX2uAKOW , assessed on 3rd April, 2018
5. http://www.studyelectrical.com/2014/07/miniature-circuit-breakers-mcb-types-characteristic-curves.html , assessed on 3rd April, 2018
6. https://thegrid.rexel.com/en-us/product_faqs/w/wiki/881/what-are-miniature-circuit-breakers-mcb , assessed on 3rd April, 2018

XX Suggested Assessment Scheme

Performance indicators		Weightage
Process related: 30 Marks		**60%**
1	Handling of the instruments	10 %
2	Identification of component/dial/scale	20 %
3	Measuring value using suitable instrument	20 %
4	Working in team	10 %
Product related: 20 Marks		**40%**
5	Writing result	10 %
6	Interpretation of result	05 %
7	Conclusions	05 %
8	Practical related questions	15 %
9	Submitting the journal in time	05%
Total		**100 %**

Names of Student Team Members

1. ……..
2. …….
3. ……

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

Practical No. 4: Working of ELCB

I Practical Significance

ELCB or 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 this component.

II Relevant Program Outcomes (POs)

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

III Competency and Practical Skills

This practical is expected to develop the following skills for the industry identified competency: **'Plan wiring/cabling activities using relevant materials following safe practices'**

i. Use ELCB in an electrical circuit.

IV Relevant Course Outcome(s)

- Follow safe practices when undertaking electrical works.

V Practical Outcome

1. Test the working of the given components: i) RCCB and ii) ELCB using relevant tools and instruments.

VI Relevant Affective domain related Outcome(s)

a. Practice good housekeeping with safety measures.
b. Demonstrate working as a leader/a team member.
c. Maintain tools and equipment.
d. Follow ethical practices.

VII Minimum Theoretical Background

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 ELCBs are old ones, they are not used now in new installations. However, Current operated ELCBs are widely used. These current operated ELCBs are called Residual Current Circuit Breakers (RCCBs). It is also called Residual Current Device (RCD). However, the popular name of this device is ELCB.

Basically RCCB works on the principle of Kirchhoff's Current Law (KCL) (i. e. 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; hence imbalance occurs between line current and neutral current. The coil in a toroidal transformer (in RCCB) senses residual current which is connected to relay.

VIII Practical set-up / Circuit diagram / Work Situation

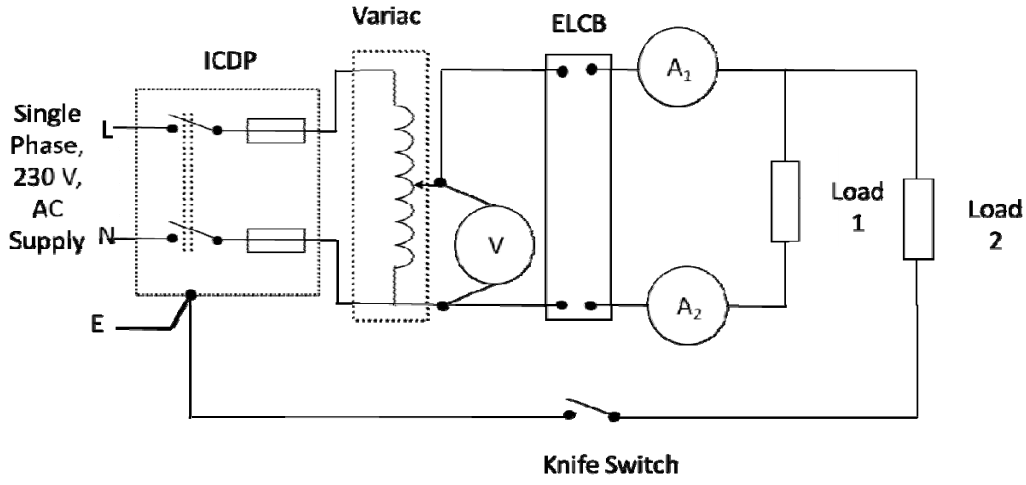

Fig. 1

Note: Students should write ratings of meters and equipment on circuit diagram.

IX Resources Required

S. No.	Name of Resource	Suggested Broad Specification	Quantity
1	ELCB/RCCB	Single phase, 240 V, 20A	1 No.
2	Digital Multi-meter	3 ½ Digit Display	1 No.
3	Auto transformer (Dimmerstat)	Single-phase 0-270 V, 4A	1 No.
4	Ammeter	MI multi-range- 0-5-10 A	2 No.
5	Resistive load / lamp load	Suitable size	2 No.
6	Knife Switch	Single Pole Single Throw	1 No.

X Precautions to be followed

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

XI Procedure

i. Record the observations.

XII Resources Used

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

S. No	Name of Resource	Broad Specifications		Quantity	Remarks (If any)
		Make	Details		
5					
6					
7					
8					

XIII Actual Procedure followed (Use blank sheet provided if space not sufficient)

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XIV Observations and Calculations (Use blank sheet provided if space not sufficient)

Before operating knife switch.

S. No	Current through Live wire	Current through Neutral wire
1.		
2.		

After operating knife switch.

S. No	Current through Live wire	Current through Neutral wire
1.		
2.		

XV Results

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XVI Interpretation of Results (Give meaning of the above obtained results)

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XVII Conclusions (Actions/decisions to be taken based on the interpretation of results).

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XVIII Practical Related Questions: (Use separate sheet for answer)

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

1. State, how ELCB differs from MCB?
2. Is ELCB trips in the event of short circuit in an electric circuit?
3. Name the device used for earth leakage as well as over current protection.

[Space for answers]

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XIX 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-rcbo-working-principle.html , assessed on 11th April, 2018
4. https://library.e.abb.com/public/d286e8468abe43dcc1256a93002c4169/GSK0500701S0201.pdf , assessed on 11th April, 2018

XX Suggested Assessment Scheme

Performance indicators		Weightage
Process related: 30 Marks		**60%**
1	Handling of the instruments	10 %
2	Identification of component/dial/scale	20 %
3	Measuring value using suitable instrument	20 %
4	Working in team	10 %
Product related: 20 Marks		**40%**
5	Writing result	10 %
6	Interpretation of result	05 %
7	Conclusions	05 %
8	Practical related questions	15 %
9	Submitting the journal in time	05%
Total		**100 %**

Names of Student Team Members

1. ……..
2. …….
3. ……

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

Practical No. 5: Kelvin's Double Bridge

I Practical Significance

The conductors are generally made from copper & aluminum. They are having low resistance. It is essential to measure its resistance precisely to calculate the voltage drop per kilometer when these conductors are used in transmission and distribution circuits.

II Relevant Program Outcomes (POs)

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

III Competency and Practical Skills

This practical is expected to develop the following skills for the industry identified competency: **'Plan wiring/cabling activities using relevant materials following safe practices'**

ii. Measure electrical parameters using proper equipment.

IV Relevant Course Outcome(s)

- Select relevant conductors and electromagnetic/magnetic materials.

V Practical Outcome

1. Measure conductor resistance of cables using Kelvin's double bridge.

VI Relevant Affective domain related Outcome(s)

a. Practice good housekeeping with safety measures.
b. Demonstrate working as a leader/a team member.
c. Maintain tools and equipment.
d. Follow ethical practices.

VII Minimum Theoretical Background

Kelvin double bridge is a measuring instrument used to measure unknown electrical resistors below 1 ohm.

Use of Kelvin's Bridge eliminates the errors due to contact resistance and lead resistance. It also improves sensitivity. On the Kelvin's Bridge terminals are provided to connect current input, galvanometer and unknown resistance. A knob is provided for adjustment of the ratio of *"P/Q'*. For balancing the bridge a variable standard resistance is used, which consists of a tapped resistance for coarse adjustment and slide wire resistance for fine adjustment.

Standard low resistance is constructed with four terminals. One pair of terminals is marked C, C called current terminals. The other pair is marked as P, P and is called as pressure terminals. The use of pressure terminals for measuring voltage across low resistance with four terminals eliminates error due to contact resistance and lead resistance.

VIII Practical set-up / Circuit diagram / Work Situation

Fig. 1 Front view of Kelvin Double Bridge

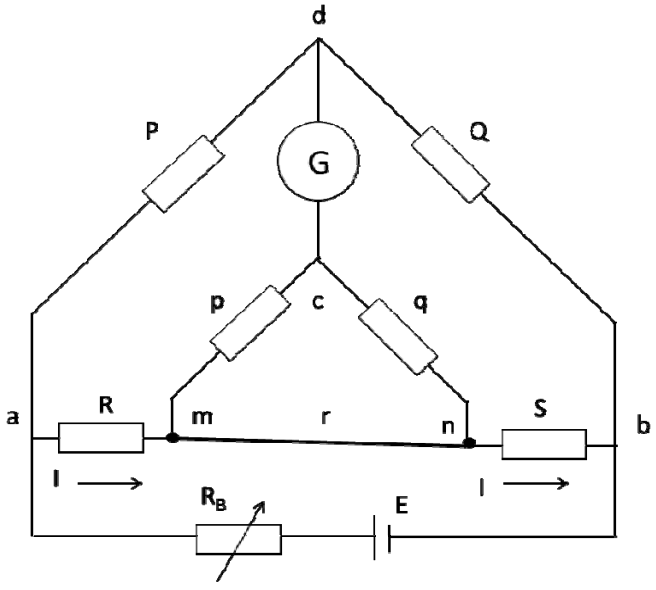

Figure 2 Kelvin Double Bridge Circuit Diagram

IX Resources Required

S. No.	Name of Resource	Suggested Broad Specification	Quantity
1	Kelvin's Double Bridge	Kit	1 No.
2	Copper wires of various sizes	1 sq. mm, 1.5 sq. mm, 2.5 sq. mm,	1 m each

X Precautions to be followed

1 Read manufactures instruction before using kit.
2 Follow instructions mentioned in the instruction sheet.
3 There should not be any loose connections.

XI Procedure

Note: Watch video reference [1] before performing practical.

1. Set the Galvanometer switch to "INT" position. (This connects the built-in galvanometer to the circuit. If an external more sensitive galvanometer is available, connect it to the terminals marked "EXTGALV" and put the galvanometer switch in "EXT" position).
2. Connect +C and +P terminals using test probs. Also connect -P and –C with test probs.
3. Connect Test wire/ cable to +C and –C terminals.
4. Now, press the push button on the panel and obtain the balance by varying the dials.
5. Note down the readings in observation Table.
6. Repeat the experiment for 2/3 samples.
7. Calculate the value of unknown resistance R.

XII Resources Used (Student should write the resources required)

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

XIII Actual Procedure Followed (Use blank sheet provided if space not sufficient)

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XIV Observations and Calculations (Use blank sheet provided if space not sufficient)

S.N.	Sample Description	P/Q=p/q	S	Unknown Resistance R=(P/Q) x S
1				
2				
3				
4				

XV Results

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XVI Interpretation of Results (Give meaning of the above obtained results)

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XVII Conclusions (Actions/decisions to be taken based on the interpretation of results).

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XVIII Practical Related Questions: (Use separate sheet for answer)

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

1. State, why Kelvins Bridge is more suitable for measurement of low resistance?
2. State, the purpose of providing four terminals on kelvin double bridge.
3. State, why "EXTGALV" terminals are provided on kit?

[Space for answers]

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XIX References / Suggestions for further reading

1. https://www.youtube.com/watch?v=EWTPvrJQG_4 , assessed on 10th April, 2018
2. https://www.electrical4u.com/kelvin-bridge-circuit-kelvin-double-bridge/ , assessed on 10th April, 2018

XX Suggested Assessment Scheme

Performance indicators		Weightage
Process related: 30 Marks		**60%**
1	Handling of the instruments	10 %
2	Identification of component/dial/scale	20 %
3	Measuring value using suitable instrument	20 %
4	Working in team	10 %
Product related: 20 Marks		**40%**
5	Writing result	10 %
6	Interpretation of result	05 %
7	Conclusions	05 %
8	Practical related questions	15 %
9	Submitting the journal in time	05%
Total		**100 %**

Names of Student Team Members

1. ……..
2. …….
3. ……

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

Practical No. 6: Megger

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 Relevant Program Outcomes (POs)

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

III. Competency and Practical Skills

This practical is expected to develop the following skills for the industry identified competency: **'Plan wiring/cabling activities using relevant materials following safe practices'**

i. Use Megger.
ii. Measure insulation resistance.

IV Relevant Course Outcome(s)

- Select relevant insulating materials.
- Perform different types of electrical wiring/cabling activities.

V Practical Outcome

1. Use the Megger to measure insulation resistance of cables.

VI Relevant Affective domain related Outcome(s)

i. Practice good housekeeping with safety measures.
ii. Demonstrate working as a leader/a team member.
iii. Maintain tools and equipment.
iv. Follow ethical practices.

VII Minimum Theoretical Background

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.

