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Participant Handbook

Sector
Hydrocarbon

Sub-Sector
Midstream

Occupation
Refineries

Reference ID: **HYC/Q6101** Version No.: **3.0**
NSQF level: 4

Industrial Electrician (Oil & Gas)

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"Skilling is building a better India. If we have to move India towards development then Skill Development should be our mission."

Shri Narendra Modi
Prime Minister of India

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for

SKILLING CONTENT : PARTICIPANT HANDBOOK

Complying to National Occupational Standards of

Job Role / Qualification pack: **"Industrial Electrician (Oil & Gas)"** QP No. "HYC/Q6101, **NSQF Level 4"**

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The preparation of this manual would not have been possible without the Hydrocarbon Industry's support. Industry feedback has been extremely encouraging from inception to conclusion and it is with their input that we have tried to bridge the skill gaps existing today in the industry.

This participant manual is dedicated to the aspiring youth who desire to achieve special skills which will be a lifelong asset for their future endeavours.

About this Book

This Participant Handbook is designed for providing skill training and /or upgrading the knowledge level of the Trainees to take up the job of an "Industrial Electrician" in the Hydrocarbon Sector.

This Participant Handbook is designed based on the Qualification Pack (QP) under the National Skill Qualification framework (NSQF) and it comprises of the following National Occupational Standards (NOS)/topics and additional topics.

- Introduction
- HYC/N6101 Job Requirements and Related Processes.
- HYC/N6102 Industrial Electrical wiring
- HYC/N9301 Work effectively in a team
- HYC/N9302 Follow Health, Safety and Security Procedures

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It is recommended that all trainings include the appropriate Employability Skills Module Content for the same is available here:

https://www.skillindiadigital.gov.in/content/list

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1. Introduction

Key Learning Outcomes

After attending the session, you will be able to:

1. Define the basic concept of electricity
2. Define the structure of matter
3. Analyze Cables and its Specifications
4. Define types of Wires joints and uses
5. Define Polarity and its test in DC
6. Define basics of Engineering Drawing

Unit 1.1 Basic Concept of Electricity

Unit Objectives

At the end of this unit, you will be able to:

1. Define Electricity
2. Define Electron Theory and Free Electron

Electricity is the flow of electrons from one place to another. Electrons can flow through any material, but it becomes more easily in some compared to others. Its easy flow is called resistance. This resistance of a material is measured in Ohms.

Electron Theory

Electron theory states that all matters comprised molecules, which in turn comprised atoms, which are again comprised protons, neutrons and electrons. A molecule is the smallest part of matter which can exist by itself and contains one or more atoms.

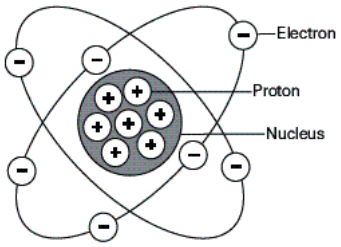

Figure: 1.1.1: Electron Theory

Free Electron

Some materials, such as metals, are good conductors of electricity; these possess free or valence electrons that do not remain permanently associated with the atoms of a solid but instead form an electron "cloud" or gas around the peripheries of the atoms and are free to move through the solid.

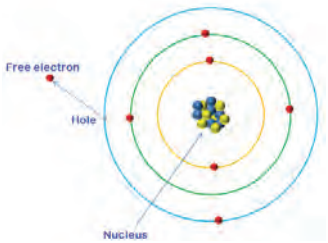

Figure: 1.1.2: Free Electron

Unit 1.2 Structure of Matter

Unit Objectives

At the end of this unit, you will be able to:

1. Define matter and its components
2. Analyze important terms related to Matter

The matter is divided into molecules, which in turn are divided into atoms. These atoms are composed of two parts: nucleus and periphery. In the nucleus of the atom, there are positive charged protons and neutrons, which as its name suggests, have no electric charge or are neutral.

Matter can be broken down into:

Conductors: In a conductor, electric current can flow freely. Metals such as copper typify conductors, while most non-metallic solids are said to be good insulators, having extremely high resistance to the flow of charge through them.

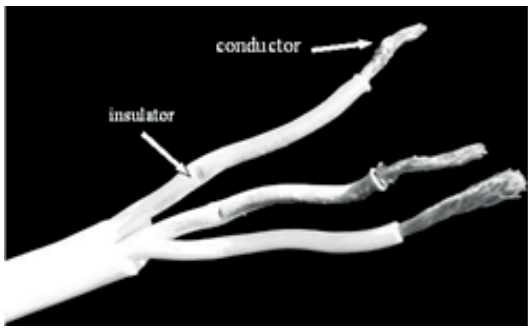

Figure: 1.2_1: Wire highlighting Conductor and Insulator

Semi-conductors: A semiconductor is a type of material that has an electrical resistance which is between the resistance typical of metals and the resistance typical of insulators, so it kind of, or "semi"-conducts electricity.

Insulators: Insulator can mean not only the material but things that are made of that material. They are made of various materials such as: glass, silicone, rubber, plastic, oil, and wood, dry cotton, quartz, ceramic etc. The type of insulator will depend on the uses. Insulators have high electrical resistivity and low conductivity.

Some more Important Terms:

EMF: Making electrons flow through a resistance requires an attractive force to pull them. This force, called Electro-Motive Force or EMF, is measured in volts.

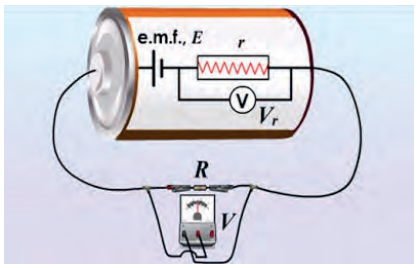

Figure: 1.2_2: EMF

Volt: The volt is the derived unit for electric potential, electric potential difference, and electromotive force.

Figure: 1.2_3: Volt

Power: As electrons flow through a resistance, it performs a certain amount of work. It may be in the form of heat or a magnetic field or motion, but it does something. This work is called Power, and is measured in Watts.

Unit 1.3 Cables and its Specifications

Unit Objectives

At the end of this unit, you will be able to:

1. Analyze different types of cables
2. Define the specifications of each cable

All electrical cables consist of at least two conducting wires and an outer protective jacket. For medium to high power cables that carry high voltages, the conducting wires within the outer protective jacket may individually be enclosed in insulating sheaths. Electrical conductors are commonly made of copper. Synthetic polymers make the outer jacket and protective, insulating material for the electrical cables.

1.3.1 Coaxial Cable

- A coaxial electrical cable has a copper-plated core, surrounded by a dielectric insulator. A woven shield of copper surrounds the insulating layer, which is finally wound by an outmost plastic sheath.
- Coaxial cables differ in size, performance, flexibility, power handling capabilities and cost.
- They are used to connect home audio and video equipment, television networks and components of a local area network. Hard line, leaky cable, RG/6, twin-axial, biaxial and semi-rigid are types of coaxial cables.

Figure: 1.3.1: Coaxial Electrical Cable

1.3.2 Ribbon Cable

- A ribbon electrical cable (also called multi-wire planar electrical cable or flat twin cables) is made up of multiple insulated wires running parallel to each other.
- These parallel wires allow the simultaneous transmission of multiple signals of data. According to "Optical Communications Essentials," a typical ribbon cable consists of four to 12 wires. It is commonly used to interconnect network devices.
- Ribbon cables also connect the motherboard with other core CPU (central processing unit) components.

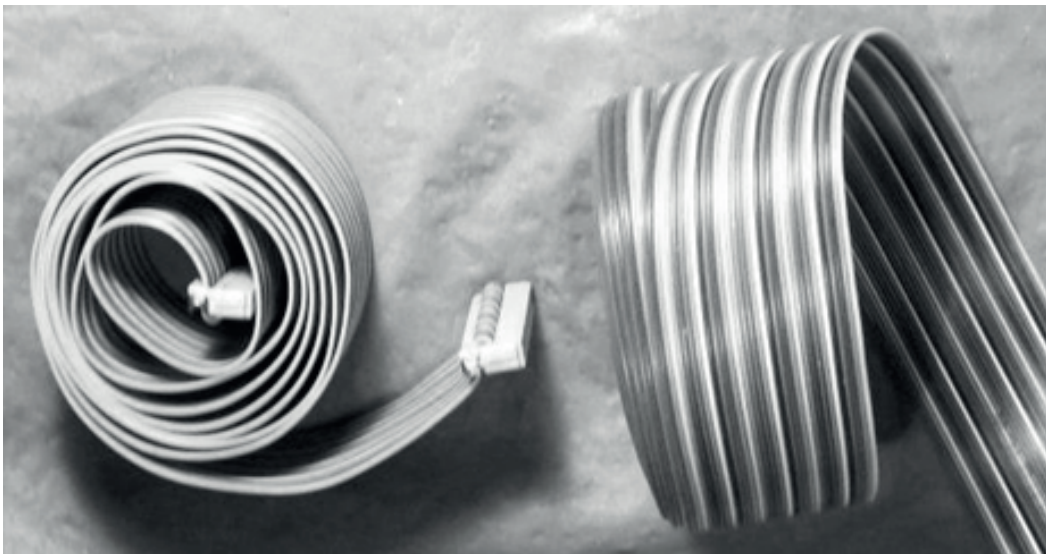

Figure: 1.3.2: Coaxial Electrical Cable

1.3.3 Twisted Pair Cable

- A twisted pair electrical cable consists of pairs of insulated copper wires (that are colour coded), which are twisted around each other.
- The diameter of each wire ranges from 0.4 to 0.8 mm, and the number of pairs vary in different types of twisted pair cables. The greater the number of pairs, the higher the resistance of the cable will be to external noise and cross-talk.
- Twisted pair cables are easy to install, flexible and inexpensive. They are used for telephone cabling and to wire local area networks.

Figure: 1.3.2: Twisted Pair Electrical Cable

1.3.4 Shielded Cable

- A shielded electrical cable is made of one or more insulated wires that are collectively enclosed by an aluminium Mylar foil or woven braid shielding.
- The shielding prevents the cable from external radio and power frequency interference, allowing the signal transmission to proceed smoothly. High-voltage power cables are commonly shielded.

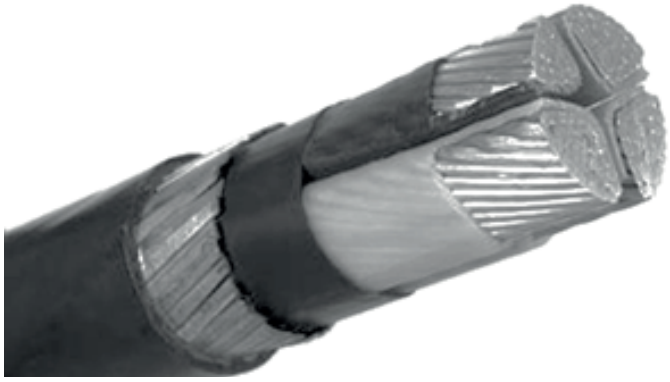

Figure: 1.3.1: Shielded Electrical Cable

Notes

Unit 1.4 Types of Wire Joints and Uses

Unit Objectives

At the end of this unit, you will be able to:

1. Define various wire joint types
2. Explain the uses of individual wire joints

Knowing the different types and uses of electrical wire joints is critical to home repair and electrical maintenance. Joining wires incorrectly or without proper insulation can make the joint overheat, resulting in a potentially deadly fire.