VIII Practical set-up / Circuit diagram / Work Situation

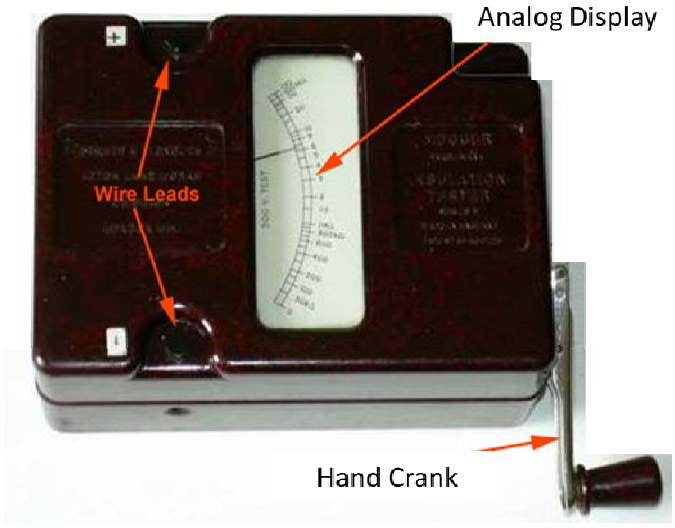

Figure 1 Front view of Megger

Connection Diagram:

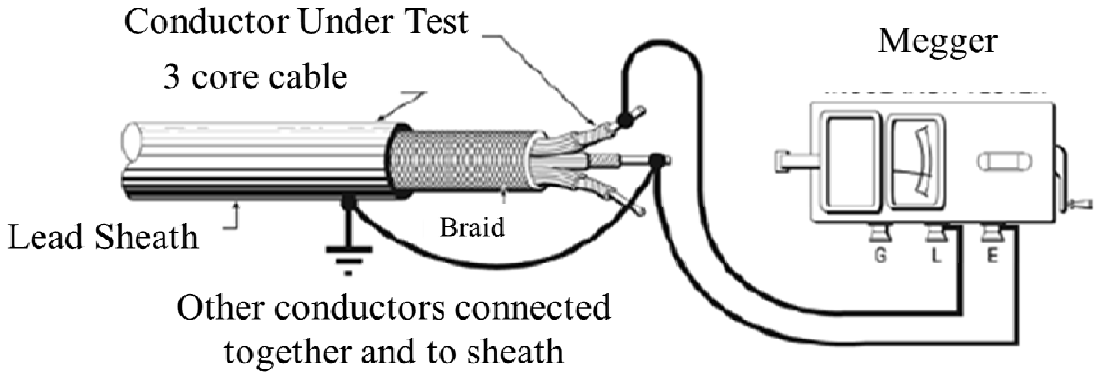

Figure 2: Insulation Resistance test of Cable

IX Resources Required

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

X 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.

XI 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.

XII Resources Used (Student should write the resources required)

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

XIII Actual Procedure Followed (Use blank sheet provided if space not sufficient)

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XIV Observations and Calculations (Use blank sheet provided if space not sufficient)

S.N.	Connection Description	Readings	Remarks
1.			
2.			
3.			

XV Results

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XVI Interpretation of Results (Give meaning of the above obtained results)

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XVII Conclusions (Actions/decisions to be taken based on the interpretation of results).

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XVIII Practical Related Questions: (Use separate sheet for answer)

(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.

[Space for answers]

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XIX References / Suggestions for further reading

1. http://www.techni-tool.com/site/ARTICLE_LIBRARY/Megger%20-%20The%20Complete%20Guide%20to%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

XX Suggested Assessment Scheme

Performance indicators		Weightage
Process related: 30 Marks		**60%**
1.	Handling of the instruments	10 %
2.	Identification of component/dial/scale	20 %
3.	Measuring value using suitable instrument	20 %
4.	Working in team	10 %
Product related: 20 Marks		**40%**
5.	Writing result	10 %
6.	Interpretation of result	05 %
7.	Conclusions	05 %
8.	Practical related questions	15 %
9.	Submitting the journal in time	05%
Total		**100 %**

Names of Student Team Members

1. ……
2. ……
3. ……

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

Practical No. 7 & 8: Wheatstone bridge

I Practical Significance

The conductors are generally made from copper & aluminum. They are having low resistance. It is essential to measure its resistance precisely to calculate the voltage drop per kilometer when these conductors are used in transmission and distribution circuits.

II Relevant Program Outcomes (POs)

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

III Competency and Practical Skills

This practical is expected to develop the following skills for the industry identified competency: **'Plan wiring/cabling activities using relevant materials following safe practices'**

1. Measure electrical parameters using proper equipment.

IV Relevant Course Outcome(s)

- Select relevant conductors and electromagnetic/magnetic materials.

V Practical Outcome

1. Use the Wheatstone's bridge to measure resistance of a conductor bundle (to determine per unit length resistance).
2. Use Wheatstone's bridge to measure resistance of conductor bundles (to determine per unit length resistance) (two specimens of different cross sections area).

VI Relevant Affective domain related Outcome(s)

1. Practice good housekeeping with safety measures.
2. Demonstrate working as a leader/a team member.
3. Maintain tools and equipment.
4. Follow ethical practices.

VII Minimum Theoretical Background

A Wheatstone bridge is an electrical circuit used to measure an unknown electrical resistance by balancing two legs of a bridge circuit, one leg of which includes the unknown component. The wheatstone bridge provide extremely accurate measurements. Its operation is similar to the original potentiometer.

The wheatstone bridge circuit is shown in Fig. 2. The resistances P, Q are known resistances and resistance S is adjustable. If the voltage across galvanometer is zero, then, P/Q = R/S.

Therefore, the unknown resistance R = P/Q x S

VIII Practical set-up / Circuit diagram / Work Situation

Fig. 1 Front view of Wheatstone Bridge

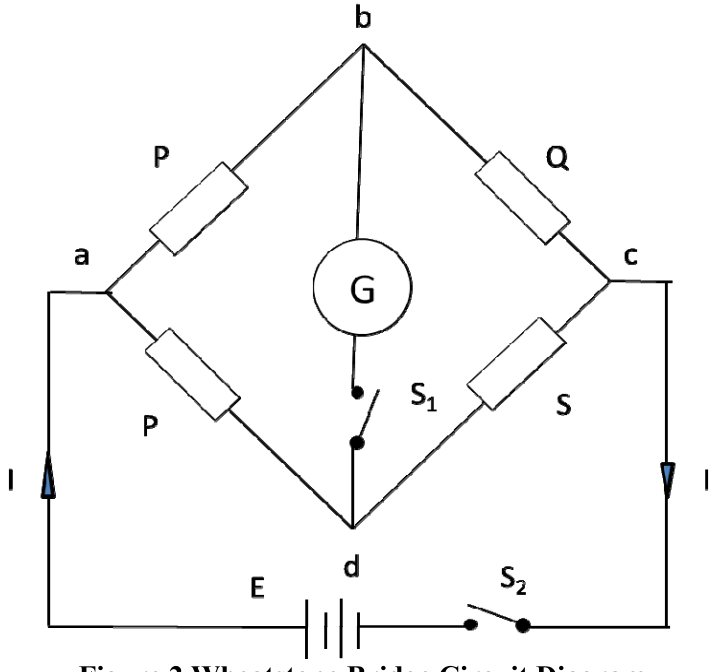

Figure 2 Wheatstone Bridge Circuit Diagram

IX Resources Required

S. No.	Name of Resource	Suggested Broad Specification	Quantity
1	Wheatstone Bridge	Kit	1 No.
2	Copper wires Coils of various sizes	1 sq. mm, 1.5 sq. mm, 2.5 sq. mm,	1 coil each

X Precautions to be followed

1 Read manufactures instruction before using kit.
2 Follow instructions mentioned in the instruction sheet.
3 There should not be any loose connections.

XI Procedure

1. Connect test wire coil to terminals.
2. Set wheatstone bridge for reading by pressing the push buttons on the panel and obtain the balance by varying the dials.
3. Note down the readings in observation Table.
4. Repeat the experiment for 2/3 samples.
5. Calculate the total resistance (R) of the coil.
6. Determine per unit length resistance

XII Resources Used (Student should write the resources required)

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

XIII Actual Procedure Followed (Use blank sheet provided if space not sufficient)

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XIV Observations and Calculations (Use blank sheet provided if space not sufficient)

S.N.	Sample Description	P/Q=p/q	S	Unknown Resistance R=(P/Q) x S
1				
2				
3				
4				

XV Determination of per unit length resistance of coils

S.N.	Sample Description	Measured Resistance (R)	Length of Coil	Per unit length resistance of coil
1				
2				
3				
4				

XVI Results

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XVII Interpretation of Results (Give meaning of the above obtained results)

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XVIII Conclusions (Actions/decisions to be taken based on the interpretation of results).

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XIX Practical Related Questions: (Use separate sheet for answer)

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

1. State the principle of wheatstone bridge.
2. State, the difference between Kelvins Bridge and wheatstone bridge.

[Space for answers]

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XX References / Suggestions for further reading

1. https://www.youtube.com/watch?v=3PYn-fG4J9c , assessed on 10th April, 2018
2. https://www.youtube.com/watch?v=yjfKts8tCDU , assessed on 10th April, 2018

XXI Suggested Assessment Scheme

S.No	Performance indicators	Weightage
Process related: 30 Marks		**60%**
1.	Handling of the instruments	10 %
2.	Identification of component/dial/scale	20 %
3.	Measuring value using suitable instrument	20 %
4.	Working in team	10 %
Product related: 20 Marks		**40%**
5.	Writing result	10 %
6.	Interpretation of result	05 %
7.	Conclusions	05 %
8.	Practical related questions	15 %
9.	Submitting the journal in time	05%
	Total	**100 %**

Names of Student Team Members

1. ……..
2. …….
3. ……

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

Practical No. 9: Selection of Fuse

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 Relevant Program Outcomes (POs)

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

III Competency and Practical Skills

This practical is expected to develop the following skills for the industry identified competency: **'Plan wiring/cabling activities using relevant materials following safe practices'**

i. Select proper fuse element.
ii. Connect fuse in electrical circuit.
iii. Replace fuse element.

IV Relevant Course Outcome(s)

- Follow safe practices when undertaking electrical works.

V Practical Outcome

1. Select and place relevant fuses in different lighting circuits.

VI Relevant Affective domain related Outcome(s)

i. Practice good housekeeping with safety measures.
ii. Demonstrate working as a leader/a team member.
iii. Maintain tools and equipment.
iv. Follow ethical practices.

VII Minimum Theoretical Background

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 (L_1, L_2 and L_3 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. Re-wirable 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 re-wirable 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.

VIII Practical set-up / Circuit diagram / Work Situation

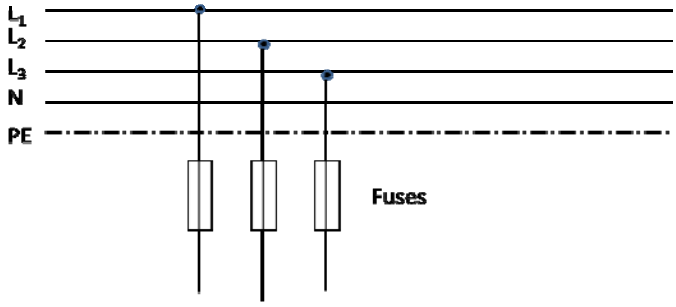

Fig. 1 Fuse Placement

IX Resources Required

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	150 mm	1 No.
4.	Insulated Combination Plier	200 mm	1 No.
5.	Test lamp	-	1 No.

X 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.

XI 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.

XII Resources Used (Student should write the resources required)

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

XIII Actual Procedure Followed (Use blank sheet provided if space not sufficient)

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XIV Observations and Calculations (Use blank sheet provided if space not sufficient)

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

S. No	Sub-circuit No.	Description	Total connected Load	Total current	Fuse current rating
1.					
2.					
3.					
4.					

XV Results

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XVI Interpretation of Results (Give meaning of the above obtained results)

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XVII Conclusions (Actions/decisions to be taken based on the interpretation of results).

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XVIII Practical Related Questions: (Use separate sheet for answer)

(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.

[Space for answers]

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XIX References / Suggestions for further reading

1. K.B. Raina, S.K.Bhattacharya, "Electrical Design Estimation and Costing", New Age International Publishers, Reprint 2010, ISBN(10): 81-224-0363-8; ISBN(13): 978-81-224-0363-3

XX Suggested Assessment Scheme

S.No	Performance indicators	Weightage
	Process related: 30 Marks	**60%**
1.	Handling of the instruments	10 %
2.	Identification of component/dial/scale	20 %
3.	Measuring value using suitable instrument	20 %
4.	Working in team	10 %
	Product related: 20 Marks	**40%**
5.	Writing result	10 %
6.	Interpretation of result	05 %
7.	Conclusions	05 %
8.	Practical related questions	15 %
9.	Submitting the journal in time	05%
	Total	**100 %**

Names of Student Team Members

1. ……..
2. …….
3. ……

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

Practical No. 10, 11: Elctromagnetic Material

I Practical Significance

To increase the efficiency of electrical machines and devices like transformer it is necessary to decrease the losses. It is necessary to minimize the core loss; hence the selection of core material is very important.

II Relevant Program Outcomes (POs)

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

III Competency and Practical Skills

This practical is expected to develop the following skills for the industry identified competency: **'Plan wiring/cabling activities using relevant materials following safe practices'**

i. Construct simple electromagnet
ii. Measure iron losses of various electromagnetic materials.

IV Relevant Course Outcome(s)

- Select relevant conductors and electromagnetic/magnetic materials.

V Practical Outcome

1. Use the coil over core arrangement to determine the iron losses per unit weight of first electromagnetic specimen.
2. Use the coil over core arrangement to determine the iron losses per unit weight of second electromagnetic specimen.

VI Relevant Affective domain related Outcome(s)

i. Practice good housekeeping with safety measures.
ii. Demonstrate working as a leader/a team member.
iii. Maintain tools and equipment.
iv. Follow ethical practices.

VII Minimum Theoretical Background

The hyteresis and eddy current losses occur within the core (magnetic material) of machine or devices. For a given magnetic circuit with a core of ferromagnetic material, volume and thickness of the plates are constant and the total core loss can be expressed as follows.

Core loss = Hysteresis loss + Eddy current loss

The core loss of electromagnetic material can be measure with the help of a wattmeter (W) by energizing the N turn coil having negligible resistance from a sinusoidal voltage of known frequency, keeping constant cross sectional area of the core as shown in fig. 1.

VIII Practical set-up / Circuit diagram / Work Situation

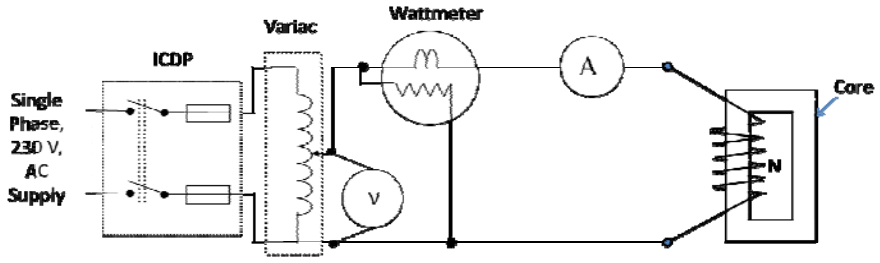

Fig. 1 Circuit diagram to measure core loss

IX Resources Required

S. No.	Name of Resource	Suggested Broad Specification	Quantity
1	Multimeter	Standard	1 No.
2	Single phase Auto Transformer	2kVA,(0-230) V, 50 Hz. A.C.	1 No.
3	Ammeter	MI, 0-5 A	1 No.
4	Voltmeter	MI, 0-300 V	1 No.
5	Wattmeter	300 V, 5/10 A	1 No.
6	Coil over core arrangement of various electromagnetic material	Suitable core size, insulate copper wire of suitable gauge & length	1 Each.

X Precautions to be Followed

1 The winding used to construct the setup should be well insulated from core.
2 Insulation paper (used for motor rewinding) may preferably use on the core
3 There should not be any loose connections.
4 Select proper range of meters.

XI Procedure

1. Take old choke of a florescent lamp (Tube Light) or a small transformer.
2. Dismantle the choke /transformer
3. Remove its windings & use its core to form coil over core arrangement.
4. Measure weight of the core.
5. Select a copper wire of suitable gauge & length (So as to have sufficient number of turns).
6. Measure resistance of the winding using multi-meter.
7. Wind copper wire over the selected core.
8. Connect circuit as shown in circuit diagram Fig. 1.
9. Switch “ON” the supply.
10. Apply suitable voltage across the coil over core with help of autotransformer.
11. Note down the readings of all meters in observation Table.
12. Switch “OFF” supply.
13. Repeat the experiment for various electromagnetic cores of same cross sectional area and size.
14. Compare the results of various core material.

XII Resources Used (Student should write the resources required)

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

XIII Actual Procedure Followed (Use blank sheet provided if space not sufficient)

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XIV Observations and Calculations (Use blank sheet provided if space not sufficient)

Weight of core 1 = …….. Kg, Weight of core 2 = …….. Kg
Resistance of winding1 R = ……Ω, Resistance of winding 2 R = …….. Ω

Sr. No.	Sample	Voltage applied (volts)	Current I (Amps)	Power P (Watts)	i^2R (Watts)	Total Iron losses (Watts) ($P- i^2R$)	Iron loss per unit weight = (Total Iron losses/ Weight of core)
1							
2							

XV Results

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XVI Interpretation of Results (Give meaning of the above obtained results)

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XVII Conclusions (Actions/decisions to be taken based on the interpretation of results).

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XVIII Practical Related Questions: (Use separate sheet for answer)

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

1 State the factors on which the core loss of material depends.
2 Define hysteresis loss and eddy current loss.
3 State how the hysteresis loss and eddy current losses are calculated from core loss.
4 What is the significance of iron loss per unit weight?
5 State methods to reduce iron loss in core.
6 State the effect of using solid core on the amount of iron loss.
7 Calculate the value of MMF produced in this experiment.

[Space for answers]

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XIX References / Suggestions for further reading

1 http://www.nptel.ac.in/courses/Webcourse-contents/IIT%20Kharagpur/Basic%20Electrical%20Technology/pdf/L-22(TB)(ET)%20((EE)NPTEL).pdf , assessed on 10th April, 2018

XX Suggested Assessment Scheme

S.No	Performance indicators	Weightage
	Process related: 30 Marks	**60%**
1	Handling of the instruments	10 %
2	Identification of component/dial/scale	20 %
3	Measuring value using suitable instrument	20 %
4	Working in team	10 %
	Product related: 20 Marks	**40%**
5	Writing result	10 %
6	Interpretation of result	05 %
7	Conclusions	05 %
8	Practical related questions	15 %
9	Submitting the journal in time	05%
	Total	**100 %**

Names of Student Team Members

1. ……..
2. …….
3. ……

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

Practical No. 12: Selection of Insulating Material

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 Relevant Program Outcomes (POs)

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

III Competency and Practical Skills

This practical is expected to develop the following skills for the industry identified competency: **'Plan wiring/cabling activities using relevant materials following safe practices'**

i. Identify various insulating materials
ii. Select proper insulating material as per class of insulation.

IV Relevant Course Outcome(s)

- Select relevant insulating materials.

V Practical Outcome

1. Select insulating materials for specific applications from given samples (at least five).

VI Relevant Affective domain related Outcome(s)

i. Practice good housekeeping with safety measures.
ii. Demonstrate working as a leader/a team member.
iii. Maintain tools and equipment.
iv. Follow ethical practices.

VII Minimum Theoretical Background

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.

VIII Practical set-up / Circuit diagram / Work Situation

…….Not Applicable…….

IX Resources Required

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

X Precautions to be followed

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

XI 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.

XII Resources Used (Student should write the resources required)

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

XIII Actual Procedure Followed (Use blank sheet provided if space not sufficient)

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XIV Observations and Calculations (Use blank sheet provided if space not sufficient)

Sample 1:

Properties:

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Identification:…….

Applications:

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Sample 2:
Properties:

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Identification: ……

Applications:

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Sample 3:
Properties:

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Identification:……

Applications:

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Sample 4:
Properties:

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Identification : ……

Applications:

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Sample 5:
Properties:

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Identification:……

Applications:

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XV Results

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XVI Interpretation of Results (Give meaning of the above obtained results)

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XVII Conclusions (Actions/decisions to be taken based on the interpretation of results).

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XVIII Practical Related Questions: (Use separate sheet for answer)
(Teacher should provide various questions related to practical- sample given)

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

[Space for answers]

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XIX 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 Enginnering Material & Electronics Components", S.K. Kataria & Sons, 2013, ISBN: 9789350144176

XX Suggested Assessment Scheme

S.No	Performance indicators	Weightage
Process related: 30 Marks		**60%**
1.	Handling of the instruments	10 %
2.	Identification of component/dial/scale	20 %
3.	Measuring value using suitable instrument	20 %
4.	Working in team	10 %
Product related: 20 Marks		**40%**
5.	Writing result	10 %
6.	Interpretation of result	05 %
7.	Conclusions	05 %
8.	Practical related questions	15 %
9.	Submitting the journal in time	05%
	Total	**100 %**

Names of Student Team Members

1. ……..
2. …….
3. ……

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

Practical No. 13, 14: Cable Fault Testing

I Practical Significance

Cable faults can be occur with insulation damage due to ageing, excess heat, wrong handling, improper termination of cable, and moisture in the soil. To restore the supply fault finding and repairing of cable fault is necessary.

II Relevant Program Outcomes (POs)

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

III Competency and Practical Skills

This practical is expected to develop the following skills for the industry identified competency: **'Plan wiring/cabling activities using relevant materials following safe practices'**

i. Use Megger for fault finding
ii. Interpret the megger results.

IV Relevant Course Outcome(s)

- Follow safe practices when undertaking electrical works
- Perform different types of electrical wiring/cabling activities.

V Practical Outcome

1. Investigate (and record observations) a cable failure by insulation breakdown (1st case)
2. Investigate (and record observations) a cable failure by insulation breakdown (2nd case)

VI Relevant Affective domain related Outcome(s)

i. Practice good housekeeping with safety measures.
ii. Demonstrate working as a leader/a team member.
iii. Maintain tools and equipment.
iv. Follow ethical practices.

VII Minimum Theoretical Background

There are three types of cable fault.

1. Short circuit between two conductor,
2. Earth fault, i.e., fault between conductor and ground,
3. Open circuit caused due to disconnection of conductor.

At a time one or more faults may occur. The primary cause of the short circuit and earth fault is due to damage of insulation caused by water, moisture or other reason. In an electrical machine due to the defect in the armature, plumbing or the lubricant compound gets out due to excess heat; insulation of the cable can get damaged. The open circuit fault can occur due to wrong handling of conductor, improper termination

of cable, loose clamping in terminal box and depression in soil which stretch the joint. Apart from these, all reasons of short circuit may lead to open circuit fault.

Apart from the various sophisticated testing equipment, megger test is a basic test for finding cable fault. Before doing megger test, it is necessary to check outdoor and indoor terminal box respectively

Type of fault in the cable, can be detect using megger by measuring earth resistance of each core. If there is a short between the core and the earth, the insulation resistance of such core will show 'ZERO" or very less in megger. If we do not find continuity in any core between two ends, there is an open circuit on such core. If there is no continuity in all the three cores, means entire three cores are open circuited. After deducting the fault, repair the cable.

VIII Practical set-up / Circuit diagram / Work Situation

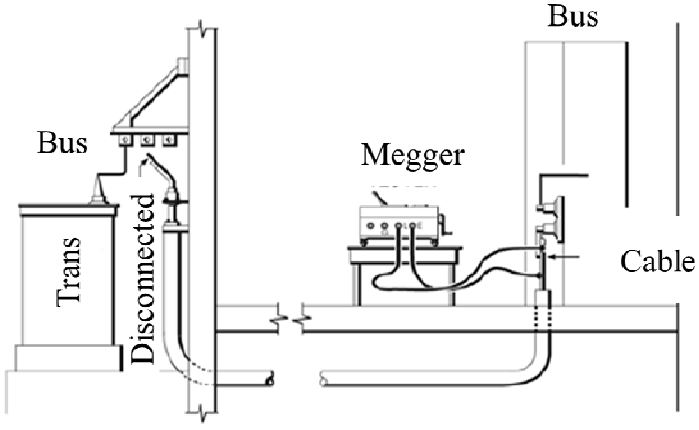

Figure 1: Insulation Resistance test of Cable

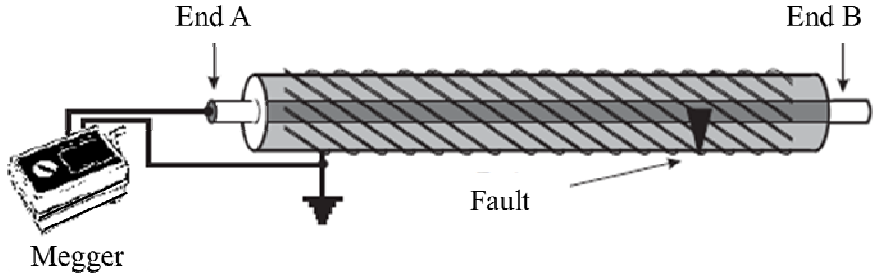

Figure 2: Insulation Resistance test using Megger

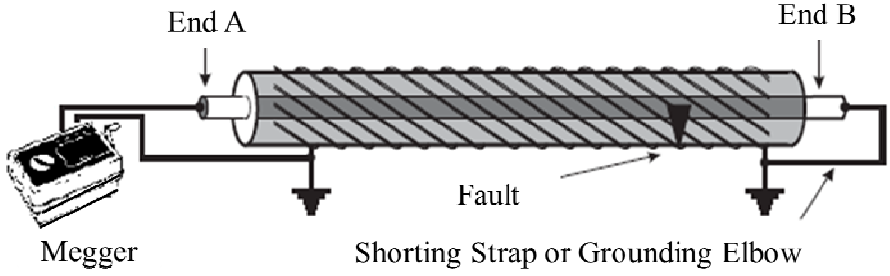

Figure 3: Loop Test for Continuity using Megger

IX Resources Required

S. No.	Name of Resource	Suggested Broad Specification	Quantity
1	Megger	As per cable voltage level	1 No.
2	Test cable	Suitable size	1 No.

X 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.

XI Procedure

1. Open the cable ends from both side as shown in Fig. 1
2. Connect the megger between the faulted conductor and ground as shown in Fig. 2.
3. Measure and record this resistance reading.
4. Connect the instrument between each of the other phase conductors, and ground and record the readings.
5. Connect a short between the phase and neutral as shown in Fig.3, do a loop test for continuity and record the reading.
6. Repeat all tests from end B and record all readings.

XII Resources Used (Student should write the resources required)

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

XIII Actual Procedure Followed (Use blank sheet provided if space not sufficient)

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XIV Observations and Calculations (Use blank sheet provided if space not sufficient)

S.N.	Connection Description	Readings	Remarks
1.			
2.			
3.			

XV Results

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XVI Interpretation of Results (Give meaning of the above obtained results)

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XVII Conclusions (Actions/decisions to be taken based on the interpretation of results).

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XVIII Practical Related Questions: (Use separate sheet for answer)

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

1. Name the other equipment's (except insulation tester) for locating the cable fault.
2. State, why cable should be disconnected from supply before testing?
3. How will you differentiate open circuit and short circuit fault in cable using megger ?

[Space for answers]

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XIX References / Suggestions for further reading

1. https://www.electrical4u.com/fault-of-electric-cable/ , assessed on 15th April, 2018
2. http://www.elandcables.com/the-cable-lab/faqs/faq-what-are-the-main-causes-of-electrical-cable-failure , assessed on 12th April, 2018
3. https://www.powerpoint-engineering.com/technical-support/technical-guides/cable-testing-fault-location-technical-guides/, , assessed on 15th April, 2018

XX Suggested Assessment Scheme

S.No	Performance indicators	Weightage
Process related: 30 Marks		**60%**
1.	Handling of the instruments	10 %
2.	Identification of component/dial/scale	20 %
3.	Measuring value using suitable instrument	20 %
4.	Working in team	10 %
Product related: 20 Marks		**40%**
5.	Writing result	10 %
6.	Interpretation of result	05 %
7.	Conclusions	05 %
8.	Practical related questions	15 %
9.	Submitting the journal in time	05%
Total		**100 %**

Names of Student Team Members

1. ……
2. ……
3. ……

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

Practical No. 15, 16: Insulating Oil Testing

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 Relevant Program Outcomes (POs)

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

III Competency and Practical Skills

This practical is expected to develop the following skills for the industry identified competency: **'Plan wiring/cabling activities using relevant materials following safe practices'**

i.Test insulating oil.

ii.Find dielectric test of insulating oil.

IV Relevant Course Outcome(s)

- Follow safe practices when undertaking electrical works.
- Select relevant insulating materials.