To complete any electrical joint, the practitioner must seal the exposed wires with electrical tape or another type of insulation. There are many types of electrical joints, but several are considered fundamental archetypes. These types of joints include the Western Union splice, tap splice and fixture splice.

1.4.1 Western Union Splice

The Western Union Splice is relatively simple and is one of the most common types of joints. This type of joint is used to connect two of the same conductor — repairing a severed wire, for example.

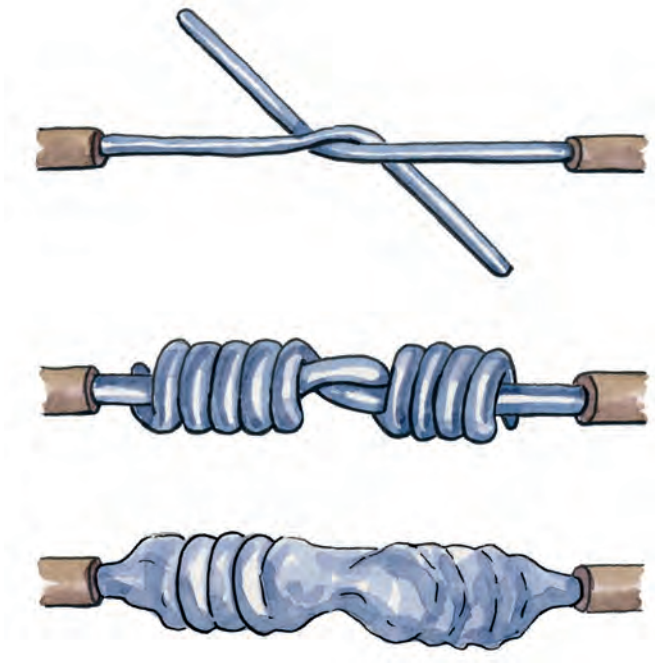

Figure: 1.4.1: Western union splice

Uses:

- To make a Western Union splice, strip 5 inches of insulation from both conductors. Hold them in an "X" shape, leaving 1 or 2 inches of exposed wire for each conductor above the intersection.
- Wrap one of the exposed wires around the base of the other, and then do the same with the remaining wire and conductor.

1.4.2 Tap Splice

A tap splice connects a loose wire to a conductor in a perpendicular shape. This joint resembles a “T” shape, with the connecting wire intersecting the running one.

Tap splices allow loose wires to tap the electrical flow of an active wire.

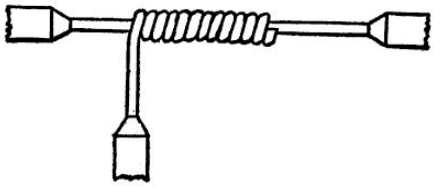

Figure: 1.4.2: Tap splice

Uses:

- A tap splice requires you to strip 4 inches of insulation from the connecting cord, and 2 inches from the running wire. Hold the two together like a “T” and wrap the exposed wire of the connecting cord around the running wire once.
- Continue to wrap the wire in the opposite direction of the first coil. This results in one loop on one side of the “T” intersection, with the remaining loops (at least five) on the other side.

1.4.3 Fixture Splice

A fixture splice is mostly used to connect different-sized conductors, particularly those in electrical fixtures. This type of splice requires a pair of pliers or a similar tool.

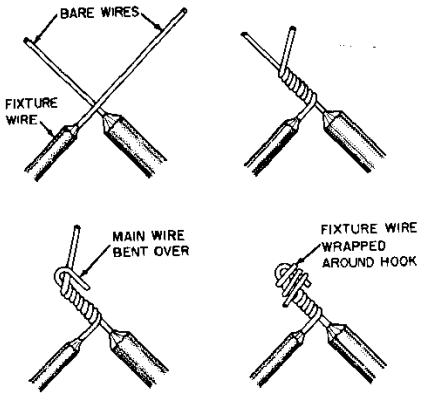

Figure: 1.4.3: Fixture splice

Uses:

- To fashion a fixture splice, remove 4 to 5 inches of insulation from both of the wires. Clean them by scraping residue and remaining insulation from the conductor.
- Hold one of the exposed wires right at the base of the other. Roughly half of the exposed conductor should be on each side of the intersection.
- Grasp the intersection with the pliers and turn both wires simultaneously. Bend the coil towards the wires to complete the joint.

Unit 1.5 Polarity Test in DC

Unit Objectives

At the end of this unit, you will be able to:

1. Define the term Polarity and Polarity Test
2. Analyze the method to Test Polarity in DC

1.5.1 What is Polarity?

Polarity means the direction of the induced voltages in the primary and the secondary winding of the transformer. If the two transformers are connected in parallel, then the polarity should be known for the proper connection of the transformer.

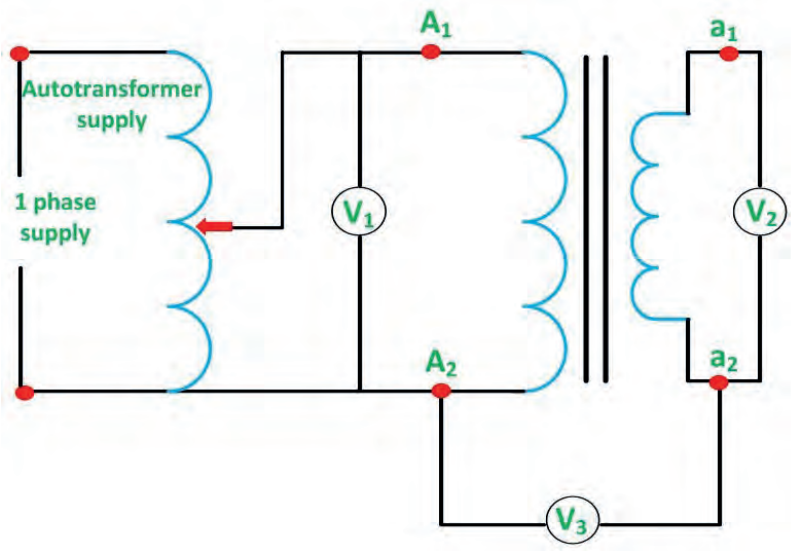

Figure: 1.5.1: Autotransformer showing polarity

1.5.2 What is meant by Polarity test?

Polarity in electrical terms refers to the Positive or Negative conductors within a DC circuit, or to the Line and Neutral conductor within an AC circuit.

1.5.3 How to test polarity in DC?

- Use a small DC motor.
- 'Calibrate' on a source of known polarity and mark the motor tab that gives clockwise rotation when positive.
- Use a small electrolytic capacitor of higher voltage as the supply. If you connect it with the right polarity, it will work normally.

Unit 1.6 Few Importance Definitions

Unit Objectives

At the end of this unit, you will be able to:

1. Elaborate few important terms related to Electricity
2. Define the terminologies

1. **Capacitor:** A capacitor has two conductors which is separated by an insulator and is known as a dielectric.

2. **Capacitive Reactance:** An opposition to the change of voltage across a capacitor and an element is known as capacitive reactance. It is inversely proportional to the single frequency or angular frequency, denoted by ω.

3. **Inductive Reactance:** The variable opposition to current flow in an inductor is related to the amount of the inductance. The larger the value of inductance the greater the back emf effect produced. The opposition to current flow through an inductor is proportional to both the amount of inductance and to the frequency of the current in the inductor. This opposition to current flow is called Inductive Reactance denoted by (XL).

4. **Impedance (Z):** The opposition to current flowing through a coil in an AC circuit is determined by the AC resistance which is also known as Impedance (Z), of the circuit.

5. **Power Factor (p.f):** The ratio of the real power flowing to the load to the apparent power in circuit of an AC electrical power is known as the power factor (p.f.). The dimensionless number for power factor is in the closed interval of -1 to 1.

Summary

- Electrons can flow through any material, but does so more easily in some than in others.
- Electron theory states all matter is comprised of molecules, which in turn are comprised of atoms, which are again comprised of protons, neutrons and electrons.
- In a conductor, electric current can flow freely, in an insulator it cannot.
- Insulator can mean not only the material but things that are made of that material.
- All electrical cables consist of at least two conducting wires and an outer protective jacket.
- Knowing the different types and uses of electrical wire joints is critical to home repair and electrical maintenance. Joining wires incorrectly or without proper insulation can make the joint overheat, resulting in a potentially deadly fire.
- Polarity in electrical terms refers to the Positive or Negative conductors within a DC circuit, or to the Line and Neutral conductor within an AC circuit.

Notes

Notes

Scan the QR codes or click on the link to watch the related videos

https://www.youtube.com/watch?v=a_o0fX_UXG0

Scan the QR codes or click on the link to watch the related videos

https://www.youtube.com/watch?v=-KmbrSe65O4

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2. Job Requirement and Related Processes

Key Learning Outcomes 

After attending the session, you will be able to:

1. Define the basics of engineering drawing
2. Define Projections
3. Define Dimensioning and Tolerance
4. Define important Diagrams
5. Demonstrate Computer Generated CAD for Electrical Drawing
6. Define Workshop Practices and Tools
7. Demonstrate Automation
8. Define Microprocessor, Micro Controller and its Applications and Functions
9. Define PLC System and its Application in Electrical Control System
10. Demonstrate the application of Power Electronics and its Use in Different fields
11. Define Thermal Power Generation
12. Demonstrate how Mechanical Maintenance of Electric Motor is done?
13. Demonstrate the process of removing and fixing bearings
14. Define aligning couplings
15. Analyze electrical installations and identify problems
16. Demonstrate how to install metal and plastic conduits/flexible conduits
17. Demonstrate how to troubleshoot electrical installations and identify faults

Unit 2.1 Basics of Engineering Drawing

Unit Objectives

At the end of this unit, you will be able to:

1. Define the Basics of Engineering Drawing
2. Analyze the methods, equipment, and standards of drawing

We can understand engineering drawing as the manipulating art, imposed on various components of numerous designs. As these designs are related to engineering, these drawings are also known as engineering graphics.

These are blueprints which take the help of lines for representing an object's features. Here, the object's features consist of:

- Edge
- Surface

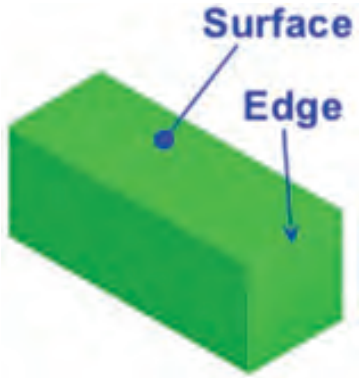


Figure 2.1: An Object's Features

2.1.1. Method to Make Simple Drawing

In order to make simple drawings in engineering drawings, there are 3 basic methods.

1. Taking the help of computer/ laptop

The drawings are made using CAD (Computer-aided drafting) software.

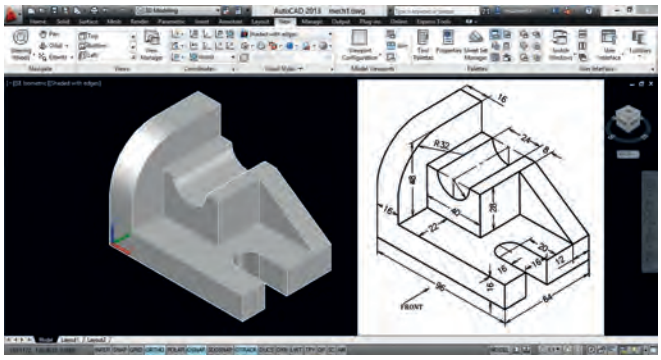


Figure 2.1.1_1: Drawing with CAD

2. Utilising typical drawing instruments

We take the help of drawing instruments to draw accurate curves, circles, and straight lines.