V Practical Outcome

1. Dielectric strength test of one insulating oil sample.
2. Dielectric strength test of two different insulating oil samples of varied usages.

VI Relevant Affective domain related Outcome(s)

i. Practice good housekeeping with safety measures.
ii. Demonstrate working as a leader/a team member.
iii. Maintain tools and equipment.
iv. Follow ethical practices.

VII Minimum Theoretical Background

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. 1, whose circuit diagram is shown in Fig. 2. Indian standard IS. 6792: 1972 covers a method for determination of electric strength of insulating oils.

VIII Practical set-up / Circuit diagram / Work Situation

Fig. 1 Oil Testing Kit

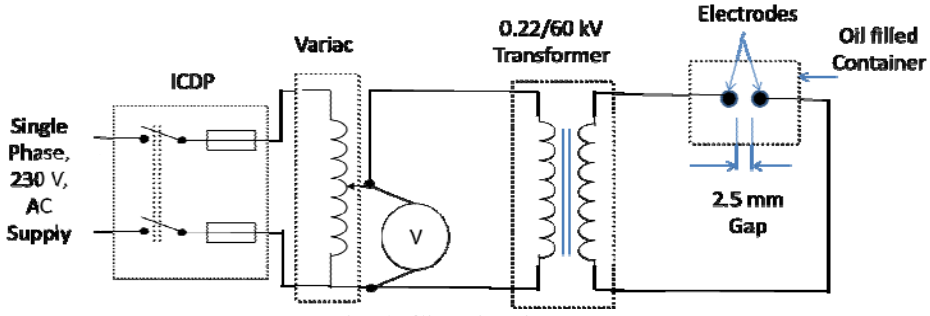

Fig. 2 Circuit Diagram

IX Resources Required

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

X 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.

XI 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.

XII Resources Used (Student should write the resources required)

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

XIII Actual Procedure Followed (Use blank sheet provided if space not sufficient)

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XIV Observations and Calculations (Use blank sheet provided if space not sufficient)

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.	
Sample 3 sample taken from ……..…….	1.	
	2.	
	3.	
	4.	
	5.	

XV Results

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XVI Interpretation of Results (Give meaning of the above obtained results)

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XVII Conclusions (Actions/decisions to be taken based on the interpretation of results).

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XVIII Practical Related Questions: (Use separate sheet for answer)

(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]

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XIX 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

XX Suggested Assessment Scheme

S.No	Performance indicators	Weightage
Process related: 30 Marks		**60%**
1	Handling of the instruments	10 %
2	Identification of component/dial/scale	20 %
3	Measuring value using suitable instrument	20 %
4	Working in team	10 %
Product related: 20 Marks		**40%**
5	Writing result	10 %
6	Interpretation of result	05 %
7	Conclusions	05 %
8	Practical related questions	15 %
9	Submitting the journal in time	05%
	Total	**100 %**

Names of Student Team Members

1. ……..
2. …….
3. ……

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

Practical No. 17: Staircase Wiring

I Practical Significance

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

II Relevant Program Outcomes (POs)

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

III Competency and Practical Skills

This practical is expected to develop the following skills for the industry identified competency: **'Plan wiring/cabling activities using relevant materials following safe practices'**

i. Wire up the circuit.
ii. Perform various types of wiring systems.
iii. Fix electrical accessories.
iv. Test wiring circuit.

IV Relevant Course Outcome(s)

- Perform different types of electrical wiring/cabling activities.

V Practical Outcome

1. Prepare staircase wiring and test it.

VI Relevant Affective domain related Outcome(s)

i. Practice good housekeeping with safety measures.
ii. Demonstrate working as a leader/a team member.
iii. Maintain tools and equipment.
iv. Follow ethical practices.

VII Minimum Theoretical Background

In electrical wiring work, the electrician is supplied with a layout of wiring installation and an installation plan initially. On the basis of the layout and installation plan, the electrician should draw the circuit and wiring diagrams before the commencement of work for systematic execution of the work. The terms used in wiring installation drawings are explained below with an example of staircase wiring (one lamp controlled from two different places).

VIII Circuit diagram: Circuit diagram shows the schematic connections of the circuit for a specific task in the simplest form, incorporating the graphical symbols. The purpose of a circuit diagram is to explain the function of the various accessories in the circuit. Fig.1 shows the wiring diagram. (Controlling a lamp from two different places).

IX **Wiring diagram:** This is the diagram in which the position of the components in the diagram bears a resemblance to their actual physical position. The wiring diagram may not have distance marking. Use of the wiring diagram along with the layout diagram enables the technician in the initial stages of the planning to specify/estimate the required type, size and length of the cables, and also to decide on the vertical, horizontal and ceiling runs of the cable. The wiring diagram is of great use to test and rectify faults in the installation during maintenance work. Fig.4 also shows the wiring diagram. (Controlling a lamp from two different places with their actual locations.) For his own good and to facilitate quick location of faults at a later stage, the customer should insist on the electrician giving him a copy of the wiring diagram soon after the completion of wiring. The electrician should make it a point to do so.

X **Layout diagram:** The layout diagram shown in fig.3 is a simplified version of the wiring diagram. Its purpose is to inform the reader quickly and exactly, what the circuit is designed for without giving any information on the circuit itself. This type of layout diagram is used for preparing architectural diagrams, plans, etc. of a building. In a layout diagram, it is necessary to indicate with symbols details like whether the wiring is on the surface or concealed, and the run 'up' or 'down', the number of wires in run, dimensions, and accessories with appropriate I.S. Symbols. Normally the layout plan is drawn and then the wiring diagram. After completion of the wiring diagram, the numbers of cables to be run in each cable run and the size of conduit or batten are estimated. With the help of the distance marking in the layout plan, the estimation of cables could be made.

XI **Practical set-up / Circuit diagram / Work Situation**

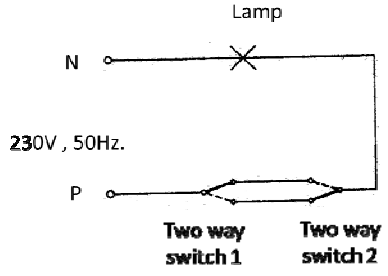

Fig. 1 Circuit Diagram

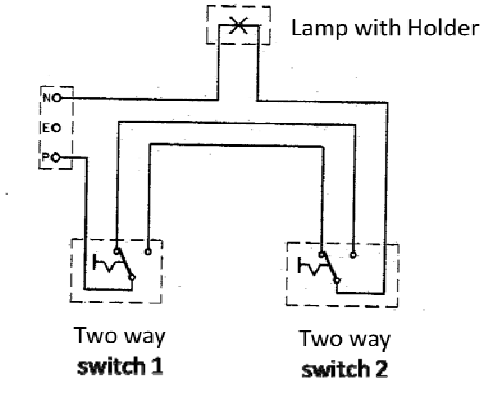

Fig. 2 Wiring Diagram

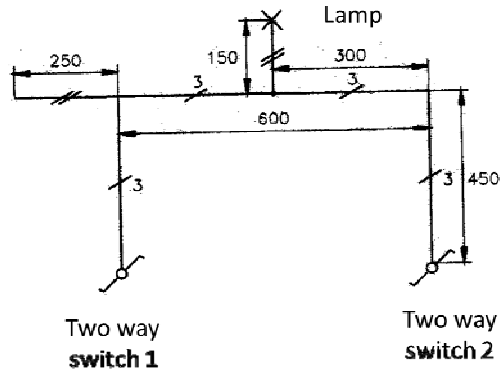

Fig. 3 Layout Diagram

XII Resources Required

S. No.	Name of Resource	Suggested Broad Specification	Quantity
1	Combination pliers	200 mm	1 No.
2	Screwdriver	200 x 5 mm	2 No.
3	Connector/ screwdriver	100 x 3 mm	1 No.
4	Screwdriver	150 mm x 3 mm	1 No.
5	Hacksaw	300 mm with blade (24 T.P.I.)	1 No.
6	Plumb bob with thread	Standard	1 No.
7	Hammer	250 grams	1 No.
8	Poker / scratch awl	150 mm	1 No.
9	Hand drilling machine with 3 mm bit	Standard	1 No.
10	Twist Drill	6 mm	1 No.
11	Measuring tape	2 mtr.	1 No.
12	Side cutter	150 mm	1 No.
13	Electrician's knife	Standard	1 No.
14	Bakelite angle batten holder	6A, 240V	1 No.
15	Single pole two way switch modular	6A, 240V	2 Nos.
16	PVC conduit pipe	19 mm x 1.2 mm thick	3 m
17	PVC Saddle	19 mm	12 Nos.
18	PVC cable, Copper	1.0 mm^2	7m
19	PVC junction box	18 mm 3-way	3 Nos.
20	Wood screws	12 mm	12 Nos.
21	Wood screws	35 mm	6 Nos.
22	PVC Modular switch box	2 M	2 Nos.
23	Modular board strips	standard	2 Nos.

XIII Precautions to be followed

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

XIV Procedure

1. Mark the layout on the wiring board.
2. Cut the PVC pipes as per the layout.
3. Fix the saddles as per the layout and installation plan. (For this work fix the saddle at a distance of 75 mm from the center of the block and conduit accessories. Fix only one side of the saddle initially. The other side is to be fixed while laying the conduit.).
4. Fix the conduits and accessories on the wiring board with the help of saddles as per the plan.
5. Cut the cables according to the route and bunch them (Leave the excess length of 200 to 300 mm in each cable for termination).
6. Insert the required cables in the appropriate pipes and accessories as per layout and push the wires to the other end of the pipes.
7. Take the modular boxes. Place them at the conduit ends and mark the external diameter of the conduit pipe on the surface.
8. Cut the upper side of modular box by Hacksaw and remove the portion from it.
9. Prepare round hole for conduit. Check the fitting of the conduit pipe in the hole at intervals till a correct fitting is made.
10. Position the accessories on the top cover of modular box close the open holes with strips (if any).
11. Prepare the end termination of the cables as per the wiring diagram.
12. Insert the lamp cables through the cable entry holes of junction box.
13. Terminate the cables in the batten holders and fix them.
14. Terminate the cables of the switches in the switch, and fix them.
15. Fix the boxes of the switches with wood screw on the wiring board.
16. Connect the supply wires in the supply terminals available.
17. Test the circuit after approval by the teacher.

XV Resources Used (Student should write the resources required)

S. No	Name of Resource	Broad Specifications		Quantity	Remarks (If any)
		Make	Details		
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					
13					
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15					
16					

XVI Actual Procedure Followed (Use blank sheet provided if space not sufficient)

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XVII Observations and Calculations (Use blank sheet provided if space not sufficient)

Draw the layout diagram as per the actual distances taken for wiring on board. (Refer Fig. 3)

(Space for drawing Layout diagram)

Calculate the length of wire and conduit from layout diagram.

Points	Length of conduit	Number of Wires	Total length of wire
Incoming Circuit			
A-B			
B-C			
B-D			
D-E			
E-F			
D-G			
G-H			
Total			
10% Extra for connection & wastage			
Total			

Calculate the material required for wiring from layout diagram.
(Write Nil in following table which is not required / used)

SN	Name of item with description	Points at which Required	Quantity
1	1.0 sq. mm PVC copper wire of size / 0.3		
2	PVC conduit 19 mm x 1.2 mm		
3	PVC Conduit Accessories		
	Junction Box- 1 Way		
	Junction Box- 2 Way		
	Junction Box- 3 Way		
	Junction Box- 4 Way		
	PVC bend 19 mm		
	PVC saddles 19 mm		
4	Single Pole Switch, 6A, 240 V		
5	Two way Switch, 6A, 240 V		
6	Socket Outlet, 6A, 240 V		
7	Ceiling Rose- 2 A, 240 V		
8	Angle Holder- 6 A, 240 V		
9	Fan regulator 65 watt, flush mounted		
10	Modular Board / PVC Boards- size…….		
11	Screw- 12 x 5 mm		
12	Screw- 35 x 6 mm		

XVIII Results

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Interpretation of Results (Give meaning of the above obtained results)

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Conclusions (Actions/decisions to be taken based on the interpretation of results).

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XIX Practical Related Questions: (Use separate sheet for answer)

(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. Draw the wiring diagram and circuit diagram for Three-Lamp control from Three different places.

[Space for answers]

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XIX References / Suggestions for further reading

K.B. Raina, S.K.Bhattacharya, "Electrical Design Estimation and Costing", New Age International Publishers, Reprint 2010, ISBN(10): 81-224-0363-8; ISBN(13): 978-81-224-0363-3

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

XX Suggested Assessment Scheme

S.No	Performance indicators	Weightage
Process related: 30 Marks		**60%**
1	Handling of the instruments	10 %
2	Identification of component/dial/scale	20 %
3	Measuring value using suitable instrument	20 %
4	Working in team	10 %
Product related: 20 Marks		**40%**
5	Writing result	10 %
6	Interpretation of result	05 %
7	Conclusions	05 %
8	Practical related questions	15 %
9	Submitting the journal in time	05%
	Total	**100 %**

Names of Student Team Members

1. ……..
2. …….
3. ……

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

Practical No. 18: Godown Wiring

I Practical Significance

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

II Relevant Program Outcomes (POs)

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

III Competency and Practical Skills

This practical is expected to develop the following skills for the industry identified competency: **'Plan wiring/cabling activities using relevant materials following safe practices'**

i. Wire up the circuit.
ii. Perform various types of wiring systems.
iii. Fix electrical accessories.
iv. Test wiring circuit.

IV Relevant Course Outcome(s)

- Perform different types of electrical wiring/cabling activities.

V Practical Outcome

1. Prepare godown wiring and test it.

VI Relevant Affective domain related Outcome(s)

i. Practice good housekeeping with safety measures.
ii. Demonstrate working as a leader/a team member.
iii. Maintain tools and equipment.
iv. Follow ethical practices.

VII Minimum Theoretical Background

Godown is a big hall having numbers of compartments. Fig. 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.