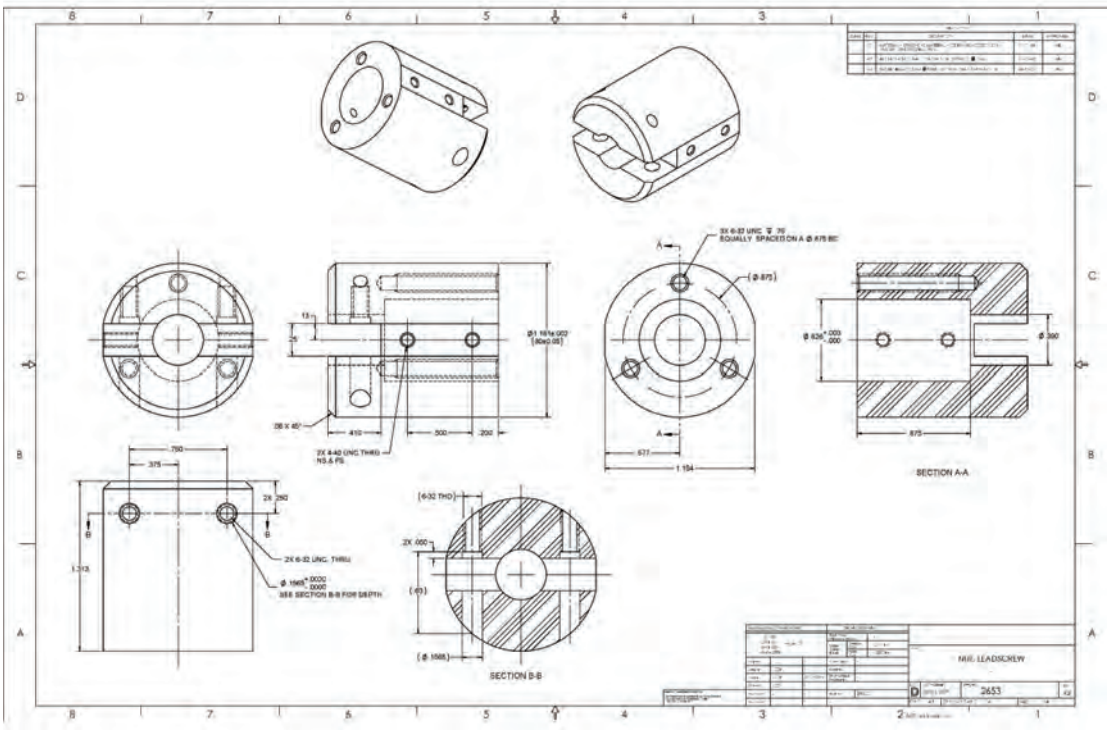


Figure 2.1.1_2: Drawing with drawing instruments

3. Freehand sketch

This drawing type uses erasers and pencils on grid paper or blank paper.

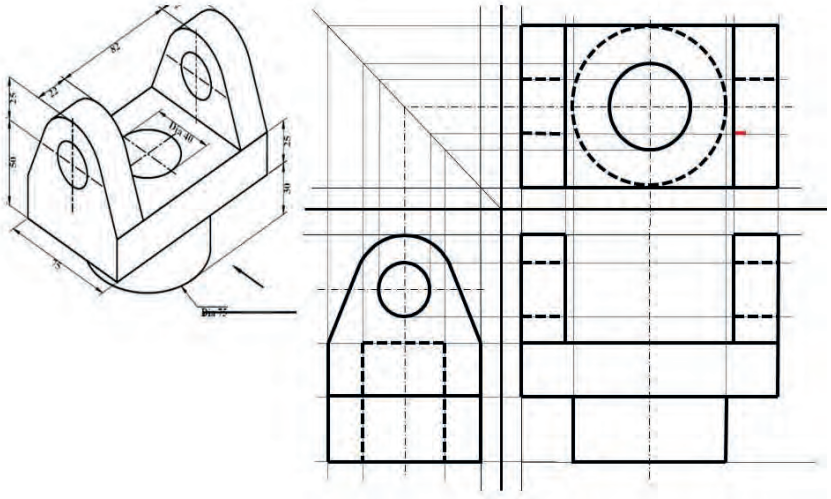


Figure 2.1.1_3: Freehand Sketch

2.1.2. Engineering Drawing Equipment

- **Mini Drafter:** This tool comes under the category of special drawing equipment. It is one of the versatile tools which are helpful in drawing any geometrical shape accurately. The things that you can draw with a mini drafter are:
  - Inclined lines
  - Perpendicular lines
  - Parallel lines

Figure 2.1.2_1: Mini Drafter

- **The Basic Instruments are:**
  - Drawing pencils
  - Eraser shield
  - Eraser
  - Drawing pins or clips
  - Drawing sheet
  - Drawing board
  - Circle Master

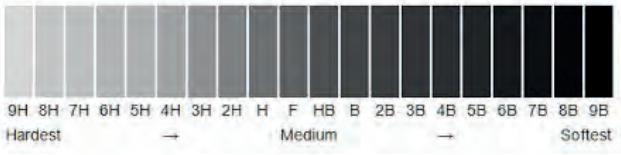


Figure 2.1.2_2: Types of pencil

- **For Angle Measurement**
  - Set-squares
  - Protractors

- **For Distance Measurement**
  - Scales
  - Small bow divider
  - Large size divider

Figure 2.1.2_3: Small bow divider

- **Drawing Curved Lines**
  - French curve
  - Small bow compass
  - Large size compass

- **Drawing Straight Lines**
  - Set- squares
  - T- Square

Figure 2.1.2_4: T- Square

2.1.3. Drawing Standards

These standards are rules set that states the students how to represent technical drawings. The main purpose of drawing standards is to make sure that whoever reads the technical drawing understands or get the same meaning as experts.

The standard aspects of engineering drawings are:

Paper Size:

A0 to A4 (trimmed paper)

Sheet Size:

- A0 = 841 x 1189
- A1 = 594 x 841
- A2 = 420 x 594
- A3 = 297 x 420
- A4 = 210 x 297

These dimensions are in millimetres.

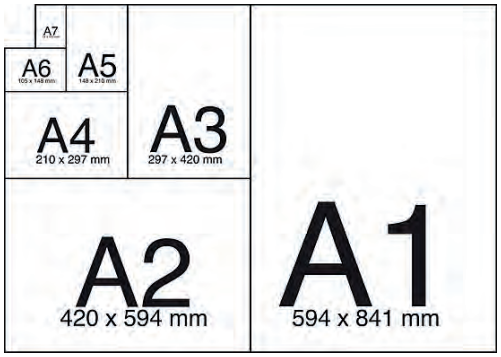


Figure 2.1.3: Sheet Size

Scale

- **Enlarging scale**
  - 100:1
  - 50:1
  - 20:1
  - 10:1
  - 5:1
  - 2:1

- **Reducing scale**
  - 1:100
  - 1:50
  - 1:20
  - 1:20
  - 1:10
  - 1:5
  - 1:2

Style

- The height of text – 2 - 3 mm
- The height of letters (lower-case) – 1 – 2 mm
- Text style – Gothic
- Space between lines - 2 - 3 mm

2.1.4. Layout Drawings

To understand the requirements for designs and their development, we follow layout drawing. The similarity of layout drawing is quite identical to installation drawing, assembling those, and detailing the drawings. However, the dissimilarity is in relation to dimensional data, notational data, and pictorial data that convey the designing solution to the topmost level, thereby making it useful in engineering drawings.

Unit 2.2 Understanding Projections, Dimensioning and Tolerance

Unit Objectives

At the end of this unit, you will be able to:

1. Define projections
2. Demonstrate first angle and third angle projections
3. Define tolerance
4. Define dimensions

1. Isometric, Orthographic projections

- **Isometric Projections:** We can obtain isometric projections on a specific plane. The inclination of this plane is equal to that of other 3 principle planes. One of the highly convenient methods to draw a solid object with an isometric view is 'Boxing.'

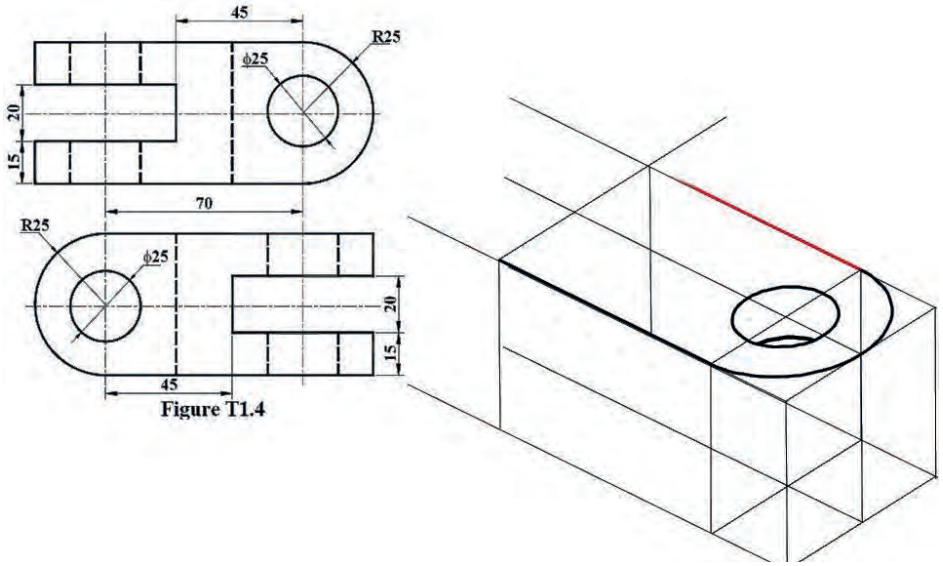


Figure 2.2_1: Isometric projection

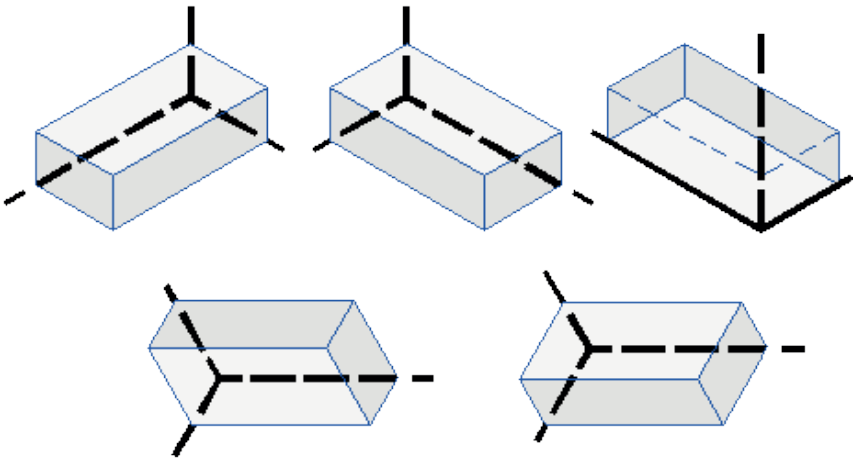


Figure 2.2_2: Positions of Isometric Projections

- **Orthographic projections:** The lines in Orthographic projections are useful in drawing construction.