VIII Practical set-up / Circuit diagram / Work Situation

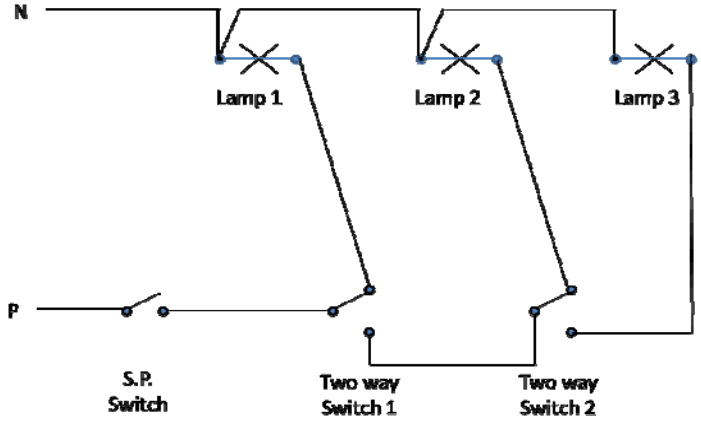

Fig. 1 Godown Wiring Circuit Diagram

IX Resources Required

S. No.	Name of Resource	Suggested Broad Specification	Quantity
1	Combination pliers	200 mm	1 No.
2	Screwdriver	200 x 5 mm	2 No.
3	Connector/ screwdriver	100 x 3 mm	1 No.
4	Screwdriver	150 mm x 3 mm	1 No.
5	Hacksaw	300 mm with blade (24 T.P.I.)	1 No.
6	Plumb bob with thread	Standard	1 No.
7	Hammer	250 grams	1 No.
8	Poker / scratch awl	150 mm	1 No.
9	Hand drilling machine with 3 mm bit	Standard	1 No.
10	Twist Drill	6 mm	1 No.
11	Measuring tape	2 mtr.	1 No.
12	Side cutter	150 mm	1 No.
13	Electrician's knife	Standard	1 No.
14	Bakelite angle batten holder	6A, 240V	1 No.
15	Single pole two way switch modular	6A, 240V	2 Nos.
16	PVC conduit pipe	19 mm x 1.2 mm thick	3 m
17	PVC Saddle	19 mm	12 Nos.
18	PVC cable, Copper	1.0 mm^2	7m
19	PVC junction box	18 mm 3-way	3 Nos.
20	Wood screws	12 mm	12 Nos.
21	Wood screws	35 mm	6 Nos.
22	PVC Modular switch box	2 M	2 Nos.
23	Modular board strips	standard	2 Nos.

X Precautions to be Followed

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

XI Procedure

1. Mark the layout on the wiring board.
2. Cut the PVC pipes as per the layout.
3. Fix the saddles as per the layout and installation plan. (For this work fix the saddle at a distance of 75 mm from the center of the block and conduit accessories. Fix only one side of the saddle initially. The other side is to be fixed while laying the conduit.).
4. Fix the conduits and accessories on the wiring board with the help of saddles as per the plan.
5. Cut the cables according to the route and bunch them (Leave the excess length of 200 to 300 mm in each cable for termination).
6. Insert the required cables in the appropriate pipes and accessories as per layout and push the wires to the other end of the pipes.
7. Take the modular boxes. Place them at the conduit ends and mark the external diameter of the conduit pipe on the surface.
8. Cut the upper side of modular box by Hacksaw and remove the portion from it.
9. Prepare round hole for conduit. Check the fitting of the conduit pipe in the hole at intervals till a correct fitting is made.
10. Position the accessories on the top cover of modular box close the open holes with strips (if any).
11. Prepare the end termination of the cables as per the wiring diagram.
12. Insert the lamp cables through the cable entry holes of junction box.
13. Terminate the cables in the batten holders and fix them.
14. Terminate the cables of the switches in the switch, and fix them.
15. Fix the boxes of the switches with wood screw on the wiring board.
16. Connect the supply wires in the supply terminals available.
17. Test the circuit after approval by the teacher.

XII Resources Used (Student should write the resources required)

S. No	Name of Resource	Broad Specifications		Quantity	Remarks (If any)
		Make	Details		
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
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12					
13					
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15					
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XIII Actual Procedure Followed (Use blank sheet provided if space not sufficient)

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XIV Observations and Calculations (Use blank sheet provided if space not sufficient)

Draw the wiring diagram of godown wiring.

(Space for drawing wiring diagram)

Draw the layout diagram as per the actual distances taken for wiring on board.

(Space for drawing Layout diagram)

Calculate the length of wire and conduit from layout diagram.

Points	Length of conduit	Number of Wires	Total length of wire
Incoming Circuit			
A-B			
B-C			
B-D			
D-E			
E-F			
D-G			
G-H			
Total			
10% Extra for connection & wastage			
Total			

Calculate the material required for wiring from layout diagram.
(Write Nil in following table which is not required / used)

SN	Name of item with description	Points at which Required	Quantity
1	1.0 sq. mm PVC copper wire of size / 0.3		
2	PVC conduit 19 mm x 1.2 mm		
3	PVC Conduit Accessories		
	Junction Box- 1 Way		
	Junction Box- 2 Way		
	Junction Box- 3 Way		
	Junction Box- 4 Way		
	PVC bend 19 mm		
	PVC saddles 19 mm		
4	Single Pole Switch, 6A, 240 V		
5	Two way Switch, 6A, 240 V		
6	Socket Outlet, 6A, 240 V		
7	Ceiling Rose- 2 A, 240 V		
8	Angle Holder- 6 A, 240 V		
9	Fan regulator 65 watt, flush mounted		
10	Modular Board / PVC Boards- size…….		
11	Screw- 12 x 5 mm		
12	Screw- 35 x 6 mm		

XV Results

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XVI Interpretation of Results (Give meaning of the above obtained results)

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XVII Conclusions (Actions/decisions to be taken based on the interpretation of results).

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XVIII Practical Related Questions: (Use separate sheet for answer)

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

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

[Space for answers]

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XIX References / Suggestions for further reading

1. K.B. Raina, S.K.Bhattacharya, "Electrical Design Estimation and Costing", New Age International Publishers, Reprint 2010, ISBN(10): 81-224-0363-8; ISBN(13): 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

XX Suggested Assessment Scheme

S.No	Performance indicators	Weightage
Process related: 30 Marks		**60%**
1	Handling of the instruments	10 %
2	Identification of component/dial/scale	20 %
3	Measuring value using suitable instrument	20 %
4	Working in team	10 %
Product related: 20 Marks		**40%**
5	Writing result	10 %
6	Interpretation of result	05 %
7	Conclusions	05 %
8	Practical related questions	15 %
9	Submitting the journal in time	05%
	Total	**100 %**

Names of Student Team Members

1. ……..
2. …….
3. ……

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

Practical No. 19: Switch Board Wiring

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 Relevant Program Outcomes (POs)

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

III Competency and Practical Skills

This practical is expected to develop the following skills for the industry identified competency: **'Plan wiring/cabling activities using relevant materials following safe practices'**

i. Use colour code in wiring.
ii. Wire up the circuit.
iii. Fix electrical accessories.
iv. Test wiring circuit.

IV Relevant Course Outcome(s)

- Perform different types of electrical wiring/cabling activities.

V Practical Outcome

1. Prepare switch board containing four switch four socket arrangements (with fuse, indicator, internal wiring etc.).

VI Relevant Affective domain related Outcome(s)

i. Practice good housekeeping with safety measures.
ii. Demonstrate working as a leader/a team member.
iii. Maintain tools and equipment.
iv. Follow ethical practices.

VII Minimum Theoretical Background

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. 1 are used in surface wiring.

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 Phase 2 Phase 3 Neutral	L_1 L_2 L_3 N	Red Yellow Blue Black
Protective	Conductor	PE	Green and yellow

VIII Practical set-up / Circuit diagram / Work Situation

Fig. 1 PVC Moular Boards (18 M)

IX Resources Required

S. No.	Name of Resource	Suggested Broad Specification	Quantity
1	Combination pliers	200 mm	1 No.
2	Screwdriver	200 x 5 mm	2 No.
3	Connector/ screwdriver	100 x 3 mm	1 No.
4	Screwdriver	150 mm x 3 mm	1 No.
5	Hacksaw	300 mm with blade (24 T.P.I.)	1 No.
6	Measuring tape	2 mtr.	1 No.
7	Side cutter	150 mm	1 No.
8	Electrician's knife	Standard	1 No.
9	Single pole switch modular	6A, 240V	4 Nos.
10	Socket outlet three pin modular	6A, 240V	4 Nos.
11	Neon Indicator modular	240V	1 No.
12	Fuse modular	6A, 240V	1 No.
13	PVC cable of red, black and green colour, Copper	1.0 mm^2	5m each
14	PVC Modular switch box	18 M	1 Nos.
15	Modular board strips	standard	4 Nos.

X 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 (Always mentioned on socket).
4 Make sure all connection should be tight.
5 Follow colour code of wires.

XI Procedure

a. 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).
b. Fix the accessories on the board.
c. Close remaining holes with modular board strips.
d. Measure and cut cables for connections according to requirement. Use the BIS recommended colour code for cable connections with in the board.
e. Wire up the board.
f. Connect the earth wire with socket outlets.
g. Complete the board.
h. Check the connection and approved the board from teacher.
i. Connect upper plate to the box with screws.
j. Test the board with test lamp.

XII Resources Used (Student should write the resources required)

S. No	Name of Resource	Broad Specifications		Quantity	Remarks (If any)
		Make	Details		
1					
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XIII Actual Procedure Followed (Use blank sheet provided if space not sufficient)

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XIV Observations and Calculations (Use blank sheet provided if space not sufficient)
Draw the wiring diagram.

XV Results

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XVI Interpretation of Results (Give meaning of the above obtained results)

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XVII Conclusions (Actions/decisions to be taken based on the interpretation of results).

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XVIII Practical Related Questions: (Use separate sheet for answer)
(Teacher should provide various questions related to practical- sample given)

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

[Space for answers]

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XIX References / Suggestions for further reading

1. K.B. Raina, S.K.Bhattacharya, "Electrical Design Estimation and Costing", New Age International Publishers, Reprint 2010, ISBN(10): 81-224-0363-8; ISBN(13): 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

XX Suggested Assessment Scheme

Performance indicators		Weightage
Process related: 30 Marks		**60%**
1	Handling of the instruments	10 %
2	Identification of component/dial/scale	20 %
3	Measuring value using suitable instrument	20 %
4	Working in team	10 %
Product related: 20 Marks		**40%**
5	Writing result	10 %
6	Interpretation of result	05 %
7	Conclusions	05 %
8	Practical related questions	15 %
9	Submitting the journal in time	05%
	Total	**100 %**

Names of Student Team Members

1. ……..
2. …….
3. ……

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

Practical No. 20: Fluorescent Tube

I Practical Significance

Fluorescent tubes are widely used in residential, commercial and industrial installation for illumination. Therefore, wiring, testing and fault finding of fluorescent tube is important.

II Relevant Program Outcomes (POs)

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

III Competency and Practical Skills

This practical is expected to develop the following skills for the industry identified competency: **'Plan wiring/cabling activities using relevant materials following safe practices'**

i. Prepare fluorescent tube light wiring.
ii. Test tube light components.
iii. Repair faults in fluorescent tube.

IV Relevant Course Outcome(s)

- Perform different types of electrical wiring/cabling activities.

V Practical Outcome

1. Prepare fluorescent tube light fixture wiring and test it.

VI Relevant Affective domain related Outcome(s)

i. Practice good housekeeping with safety measures.
ii. Demonstrate working as a leader/a team member.
iii. Maintain tools and equipment.
iv. Follow ethical practices.

VII Minimum Theoretical Background

Fluorescent tube consists of following main components:

1. Fluorescent light bulb / tube
2. Ballast or Choke
3. Starter

Troubleshooting chart of Fluorescent tube:

Sr. No.	Problem	Possible causes	Remedies
a.	The tube fails to start.	Tube burnt out. Defective choke. Defective starter. Wiring incorrect. Line voltage too low. Open connection.	Replace tube. Replace choke. Replace starter. Check wiring. Call power utility Check for open

b.	The tube flickers or blinks.	Line voltage too low. Tube burnt out. Defective starter.	Call power utility Replace tube. Replace starter.
c.	Ends of tube are black.	Tube burnt out & Short circuited choke	Replace tube. Replace choke.
d.	Continuous humming sound.	Choke defective.	Replace choke.
e.	Ends of tube glow but center does not.	Defective starter. Incorrect wiring.	Replace starter. Check wiring.
f.	Short life of tube.	Excess voltage.	Check voltage.

VIII Practical set-up / Circuit diagram / Work Situation

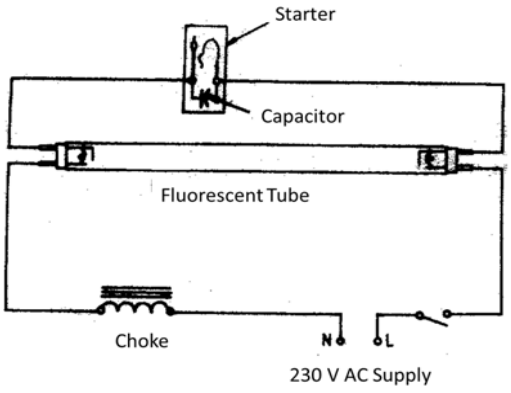

Fig. 1 Circuit Diagram of Fluorescent Tube Light

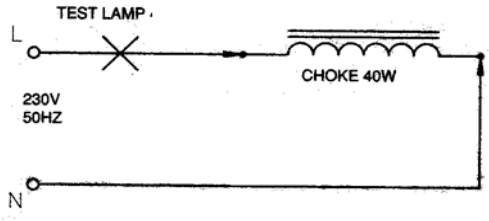

Fig. 2 Testing of Choke

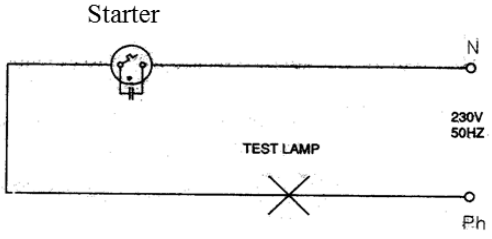

Fig. 3 Testing of Starter

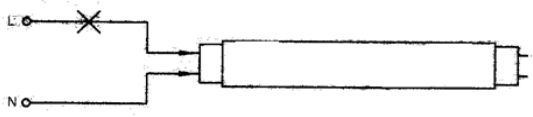

Fig. 4 Testing of Tube Rod

IX Resources Required

S. No.	Name of Resource	Suggested Broad Specification	Quantity
1	Tube light fixture	Unwired	1 No.
2	Tube light holder	Regular size	2 No.
3	Tube light Starter Holder	Regular size	1 No.
4	Choke	40 w, 240V	1 No.
5	Tube rod	40 w, 240V	1 No.
6	Tube light starter	Regular size	1 No.
7	Test Board / Test lamp	100 w, 240V	1 No.
8	Electricians Screw driver	150 mm	1 No.
9	Combination Plier	200 mm	1 No.