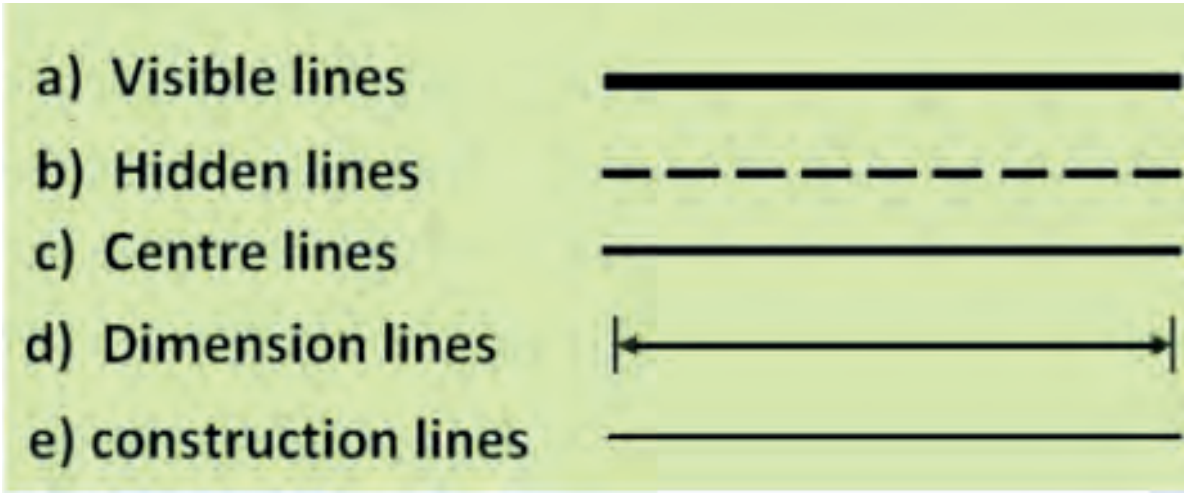


Figure 2.2_3: Orthographic projections lines

We can also understand these projections as a set of 2-D drawings that helps to represent an accurate diagram of an object. The other name for this drawing style is also known as Multiview Drawing.

There are various dimensioning types that are in use in orthographic projections.

- Combined dimensions
- Chain dimensions
- Superimposed running dimensions
- Parallel dimensions

2. First Angle and Third Angle Projections

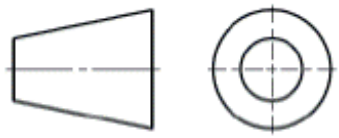
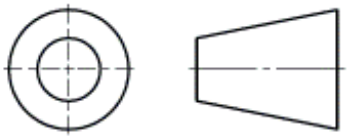
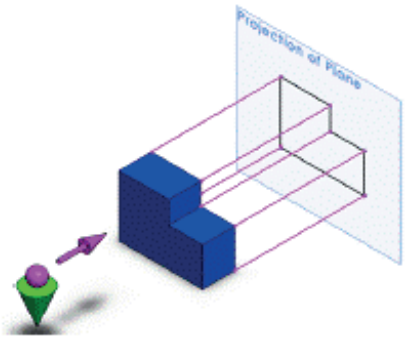
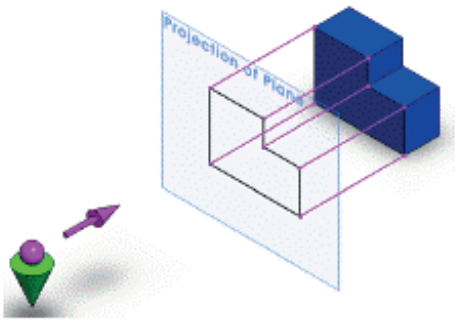
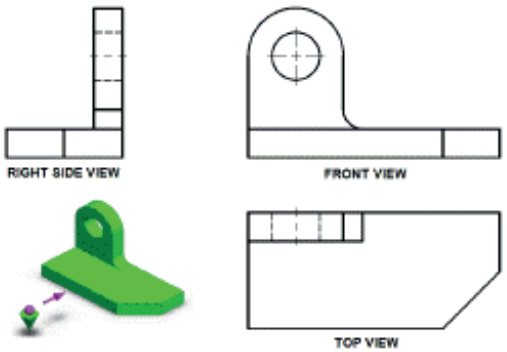
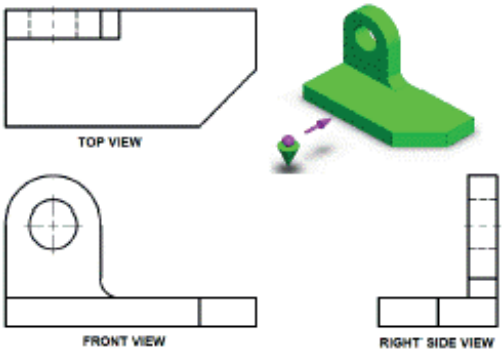
First Angle Projection	Third Angle Projection
The object is imagined to be in first quadrant.	The object is imagined to be in third quadrant.
The object is lies between the observer and plane of projection.	The plane of projection lies between the observer and object.
The plane of projection is assumed to be non transparent.	The plane of projection is assumed to be transparent.
When view are drawn in their relative position Top view comes below Front view, Right side view drawn to the left side of elevation.	When view are drawn in their relative position Top view comes above Front view, Right side view drawn to the right side of elevation.
 SYMBOL	 SYMBOL
	
 RIGHT SIDE VIEW FRONT VIEW TOP VIEW	 TOP VIEW FRONT VIEW RIGHT SIDE VIEW

Figure 2.2_3: First Angle and Third angle Projections

- **Dimension lines as per SP- 46:** For proper dimensioning in engineering, detailing and sizes related to the objects are important. The construction and proper function can be highlighted with the help of:
  - Notes
  - Symbol
  - Numerals
  - Lines

There are 2 spaces where we write dimensions. One is by breaking dimension lines and then inserting the dimensions. The other one can be written above dimension lines.

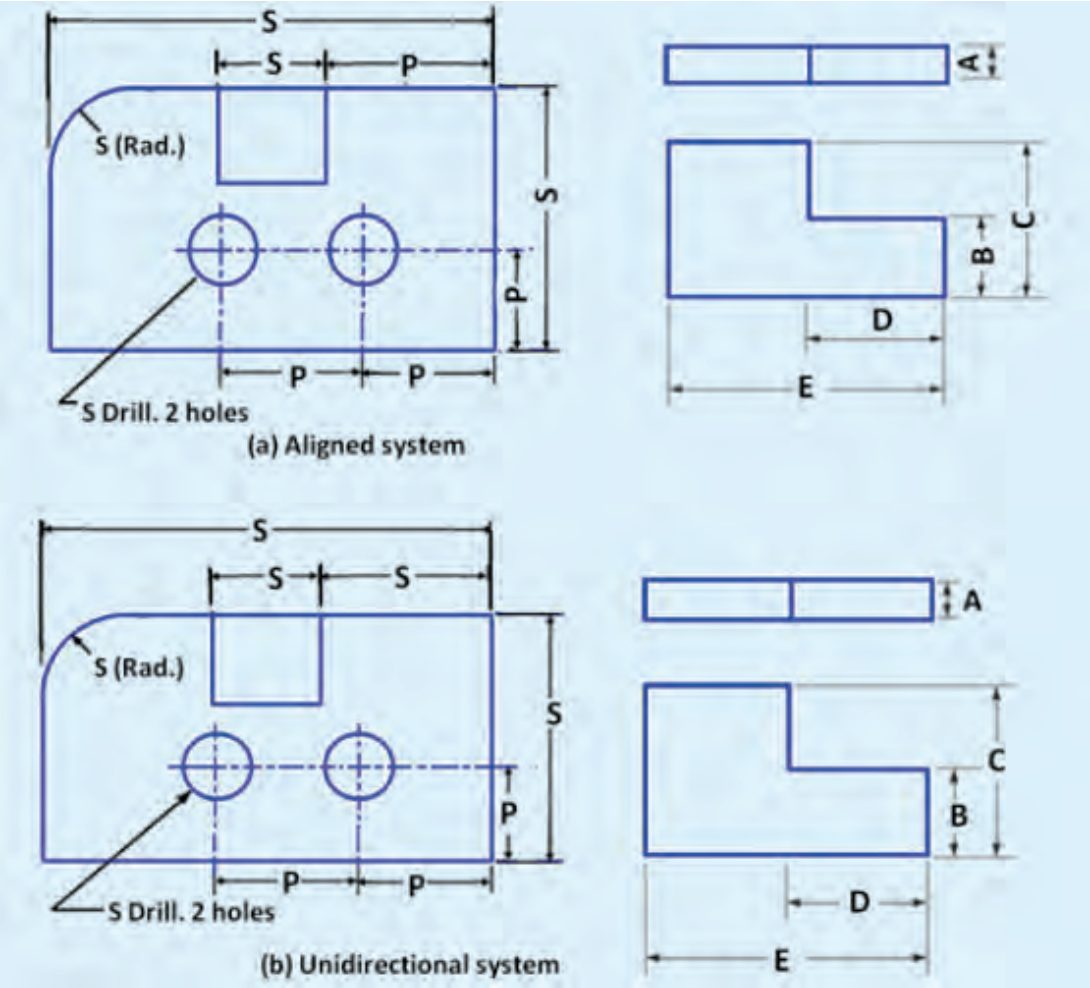


Figure 2.2_4: Dimension Lines

The above diagram showcases a unidirectional and aligned system.

Some of the other aspects of Dimension lines:

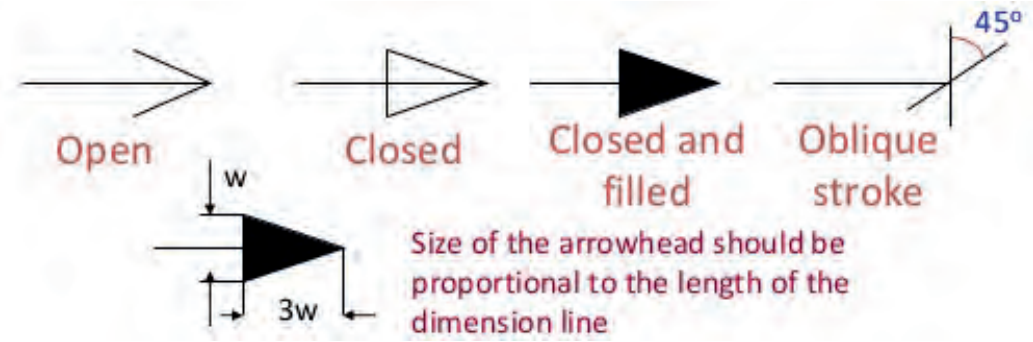


Figure 2.2_5: Arrow types used for dimensioning

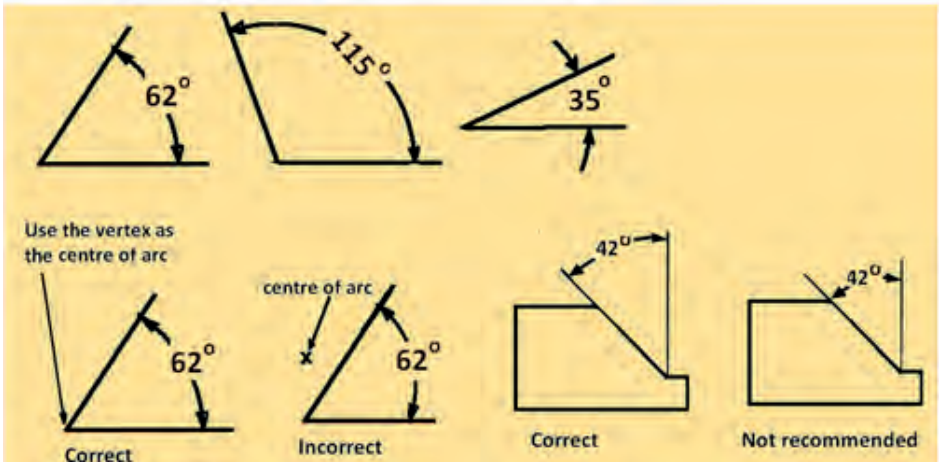


Figure 2.2_6: Conventions

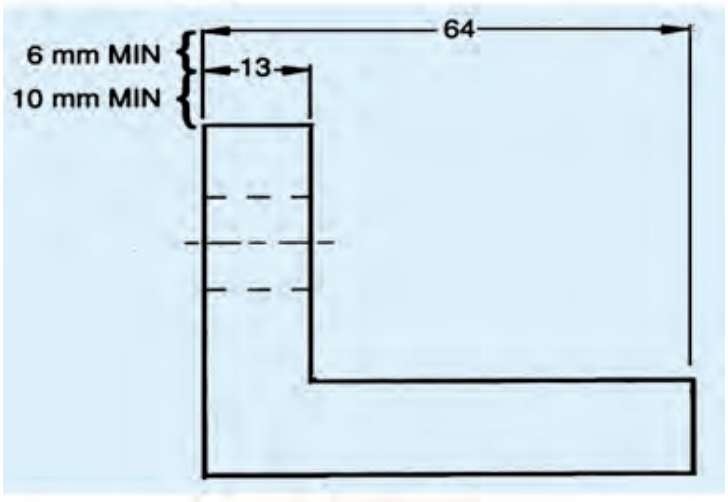


Figure 2.2_7: Extension Lines

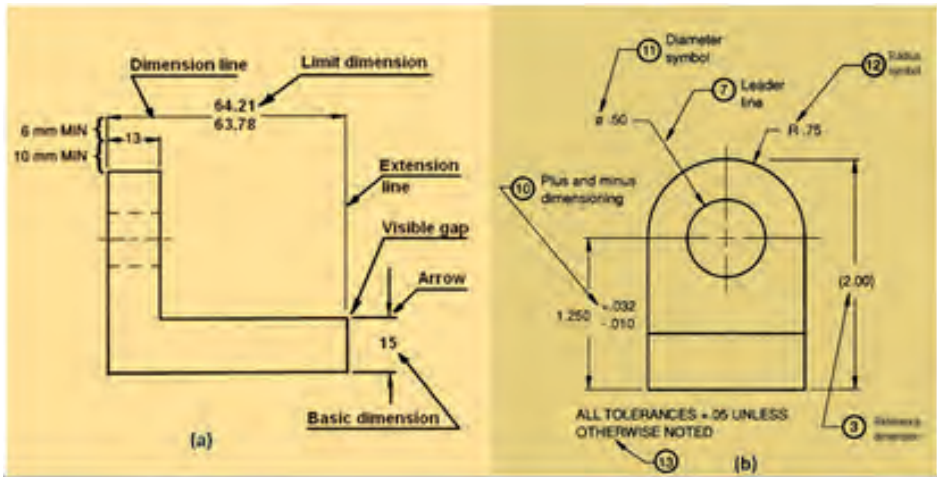


Figure 2.2_8: Specifications

- **Examples**

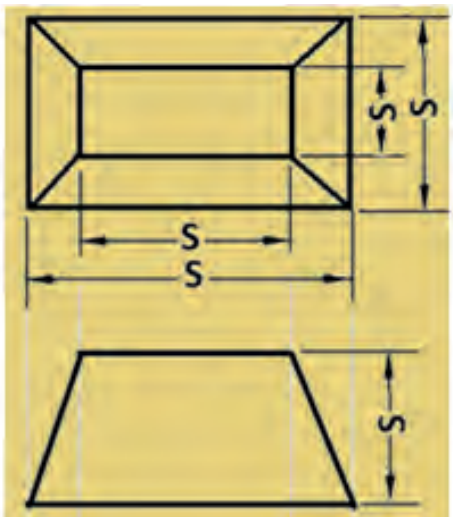


Figure 2.2_9: Dimension lines – Pyramid

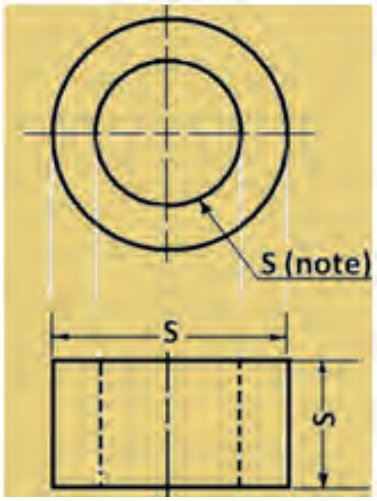


Figure 2.2_10: Dimension lines – Cylinder

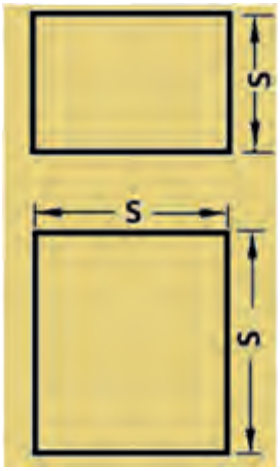


Figure 2.2_11: Dimension lines – Prism

- **Tolerance**

  In case of tolerance, there are various standards. Some of the highly used standards are:

  - JIS B 0401
  - EN 20286
  - ISO 2768
  - ISO 1829
  - ISO 286
  - ANSI B4.2
  - ANSI B4.1
  - ISO (Metric System)
  - ANSI (Inch System)

To attain proper function, the allowed variation allocated in size is known as tolerance. In simple terms:
Upper limit – Lower limit = Tolerance

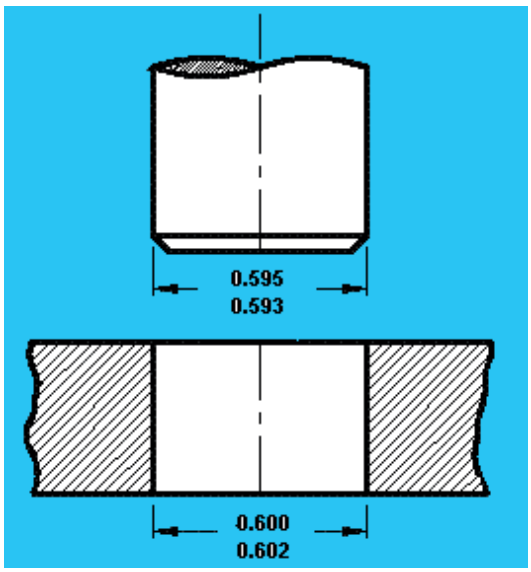


Figure 2.2_12: Tolerance Chart

In case of Clearance Fit:

The hole is always bigger than the shaft.

Here, 0.002 inch is the tolerance on both the shaft and the hole

Maximum clearance is 0.009 inch (0.602 - 0.593)

Minimum clearance is 0.005 inch (0.600 - 0.595)

In this case, on the application of the tolerance formula, the tightest fit is with clearance 0.005.

SYMBOL	GEOMETRIC CHARACTERISTIC	TOLERANCE TYPE	CONTROL SUMMARY
	FLATNESS	FORM (NO RELATION BETWEEN FEATURES)	CONTROLS FORM (SHAPE) OF SURFACES AND CAN ALSO CONTROL FORM OF AN AXIS OR MEDIAN PLANE DATUM REFERENCE IS NOT ALLOWED
	STRAIGHTNESS		
	CYLINDRICITY		
	CIRCULARITY (ROUNDNESS)		
	PERPENDICULARITY	ORIENTATION (NO RELATION BETWEEN FEATURES)	CONTROLS ORIENTATION (TILT) OF SURFACES, AXES, OR MEDIAN PLANES FOR SIZE AND NON-SIZE FEATURES DATUM REFERENCE REQUIRED
	PARALLELISM		
	ANGULARITY		
	POSITION	LOCATION	LOCATES CENTER POINTS, AXES, AND MEDIAN PLANES FOR SIZE FEATURES ALSO CONTROLS ORIENTATION
	PROFILE OF A SURFACE		LOCATES SURFACES ALSO CONTROLS SIZE, FORM, AND ORIENTATION OF SURFACES BASED ON DATUM REFERENCE
	PROFILE OF A LINE		
	TOTAL RUNOUT	RUNOUT	CONTROLS SURFACE COAXIALITY ALSO CONTROLS FORM AND ORIENTATION OF SURFACES
	CIRCULAR RUNOUT		
	CONCENTRICITY	LOCATION (DERIVED MEDIAN POINTS)	LOCATES DERIVED MEDIAN POINTS OF A FEATURE *NOT COMMON...CONSIDER USING POSITION, RUNOUT, OR PROFILE*
	SYMMETRY		

Table 2.2_13: Tolerance Formula Table

Notes

Unit 2.3 Important Diagrams

Unit Objectives

At the end of this unit, you will be able to:

1. Analyze various types of starters
2. Elaborate single line diagram

- **DOL Starter:** This starter has maximum start torque and maximum start current. DOL has a circuit breaker or an MCCB (Moulded Case Circuit Breaker), an overload relay, and a contractor for protection.

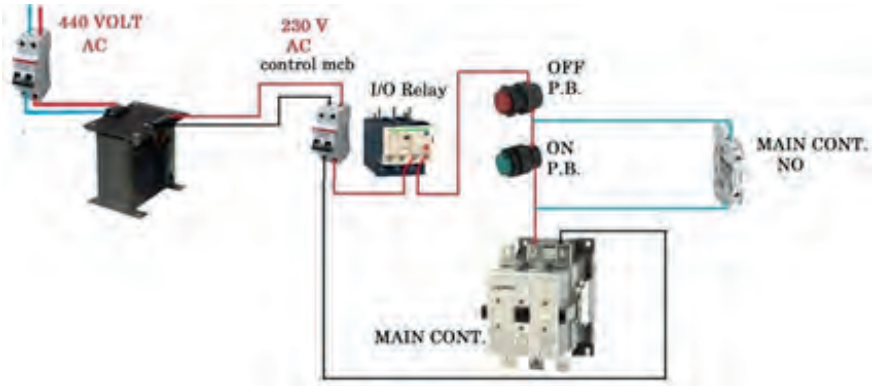


Figure 2.3_1: Circuit Diagram_1

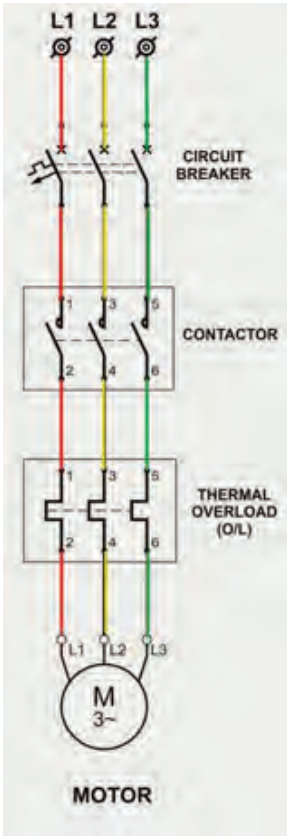


Figure 2.3_2: Circuit diagram

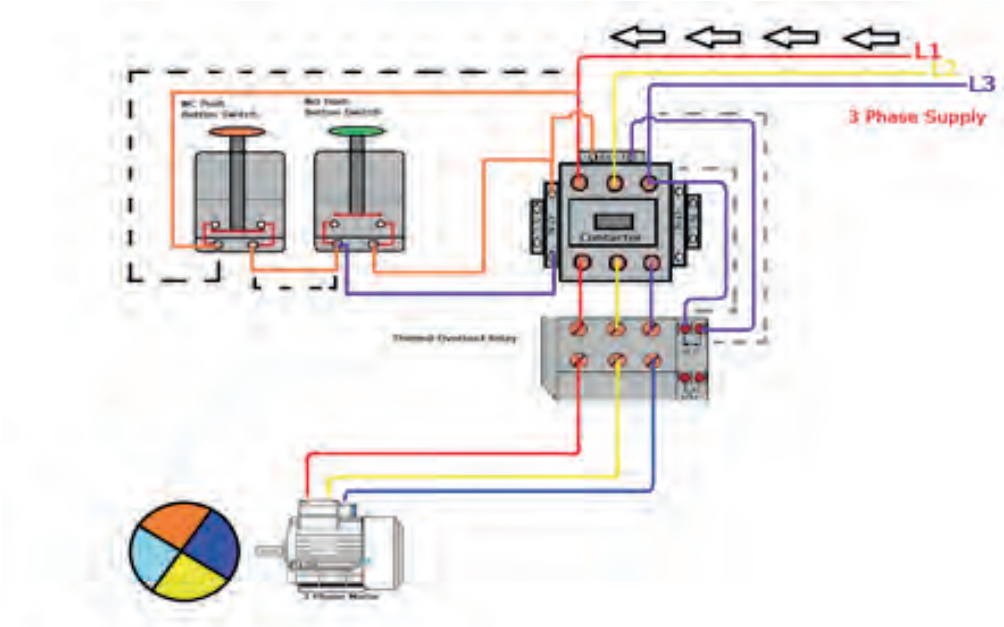


Figure 2.3_3: 3 phase motor controlling diagram

- **Star Delta Starter:** In comparison to other starting technique of induction motors, star delta starter is the one in extensive use. Its use is mainly seen in cage motor design, and it runs on the stator winding that is in connection with Delta connector.

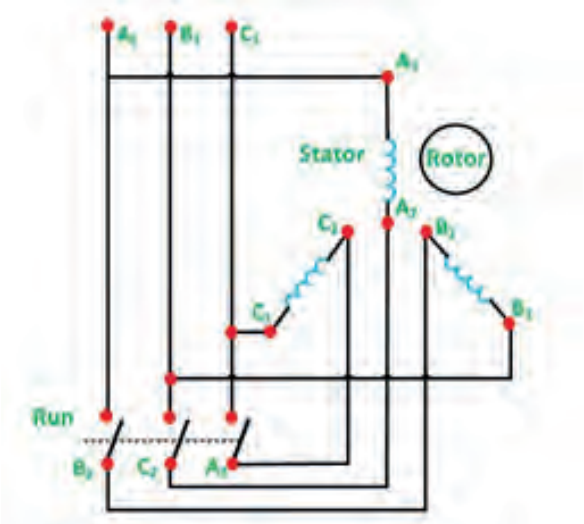


Figure 2.3_4: Star delta starter with a 3-phase induction motor

- **Auto Transformer Starter:** This starter suits both delta connected motors and star connected motors. To minimise stator applied voltage (initial), the limitation or boundation of starting current is done by 3 -phase autotransformer.

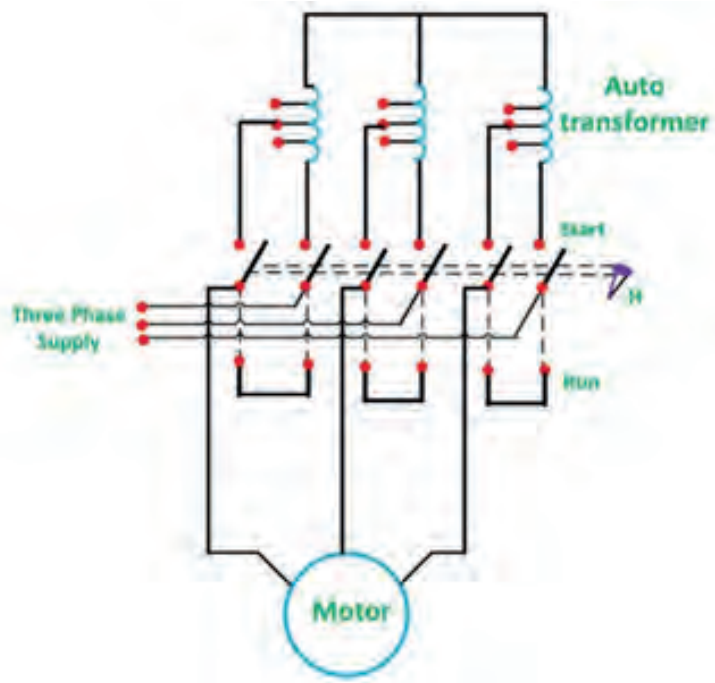


Figure 2.3_5: Auto Transformer Starter

- **Rotor Resistance Starter:** The use of rotor resistance starter is primarily seen in induction motors. The main purpose of rotor resistance starter is to control motor speed. There is 2 classifications of this starter.
  - Slip Ring Induction Motor
  - Squirrels Cage Induction Motor