X Precautions to be followed

1 Use 100 W incandescent lamp for testing.
2 Make sure all connection should be tight.

XI Procedure

1. Check the choke for its short and open circuit by using test lamp as shown in figure 2 and record the result in table 1.
2. Check the starter by using test lamp as shown in figure 3 and record the result in table 2.
3. Test the filament on the both sides of the fluorescent tube for its continuity as shown in fig 4. Discard the fluorescent tube with open or fused filament in either side.
4. Replace the faulty components (if any) & assemble all accessories & connect as per circuit shown in Fig.1
5. Fix the tube rod in the holder.
6. Make sure that the slot in the inner parts of the holder is turned to the proper position.
7. Fix starter properly
8. Connect the tube assembly to the supply & switch on the supply. If tube does not glow, turn the rod properly and fix the starter properly in holder.

XII Resources Used (Student should write the resources required)

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

XIII Actual Procedure Followed (Use blank sheet provided if space not sufficient)

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XIV Observations and Calculations (Use blank sheet provided if space not sufficient)

Table 1: Testing of Choke

Sr. No.	State of Lamp Glow	Condition of choke	Result (Tick)
1.	Normal Glow	Internal Short Circuit	
2.	Dim	Good working Condition	
3.	No Glow, Even after checking the leads & Connection	Open Circuit in choke	

Table 2: Testing of Starter

Sr. No.	State of Lamp Glow	Condition of starter	Result (Tick)
1.	Flickering	Good working Condition	
2.	Normal Glow	Defective Starter	
3.	No Glow	Defective Starter	

Testing of Tube Rod: ……..

Testing of Complete fitting: ……..

XV Results

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XVI Interpretation of Results (Give meaning of the above obtained results)

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XVII Conclusions (Actions/decisions to be taken based on the interpretation of results).

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XVIII Practical Related Questions: (Use separate sheet for answer)

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

1. Draw a complete wiring diagram of fluorescent tube.
2. Describe the procedure for checking a choke, starter and tube
3. State the possible causes for following problems in tube light.
   i. The tube flickers or blinks
   ii. Ends of tube glow but center does not

[Space for answers]

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XIX References / Suggestions for further reading

a. https://www.electrical4u.com/fluorescent-lamp-its-working-principle/ , assessed on 10th April, 2018

XX Suggested Assessment Scheme

S.No	Performance indicators	Weightage
Process related: 30 Marks		**60%**
1	Handling of the instruments	10 %
2	Identification of component/dial/scale	20 %
3	Measuring value using suitable instrument	20 %
4	Working in team	10 %
Product related: 20 Marks		**40%**
5	Writing result	10 %
6	Interpretation of result	05 %
7	Conclusions	05 %
8	Practical related questions	15 %
9	Submitting the journal in time	05%
	Total	**100 %**

Names of Student Team Members

1. ……..
2. …….
3. ……

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

Practical No. 21: Cable Laying

I Practical Significance

Cable laying is necessary for the electrical installation systems. Laying of the cable depends on the type of installation and whether the installation work is indoor or outdoor.

II Relevant Program Outcomes (POs)

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

III Competency and Practical Skills

This practical is expected to develop the following skills for the industry identified competency: **'Plan wiring/cabling activities using relevant materials following safe practices'**

i. Select cable laying method
ii. Demonstrate cable laying process
iii. Mark cable route

IV Relevant Course Outcome(s)

- Perform different types of electrical wiring/cabling activities.

V Practical Outcome

1. Perform cable laying from incoming bus to a machine installation.

VI Relevant Affective domain related Outcome(s)

i. Practice good housekeeping with safety measures.
ii. Demonstrate working as a leader/a team member.
iii. Maintain tools and equipment.
iv. Follow ethical practices.

VII Minimum Theoretical Background

v. There are different methods used to lay cable. Normally in the electrical system, most of the high voltage cables are laid under the ground. So many parameters are considered while laying of these cables. In a practical situation, three main Cable Laying Systems are commonly used for laying under ground cables which are.
vi. (i) Direct System, (ii) Draw in System and (iii) Solid System.

VIII Practical set-up / Circuit diagram / Work Situation

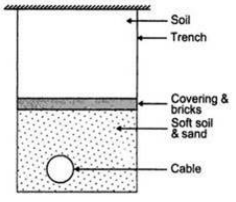

Fig. 1 Direct Laying System

IX Resources Required

S. No.	Name of Resource	Suggested Broad Specification	Quantity
1	Measurement tape	10 m size	1 No.
2	Bricks	Regular size	5 No.
3	Cable Piece	3- core of any size and length 5m	1 No.
4	Tong tester	---	1 No.

X Precautions to be followed

1 Avoid sharp bends while laying
2 Care about mechanical damage.

XI Procedure

1. Prepare a sand bed or fine riddled soil bed as per the measurements given in the drawing.
2. Lay the cable in the middle of the trench.
3. Provide sand bed on top of the cable.
4. Lay the protective tile just above the sand bed.
5. Backfill the excavated soil leaving 300 mm from the ground level.
6. Lay the Cable warning tape and again back-fill the remaining portion of the trench up-to the ground level.

XII Resources Used (Student should write the resources required)

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

XIII Actual Procedure Followed (Use blank sheet provided if space not sufficient)

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XIV Observations and Calculations (Use blank sheet provided if space not sufficient)

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XV Results

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XVI Interpretation of Results (Give meaning of the above obtained results)

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XVII Conclusions (Actions/decisions to be taken based on the interpretation of results).

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XVIII Practical Related Questions: (Use separate sheet for answer)

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

1. List the application of direct cable laying method.
2. State precaution taken in road crossing while laying cable.
3. State the difference between LT and HT cable laying.

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XIX References / Suggestions for further reading

1. https://www.youtube.com/watch?v=Odok9nqtoCM , assessed on 10th April, 2018
2. http://mailweb.iacs.res.in/tender/Cable_Laying_Spcfn_EL_072_Adm_13_07.05.13 .pdf , assessed on 10th April, 2018

XX Suggested Assessment Scheme

S.No	Performance indicators	Weightage
	Process related: 30 Marks	**60%**
1	Handling of the instruments	10 %
2	Identification of component/dial/scale	20 %
3	Measuring value using suitable instrument	20 %
4	Working in team	10 %
	Product related: 20 Marks	**40%**
5	Writing result	10 %
6	Interpretation of result	05 %
7	Conclusions	05 %
8	Practical related questions	15 %
9	Submitting the journal in time	05%
	Total	**100 %**

Names of Student Team Members

1. ……..
2. …….
3. ……

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

Practical No. 22: Cable Route Tracing

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 Relevant Program Outcomes (POs)

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

III Competency and Practical Skills

This practical is expected to develop the following skills for the industry identified competency: **'Plan wiring/cabling activities using relevant materials following safe practices'**

i. Identify types of service connection
ii. Trace cable route

IV Relevant Course Outcome(s)

- Perform different types of electrical wiring/cabling activities.

V Practical Outcome

1. Trace cable from incoming main to a residential unit.

VI Relevant Affective domain related Outcome(s)

i. Practice good housekeeping with safety measures.
ii. Demonstrate working as a leader/a team member.
iii. Maintain tools and equipment.
iv. Follow ethical practices.

VII Minimum Theoretical Background

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.

VIII Practical set-up / Circuit diagram / Work Situation

…….Not Applicable…….

IX Resources Required

S. No.	Name of Resource	Suggested Broad Specification	Quantity
1	Drawing Instruments	-	1 Set.
2	Drawing Sheet	A4 size	1 No.

X Precautions to be followed

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

XI 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.

XII Resources Used (Student should write the resources required)

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

XIII Actual Procedure Followed (Use blank sheet provided if space not sufficient)

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XIV Observations and Calculations (Use blank sheet provided if space not sufficient)

List the materials used in service connection.

XV Results

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XVI Interpretation of Results (Give meaning of the above obtained results)

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XVII Conclusions (Actions/decisions to be taken based on the interpretation of results).

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XVIII Practical Related Questions: (Use separate sheet for answer)

(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.

[Space for answers]

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XIX References / Suggestions for further reading

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

XX Suggested Assessment Scheme

S.No	Performance indicators	Weightage
Process related: 30 Marks		**60%**
1	Handling of the instruments	10 %
2	Identification of component/dial/scale	20 %
3	Measuring value using suitable instrument	20 %
4	Working in team	10 %
Product related: 20 Marks		**40%**
5	Writing result	10 %
6	Interpretation of result	05 %
7	Conclusions	05 %
8	Practical related questions	15 %
9	Submitting the journal in time	05%
Total		**100 %**

Names of Student Team Members

1. ……..
2. …….
3. ……

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

Practical No. 23: Cable Locator

I Practical Significance

Before locating a fault in an underground cable, it is necessary to know the route of the cable. Locating underground cable is necessary not only for finding faults, but also for undertaking any excavation near cable route.

II Relevant Program Outcomes (POs)

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

III Competency and Practical Skills

This practical is expected to develop the following skills for the industry identified competency: **'Plan wiring/cabling activities using relevant materials following safe practices'**

i. Read cable laying diagram.
ii. Demonstrate cable tracing process
iii. Identify cable route
iv. Demonstrate cable locator

IV Relevant Course Outcome(s)

- Perform different types of electrical wiring/cabling activities.

V Practical Outcome

1. Trace laid down cables and identify the path.

VI Relevant Affective domain related Outcome(s)

i. Practice good housekeeping with safety measures.
ii. Demonstrate working as a leader/a team member.
iii. Maintain tools and equipment.
iv. Follow ethical practices.

VII Minimum Theoretical Background

The supplier's distribution system brings power to the consumer through overhead lines or by means of underground cables to a place just outside the consumer's premises. 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.

Installers routinely use copper-cable-tracing devices to verify, label and test a new installation or to trace existing cabling during renovation or maintenance projects.

Cable locator has generally consisted of two parts--a transmitter and a receiver. The transmitter puts an electrical signal onto the cable or pipe being traced, while the receiver picks up that signal, allowing the locator operator to trace the signal`s path and follow the cable being located.

For identification of the cable route, route markers are provided along the runs of cables at locations.

VIII Practical set-up / Circuit diagram / Work Situation

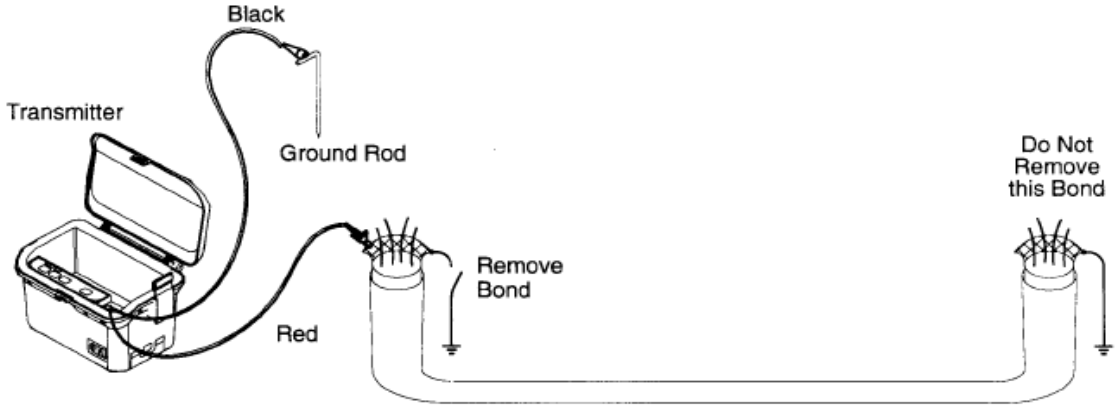

Fig. 1 UG Cable Tracing System

IX Resources Required

S. No.	Name of Resource	Suggested Broad Specification	Quantity
1	Cable locator unit	---	1 No.
2	Cable route markers	---	--

X Precautions to be followed

1 Route markers should touch with cable

XI Procedure

1. Visit to nearby electrical substation (or watch video demonstration).
2. Read and interpret cable laying diagram.
3. Watch given demonstration.
4. Record observations.
5. Identify cable route markers.
6. Draw single line diagram, showing details of cable rout and cable specifications.

XII Resources Used (Student should write the resources required)

S. No	Name of Resource	Broad Specifications		Quantity	Remarks (If any)
		Make	Details		
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2					
3					
4					
5					

XIII Actual Procedure Followed (Use blank sheet provided if space not sufficient)

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XIV Observations and Calculations (Use blank sheet provided if space not sufficient)

XV Results

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XVI Interpretation of Results (Give meaning of the above obtained results)

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XVII Conclusions (Actions/decisions to be taken based on the interpretation of results).

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XVIII Practical Related Questions: (Use separate sheet for answer)

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

1. List the components of cable locator equipment.
2. State precaution taken while using cable locator equipment.
3. What are cable route markers?
4. List different cable route markers.

[Space for answers]

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XIX References / Suggestions for further reading

1. https://www.youtube.com/watch?v=S1GgK18BY14 , assessed on 10th April, 2018
2. https://www.electricaleasy.com/2017/07/how-underground-cable-locator-works.html , assessed on 10th April, 2018

XX Suggested Assessment Scheme

S.No	Performance indicators	Weightage
Process related: 30 Marks		**60%**
1	Handling of the instruments	10 %
2	Identification of component/dial/scale	20 %
3	Measuring value using suitable instrument	20 %
4	Working in team	10 %
Product related: 20 Marks		**40%**
5	Writing result	10 %
6	Interpretation of result	05 %
7	Conclusions	05 %
8	Practical related questions	15 %
9	Submitting the journal in time	05%
	Total	**100 %**

Names of Student Team Members

1. ……..
2. …….
3. ……

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

Practical No. 24: Wire 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 Relevant Program Outcomes (POs)

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

III Competency and Practical Skills

This practical is expected to develop the following skills for the industry identified competency: **'Plan wiring/cabling activities using relevant materials following safe practices'**

i. Select and use tools used for cable/wire joints.
ii. Prepare cable/wire joints

IV Relevant Course Outcome(s)

- Perform different types of electrical wiring/cabling activities.

V Practical Outcome

1. Prepare cable joints (different joints).

VI Relevant Affective domain related Outcome(s)

i. Practice good housekeeping with safety measures.
ii. Demonstrate working as a leader/a team member.
iii. Maintain tools and equipment.
iv. Follow ethical practices.

VII Minimum Theoretical Background

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.

Following stepwise procedure should be adopted while preparing wire joints.

1. Removing insulation over wire
2. Preparation of joint
3. Performing soldering on joint
4. Wrapping insulation tape over joint

VIII Practical set-up / Circuit diagram / Work Situation

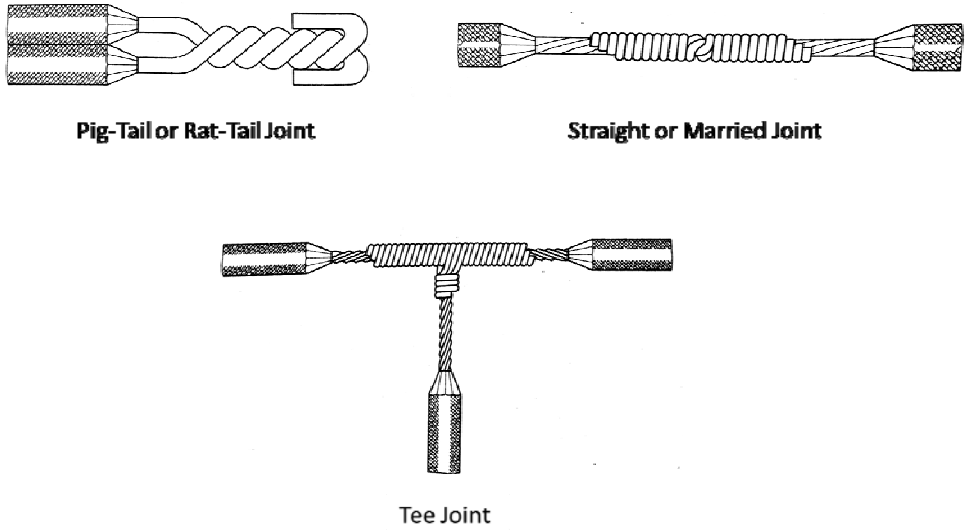

Fig. 1 Stranded Conductor Joints

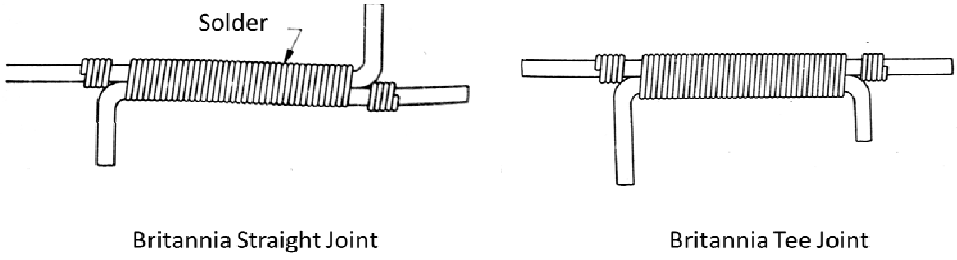

Fig. 2 Bare Conductor Joints

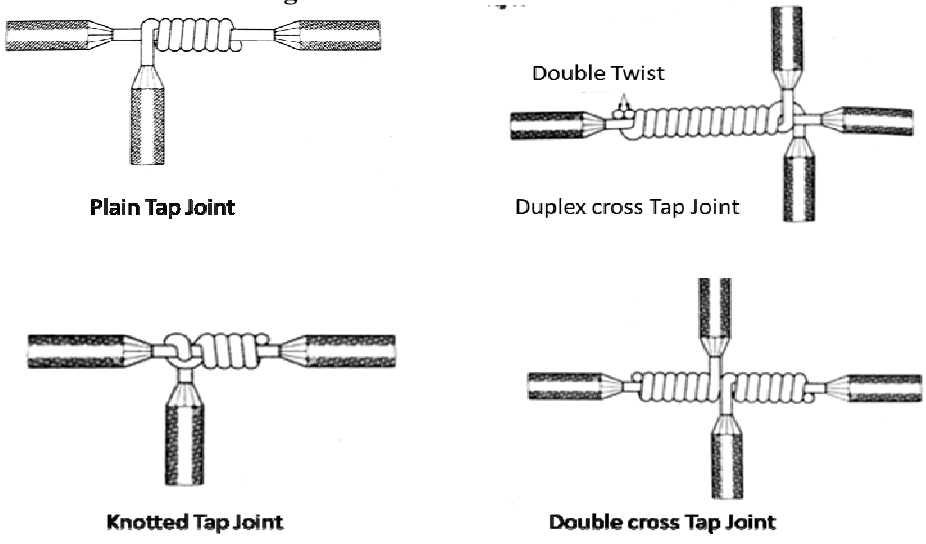

Fig. 3 Single Stranded Conductor Joints

IX Resources Required

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	200 mm	1 No.
5	Wire stripper / electrician knife	Standard size	1 No.
6	Long nose plier	200 mm	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	150 mm	1 No.

X Precautions to be followed

1 Handle tools carefully.

XI 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).

Note: Each student should prepare one joint of stranded conductor, solid conductor and single stranded conductor)

XII Resources Used (Student should write the resources required)

S. No	Name of Resource	Broad Specifications		Quantity	Remarks (If any)
		Make	Details		
1					
2					
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XIII Actual Procedure Followed (Use blank sheet provided if space not sufficient)

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XIV Observations and Calculations (Use blank sheet provided if space not sufficient)

XV Results

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XVI Interpretation of Results (Give meaning of the above obtained results)

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XVII Conclusions (Actions/decisions to be taken based on the interpretation of results).

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XVIII Practical Related Questions: (Use separate sheet for answer)

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

1. State necessity of wire joints.
2. State where following joints are used.
   - **i.** Britannia Straight joint
   - **ii.** Western union joint
3. State the necessity of soldering the joint.

[Space for answers]

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XIX 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

XX Suggested Assessment Scheme

S.No	Performance indicators	Weightage
Process related: 30 Marks		**60%**
1	Handling of the instruments	10 %
2	Identification of component/dial/scale	20 %
3	Measuring value using suitable instrument	20 %
4	Working in team	10 %
Product related: 20 Marks		**40%**
5	Writing result	10 %
6	Interpretation of result	05 %
7	Conclusions	05 %
8	Practical related questions	15 %
9	Submitting the journal in time	05%
	Total	**100 %**

Names of Student Team Members

1. ……..
2. …….
3. ……

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

Practical No. 25, 26: Crimping Lugs

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 Relevant Program Outcomes (POs)

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

III Competency and Practical Skills

This practical is expected to develop the following skills for the industry identified competency: **'Plan wiring/cabling activities using relevant materials following safe practices'**

i. Select proper tools for cable leads crimping.
ii. Use crimping tool crimping process
iii. Prepare leads crimping.

IV Relevant Course Outcome(s)

- Perform different types of electrical wiring/cabling activities.

V Practical Outcome

1. Perform lug crimping for cable leads of a specific size.
2. Perform lug crimping for cable leads of a size other than above.

VI Relevant Affective domain related Outcome(s)

i. Practice good housekeeping with safety measures.
ii. Demonstrate working as a leader/a team member.
iii. Maintain tools and equipment.
iv. Follow ethical practices.

VII Minimum Theoretical Background

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.

VIII Practical set-up / Circuit diagram / Work Situation

Fig. 1 Crimping Tool

Fig. 2 various types of Lugs

IX Resources Required

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 hydraulic Crimp tool kit	For cable size of 2.5 to 16 sqm	1 set
5	Lugs/ Connector of different size	Various sizes as per cable size	As required

X 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.

XI Procedure

1. Select the cable of appropriate size (for example 16 sq.mm)
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.

XII Resources Used (Student should write the resources required)

S. No	Name of Resource	Broad Specifications		Quantity	Remarks (If any)
		Make	Details		
1					
2					
3					
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XIII Actual Procedure Followed (Use blank sheet provided if space not sufficient)

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XIV Observations and Calculations (Use blank sheet provided if space not sufficient)

XV Results

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XVI Interpretation of Results (Give meaning of the above obtained results)

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XVII Conclusions (Actions/decisions to be taken based on the interpretation of results).

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XVIII Practical Related Questions: (Use separate sheet for answer)

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

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

[Space for answers]

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XIX References / Suggestions for further reading

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

XX Suggested Assessment Scheme

S.No	Performance indicators	Weightage
Process related: 30 Marks		**60%**
1	Handling of the instruments	10 %
2	Identification of component/dial/scale	20 %
3	Measuring value using suitable instrument	20 %
4	Working in team	10 %
Product related: 20 Marks		**40%**
5	Writing result	10 %
6	Interpretation of result	05 %
7	Conclusions	05 %
8	Practical related questions	15 %
9	Submitting the journal in time	05%
	Total	**100 %**

Names of Student Team Members

1. ……..
2. …….
3. ……

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

Practical No. 27: Cable Joint

I Practical Significance

Cable joint is necessary for the different electrical installation systems. Joints are prepared when cable breaks due to fault for any type of installation (indoor or outdoor). Cable jointing is done using cable jointing kit.

II Relevant Program Outcomes (POs)

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

III Competency and Practical Skills

This practical is expected to develop the following skills for the industry identified competency: **'Plan wiring/cabling activities using relevant materials following safe practices'**

i. Select proper water proofing tape for cable joint
ii. Perform compound filling process
iii. Prepare water proof taping for break/jointed cable.

IV Relevant Course Outcome(s)

- Perform different types of electrical wiring/cabling activities.

V Practical Outcome

1. Perform compound filling and water proof taping of cable joint.

VI Relevant Affective domain related Outcome(s)

i. Practice good housekeeping with safety measures.
ii. Demonstrate working as a leader/a team member.
iii. Maintain tools and equipment.
iv. Follow ethical practices.

VII Minimum Theoretical Background

Cable joints play an essential role in the electrical and electronic systems of any home or industry. They connect the power cables and ensure the flow of continuous electric current through them. Different types of heat shrink cable joints are used depending upon their intended application and accordingly the type of requirements will differ. The heat shrinkable cable joints can be Straight Through for XLPE to XLPE or PILC to PILC Cable and can be Transition Cable Joint type for connection of XLPE to PILC Cable. The voltage grade is from 1.1 kV onwards.

Heat shrinkable cable joints are easy to install and once installed can be used in a trench that is to be immediately back-filled. Cable jointing kits includes Resin Joints, Heat Shrink Cable Joints, heat Shrink Cable Terminations etc.

VIII Practical set-up / Circuit diagram / Work Situation

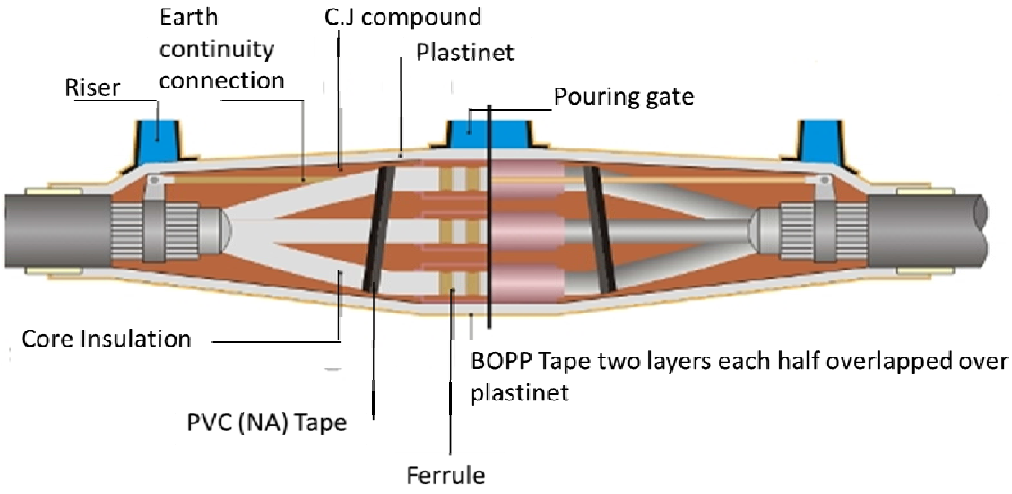

Fig. 1 Straight Cable Joint

Fig. 2 Compound filling process in joint kit

Fig. 3 Water proof tape

IX Resources Required

S. No.	Name of Resource	Suggested Broad Specification	Quantity
1	Measurement tape	3 m size	1 No.
2	Electrician Knife	Regular size	1 No.
3	Cable/wire Pieces	Any size and length	As required
4	Hand hydraulic Crimp tool kit	For cable size of 4 and 10 sqm	1 No.
5	Straight Connector of different size	50-100 sqm	1 No.
6	Cable Joint kit	50-100 Sqm size	1 No.
7	Water proof tape	5 m	1 No
8	Electricians Tool kit	Standard size	1 set

X Precautions to be followed

1 Read instruction given with kit before preparing joint.
2 Take care to prevent cutting of wire conductors, uneven stripping length and insufficient cutting of the insulation.
3 Ensure compound prepared by proper stirring.
4 Fill the compound in kit in short time.
5 Use proper size tape and taping process.

XI Procedure

Compound filling

1. Select the cable of appropriate size for jointing.
2. Select the straight connector of the proper size for cable joint.
3. Remove the insulation of the cable as per the measured dimension.
4. Make the joint of cable using the crimping tool.
5. After preparing joint make the taping on the bare conductor.
6. Fixed the lower and upper PVC caps of jointing kit.
7. Prepare the resin compound solution
8. Pour the solution in to the PVC kit.

Water proof taping

1. Prepare cable joint by the said procedure in above practical
2. Take the water proof tape of appropriate width and length
3. Start wounding of tape 50-75 mm before joint and finish after joint at 50-75 mm.

XII Resources Used (Student should write the resources required)

S. No	Name of Resource	Broad Specifications		Quantity	Remarks (If any)
		Make	Details		
1					
2					
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XIII Actual Procedure followed (Use blank sheet provided if space not sufficient)

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XIV Observations and Calculations (Use blank sheet provided if space not sufficient)

XV Results

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XVI Interpretation of Results (Give meaning of the above obtained results)

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XVII Conclusions (Actions/decisions to be taken based on the interpretation of results).

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XVIII Practical Related Questions: (Use separate sheet for answer)

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

1. List various components of joint kit and state their materials
2. State the precautions taken while preparing solution.
3. How the solution will shrinkage?
4. What happen when water proof tape is loosely tighten?

[Space for answers]

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XIX References / Suggestions for further reading

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

XX Suggested Assessment Scheme

S.No	Performance indicators	Weightage
Process related: 30 Marks		**60%**
1	Handling of the instruments	10 %
2	Identification of component/dial/scale	20 %
3	Measuring value using suitable instrument	20 %
4	Working in team	10 %
Product related: 20 Marks		**40%**
5	Writing result	10 %
6	Interpretation of result	05 %
7	Conclusions	05 %
8	Practical related questions	15 %
9	Submitting the journal in time	05%
	Total	**100 %**

Names of Student Team Members

1. ……..
2. …….
3. ……

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

Practical No. 28, 29, 30: 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 Relevant Program Outcomes (POs)

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

III Competency and Practical Skills

This practical is expected to develop the following skills for the industry identified competency: **'Plan wiring/cabling activities using relevant materials following safe practices'**

i. Select material required for plate earthing.
ii. Select proper size of plate and electrode
iii. Perform earthing.

IV Relevant Course Outcome(s)

- Follow safe practices when undertaking electrical works.
- Implement relevant earthing systems.

V Practical Outcome

1. Perform plate earthing for a machine laboratory.
2. Perform plate earthing for a computer centre.
3. Perform plate earthing for a building.

VI Relevant Affective domain related Outcome(s)

1. Practice good housekeeping with safety measures.
2. Demonstrate working as a leader/a team member.
3. Maintain tools and equipment.
4. Follow ethical practices.

VII Minimum Theoretical Background

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.

VIII Practical set-up / Circuit diagram / Work Situation

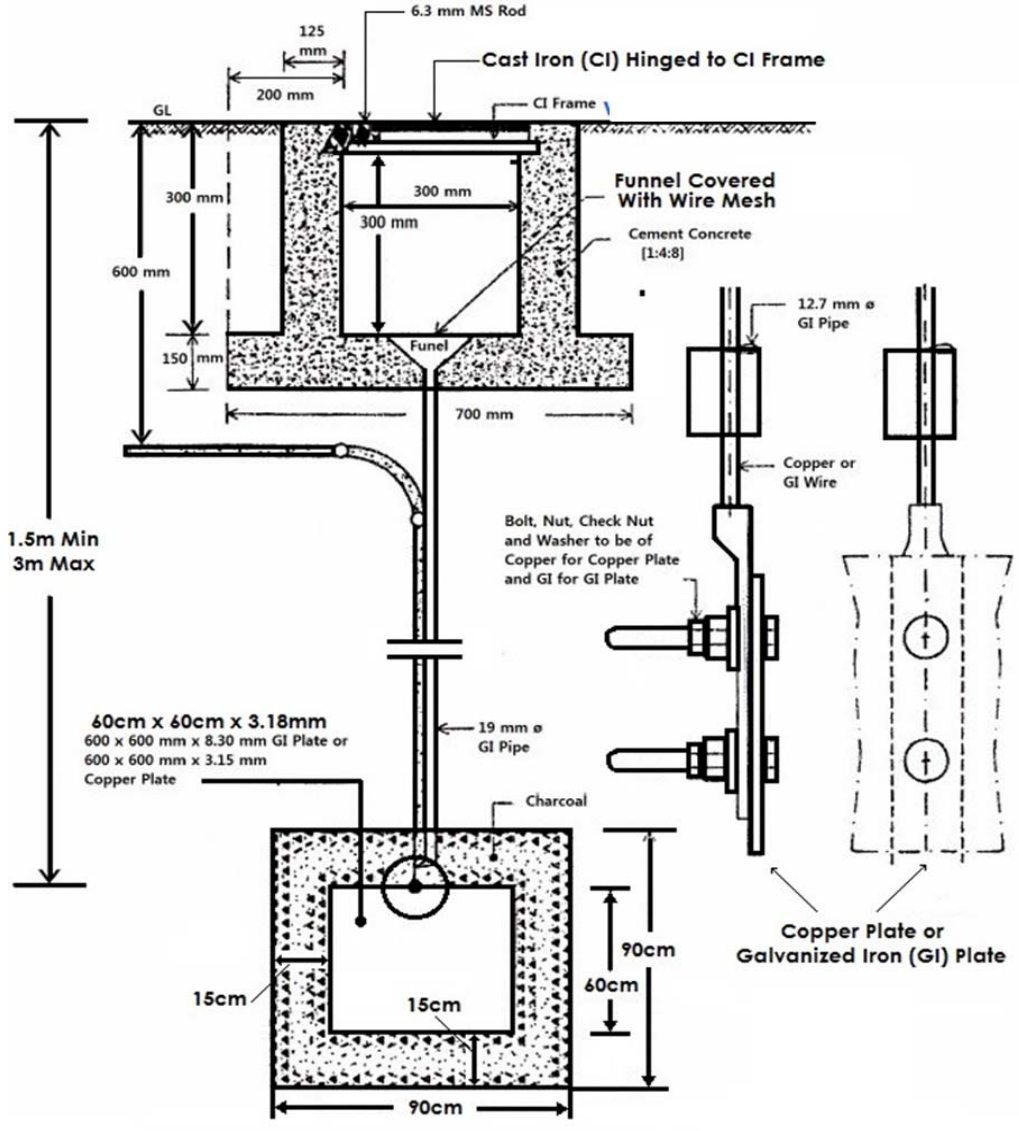

Fig. 1 Plate Earthing

Fig. 2 Copper Plate

IX Resources Required

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

X 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.

XI Procedure

1. Dig a 1.5×1.5m 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.
3. Tight earth lead through nut bolts from two different places on earth plate.
4. Use two earth leads with each earth plate (in case of two earth plates) and tight them.
5. Apply grease around earth leads, to protect the joints from corrosion,.
6. 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.
7. 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.
8. 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.
9. Connect tightly, Earth continuity conductor which is connected to the body and metallic parts of all installation to earth lead.

XII Resources Used (Student should write the resources required)

S. No	Name of Resource	Broad Specifications		Quantity	Remarks (If any)
		Make	Details		
1					
2					
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4					
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XIII Actual Procedure followed (Use blank sheet provided if space not sufficient)

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XIV Observations and Calculations (Use blank sheet provided if space not sufficient)

XV Results

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XVI Interpretation of Results (Give meaning of the above obtained results)

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XVII Conclusions (Actions/decisions to be taken based on the interpretation of results).

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XVIII Practical Related Questions: (Use separate sheet for answer)

(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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XIX References / Suggestions for further reading

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

XX Suggested Assessment Scheme

Performance indicators		Weightage
Process related: 30 Marks		**60%**
1	Handling of the instruments	10 %
2	Identification of component/dial/scale	20 %
3	Measuring value using suitable instrument	20 %
4	Working in team	10 %
Product related: 20 Marks		**40%**
5	Writing result	10 %
6	Interpretation of result	05 %
7	Conclusions	05 %
8	Practical related questions	15 %
9	Submitting the journal in time	05%
	Total	**100 %**

Names of Student Team Members

1. ……..
2. …….
3. ……

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

Practical No. 31, 32: Earth Tester

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 Relevant Program Outcomes (POs)

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

III Competency and Practical Skills

This practical is expected to develop the following skills for the industry identified competency: **'Plan wiring/cabling activities using relevant materials following safe practices'**

i. Use earth tester.
ii. Measure earthing resistance.

IV Relevant Course Outcome(s)

- Follow safe practices when undertaking electrical works.
- Implement relevant earthing systems.

V Practical Outcome

1. Test / measure earthing system resistance of a computer centre.
2. Test / measure earthing system resistance of a building.

VI Relevant Affective domain related Outcome(s)

i. Practice good housekeeping with safety measures.
ii. Demonstrate working as a leader/a team member.
iii. Maintain tools and equipment.
iv. Follow ethical practices.

VII Minimum Theoretical Background

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 P_1, P_2 and C_1, C_2. Two terminals P_1 and C_1 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.

VIII Practical set-up / Circuit diagram / Work Situation

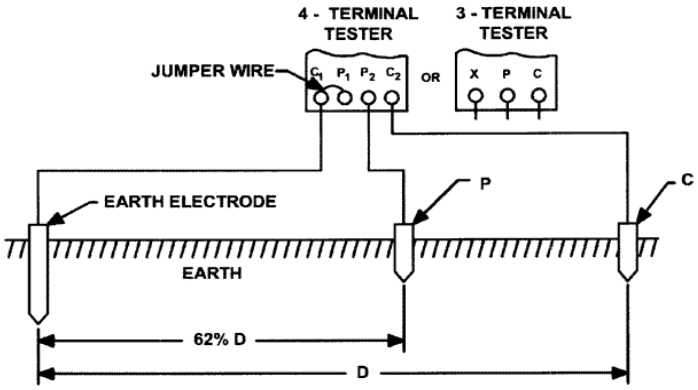

Fig. 1 Earth Testing system diagram

Fig. 2 Four Terminal Earth Tester

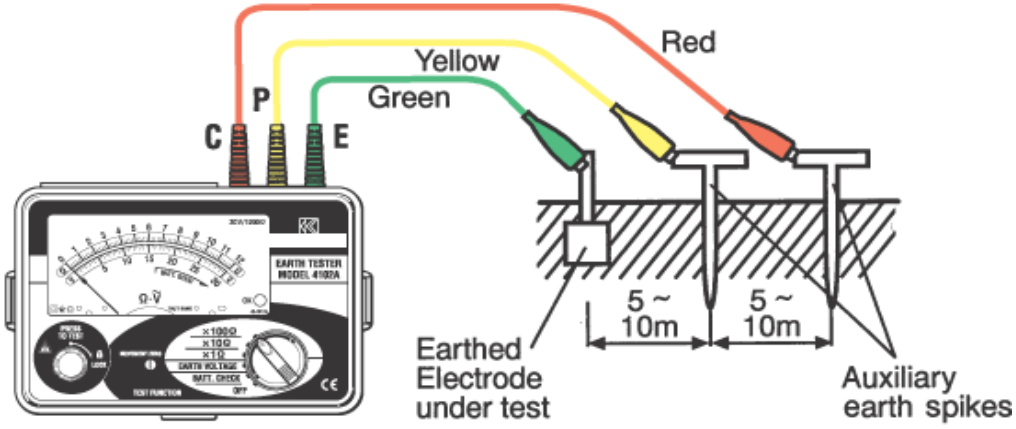

Fig. 3 Three Terminal Earth Tester

IX Resources Required

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	1No.
3	Combination plier	200 mm	1No.
4	Screw driver	300 mm	1No.
5	Earth Electrode (For Test)	-	1No.

X Precautions to be followed

Read carefully the instructions of the manufacturer. There are a number of manufacturers of earth testers. The students are advised to follow the manufacturer's instructions for the operation and testing. Some manufacturers suggest that the auxiliary electrodes should be placed in an equal-internal triangle instead of in a straight line.
All connection should be tight
Select the proper range of tester
Handle rotation should be as per instruction given on instruments

XI 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.

XII Resources Used (Student should write the resources required)

S. No	Name of Resource	Broad Specifications		Quantity	Remarks (If any)
		Make	Details		
1					
2					
3					
4					
5					

XIII Actual Procedure followed (Use blank sheet provided if space not sufficient)

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XIV Observations and Calculations (Use blank sheet provided if space not sufficient)

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)		

XV Results

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XVI Interpretation of Results (Give meaning of the above obtained results)

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XVII Conclusions (Actions/decisions to be taken based on the interpretation of results).

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XVIII Practical Related Questions: (Use separate sheet for answer)

(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

[Space for answers]

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XIX 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

XX Suggested Assessment Scheme

S.No	Performance indicators	Weightage
Process related: 30 Marks		**60%**
1	Handling of the instruments	10 %
2	Identification of component/dial/scale	20 %
3	Measuring value using suitable instrument	20 %
4	Working in team	10 %
Product related: 20 Marks		**40%**
5	Writing result	10 %
6	Interpretation of result	05 %
7	Conclusions	05 %
8	Practical related questions	15 %
9	Submitting the journal in time	05%
Total		**100 %**

Names of Student Team Members

1. ……..
2. …….
3. ……

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

List Of Laboratory Manuals Developed by MSBTE

First Semester:

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

Second Semester:

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

Third Semester:

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

Fourth Semester:

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

Fifth Semester:

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

Sixth Semester:

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

Pharmacy Lab Manual

First Year:

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

Second Year:

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

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