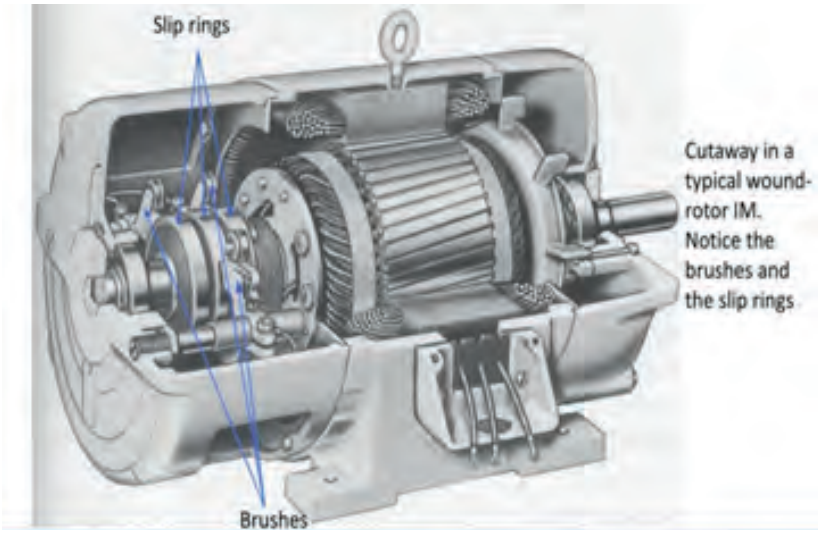


Figure 2.3_6: Squirrels Cage Induction Motor

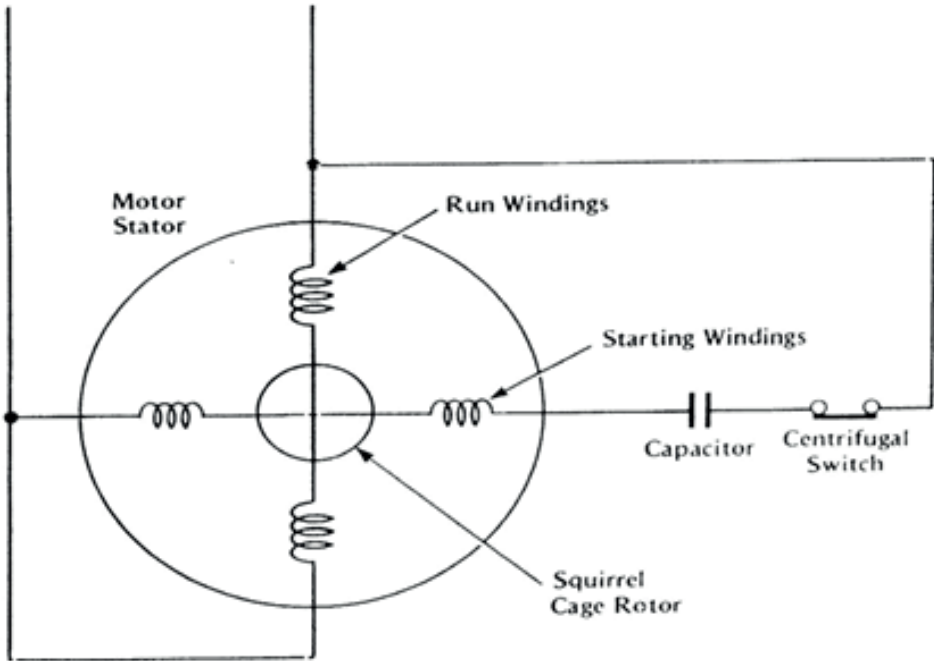


Figure 2.3_7: Circuit Diagram- Squirrels Cage Induction Motor

- **Control of 2 Lamps from Various Positions**

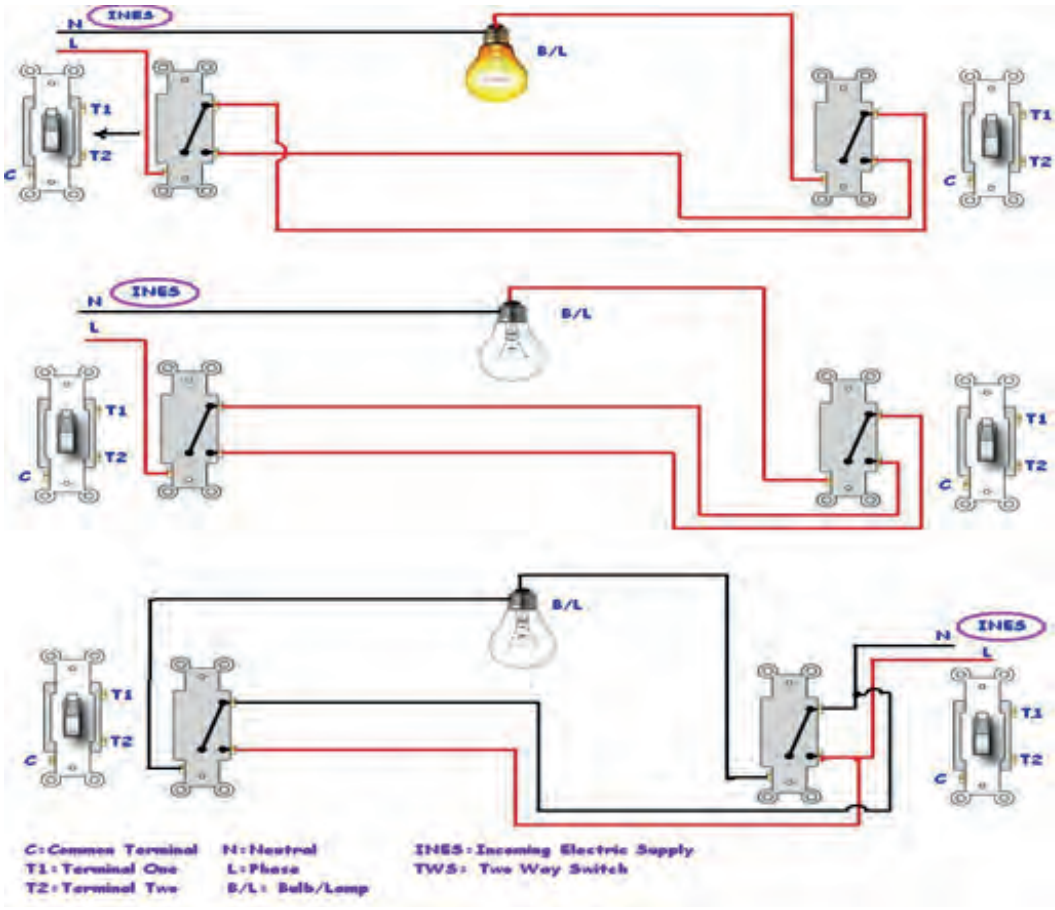


Figure 2.3_8: Controlling 2 lamps from various positions

- **Alternator Stator without Winding**

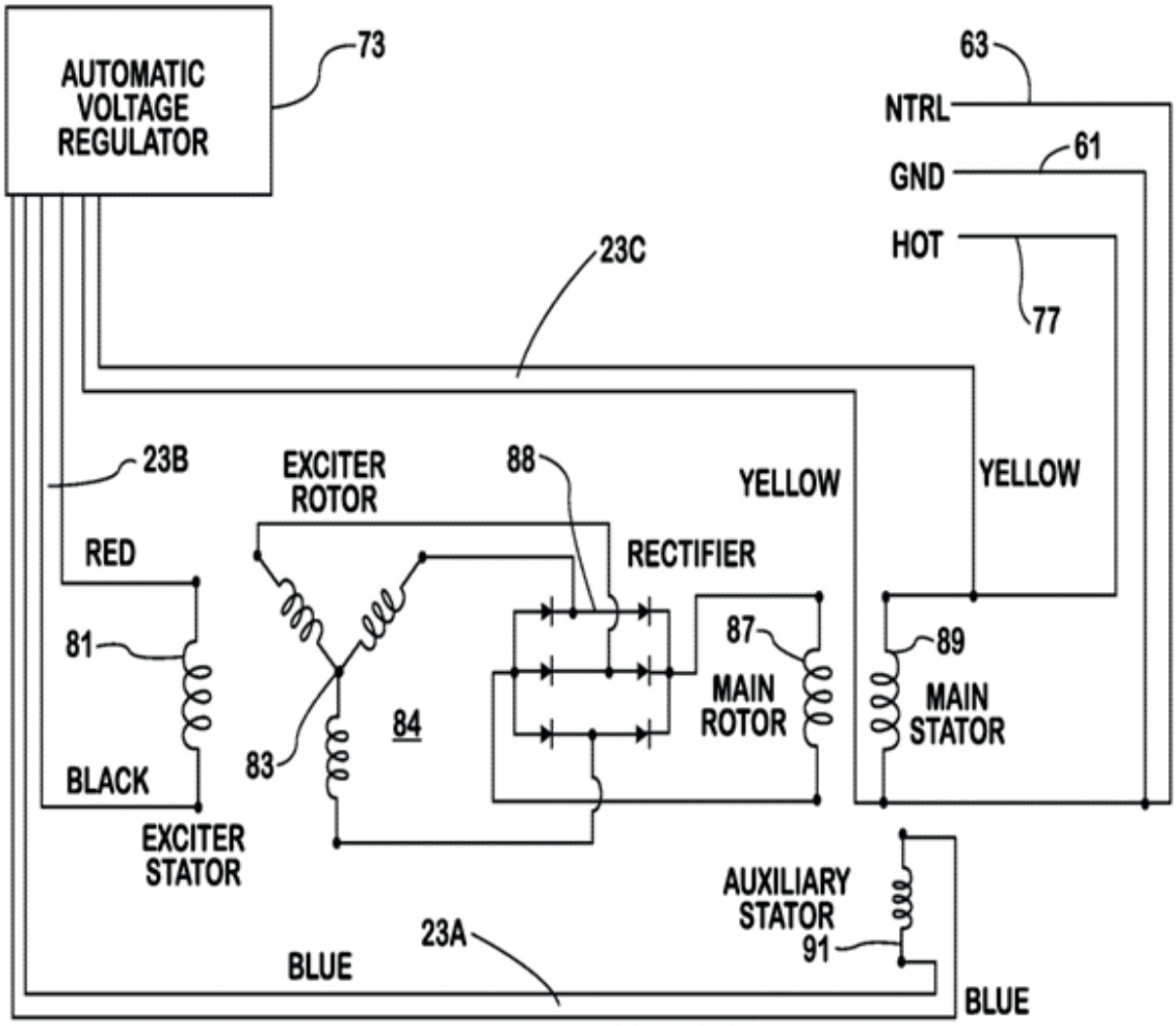


Figure 2.3_9: Alternator Stator without winding

- **Earthing Installation**

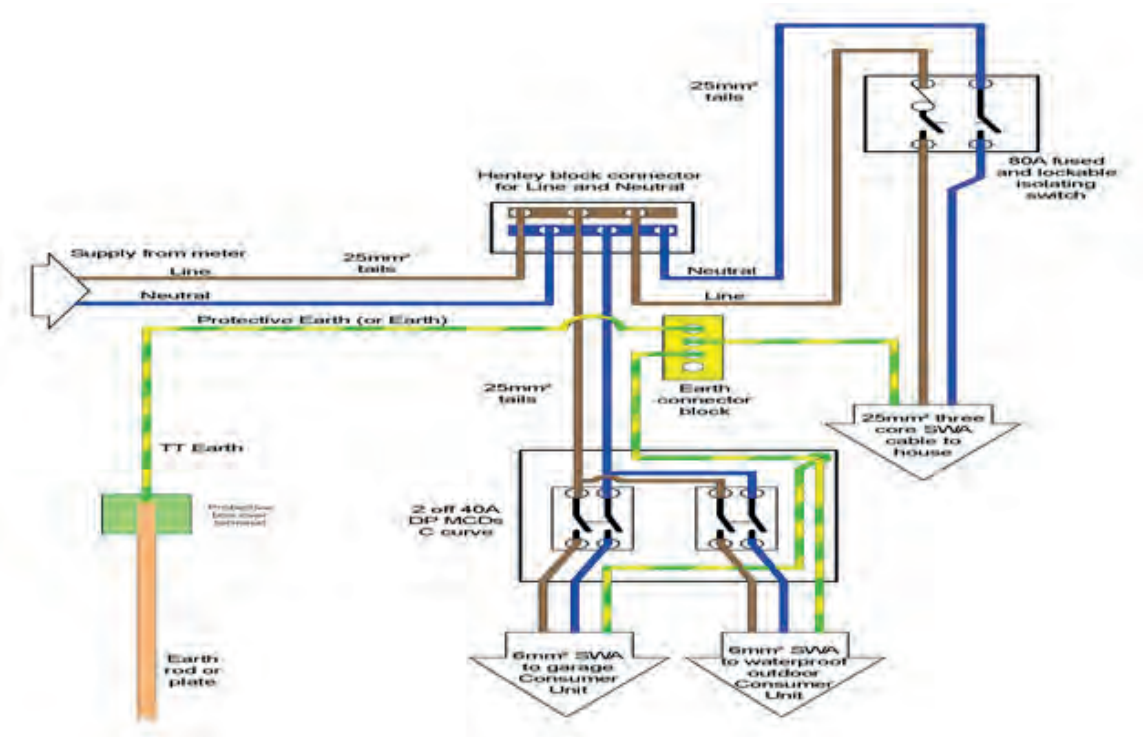


Figure 2.3_10: Earthing installation

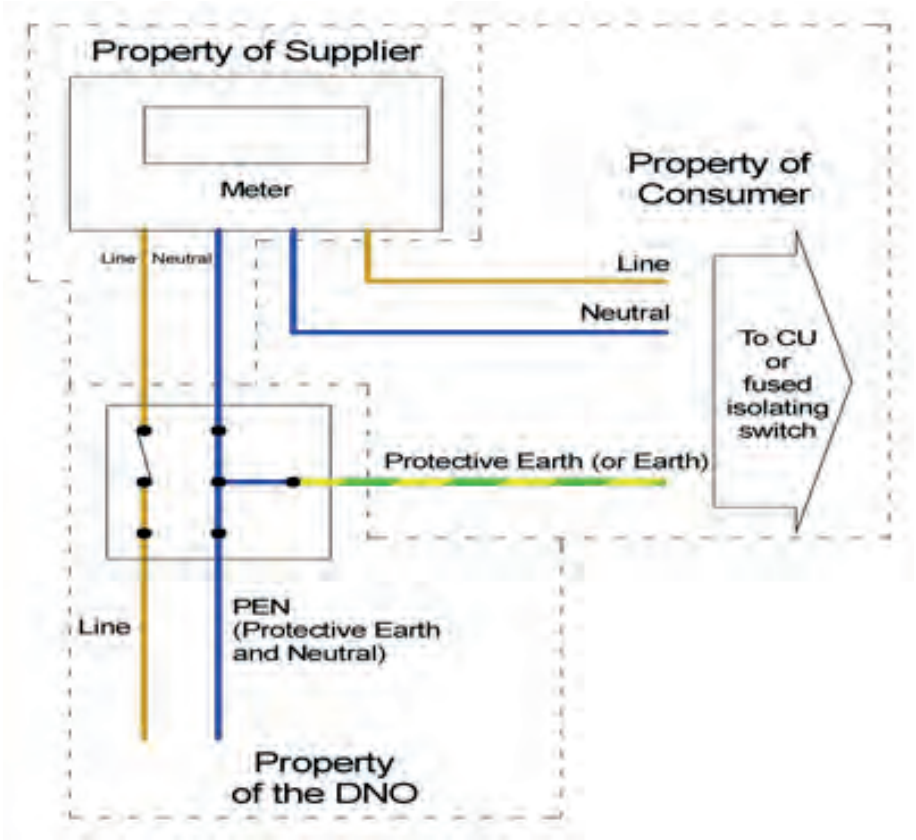


Figure 2.3_11: Simplified circuit diagram for Earthing installation

- **Single Line Diagram Of 33/11KVA Distribution Substation**

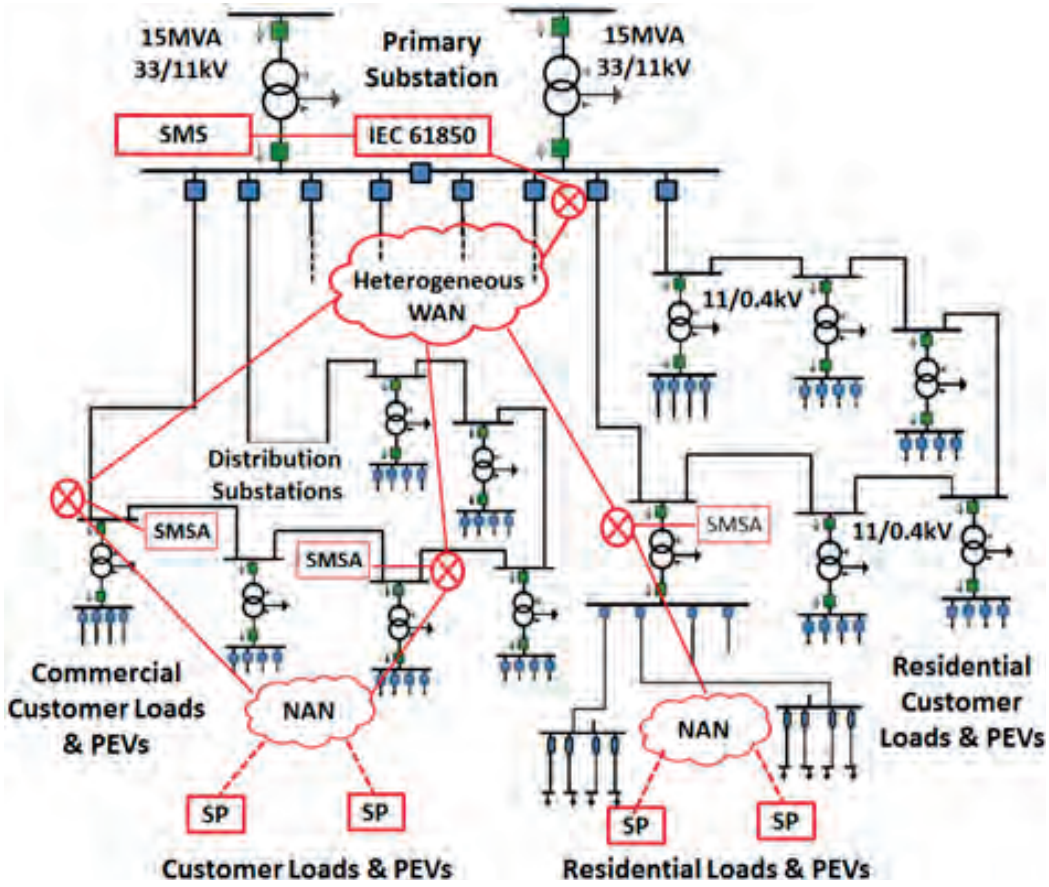


Figure 2.3_12:

- **Single Line Diagram Of 11/440V Distribution Substation**

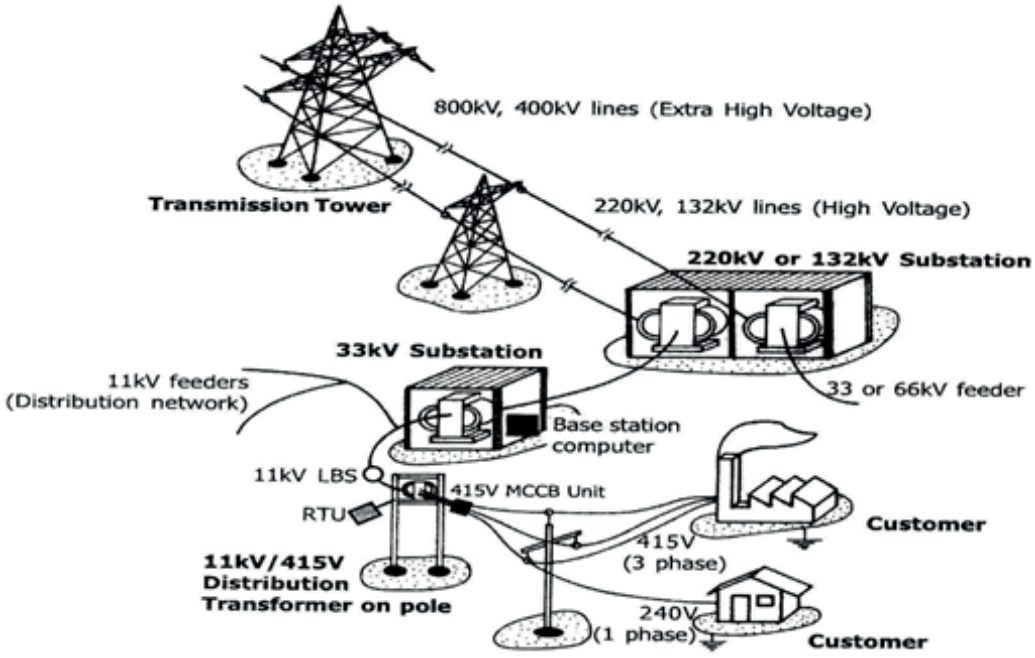


Figure2.3_13: Single line Diagram of 11/440V Distribution Substation

Unit 2.4 Computer Generated CAD for Electrical Drawing

Unit Objectives

At the end of this unit, you will be able to:

1. Define electrical symbols
2. Analyze ac and dc machine parts

- **Electrical Symbols**

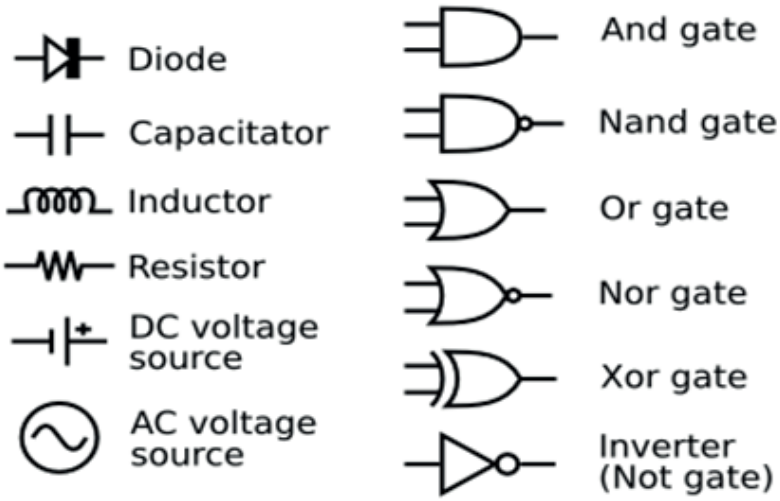


Figure 2.4_1: Electrical Symbols (1)

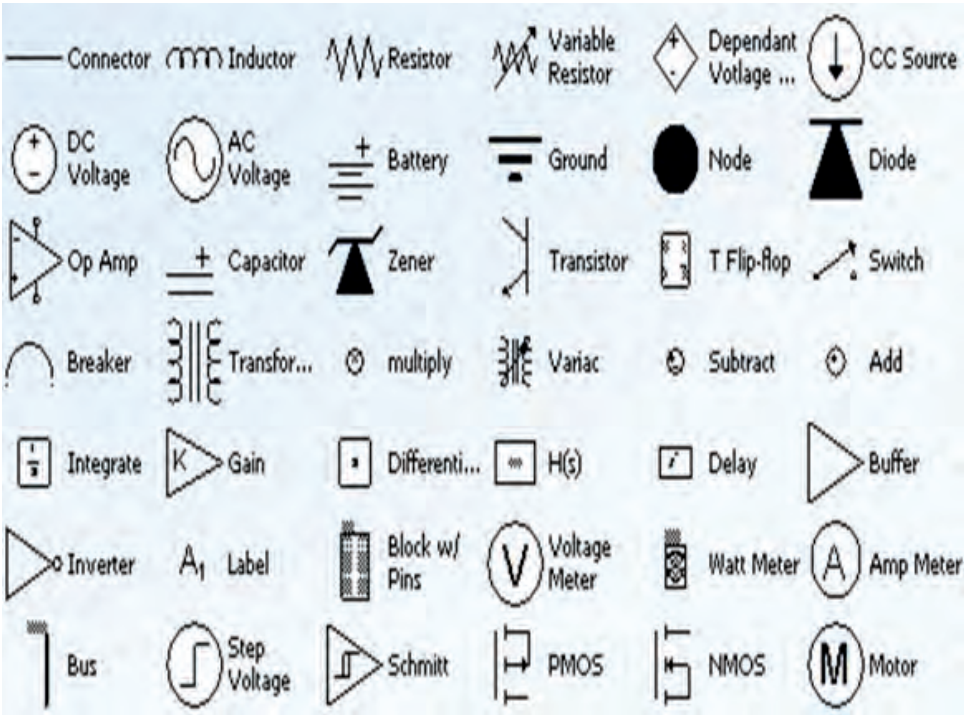


Figure 2.4_2: Electrical Symbols (2)

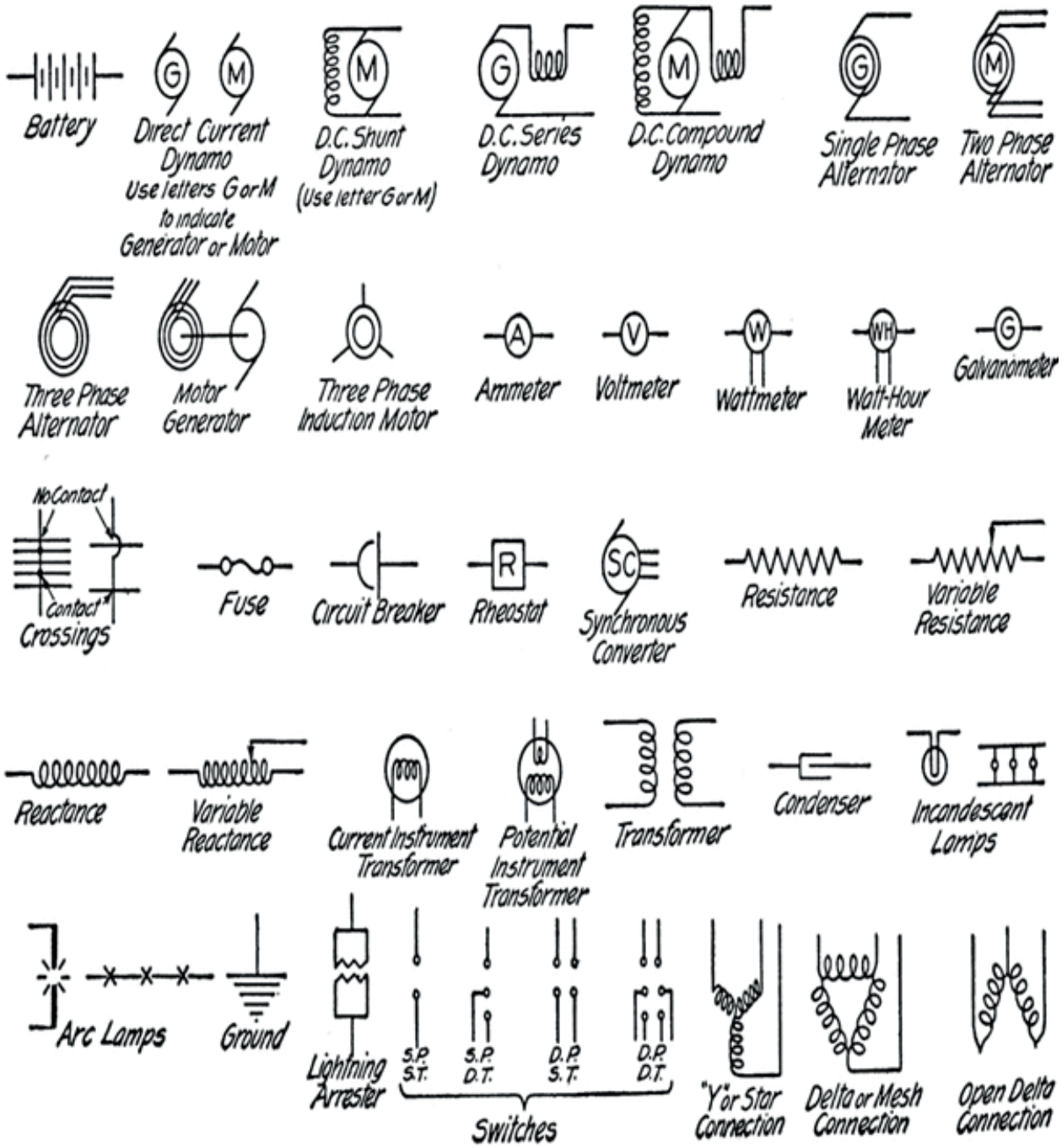


Figure 2.4_3: Electrical Symbols (3)

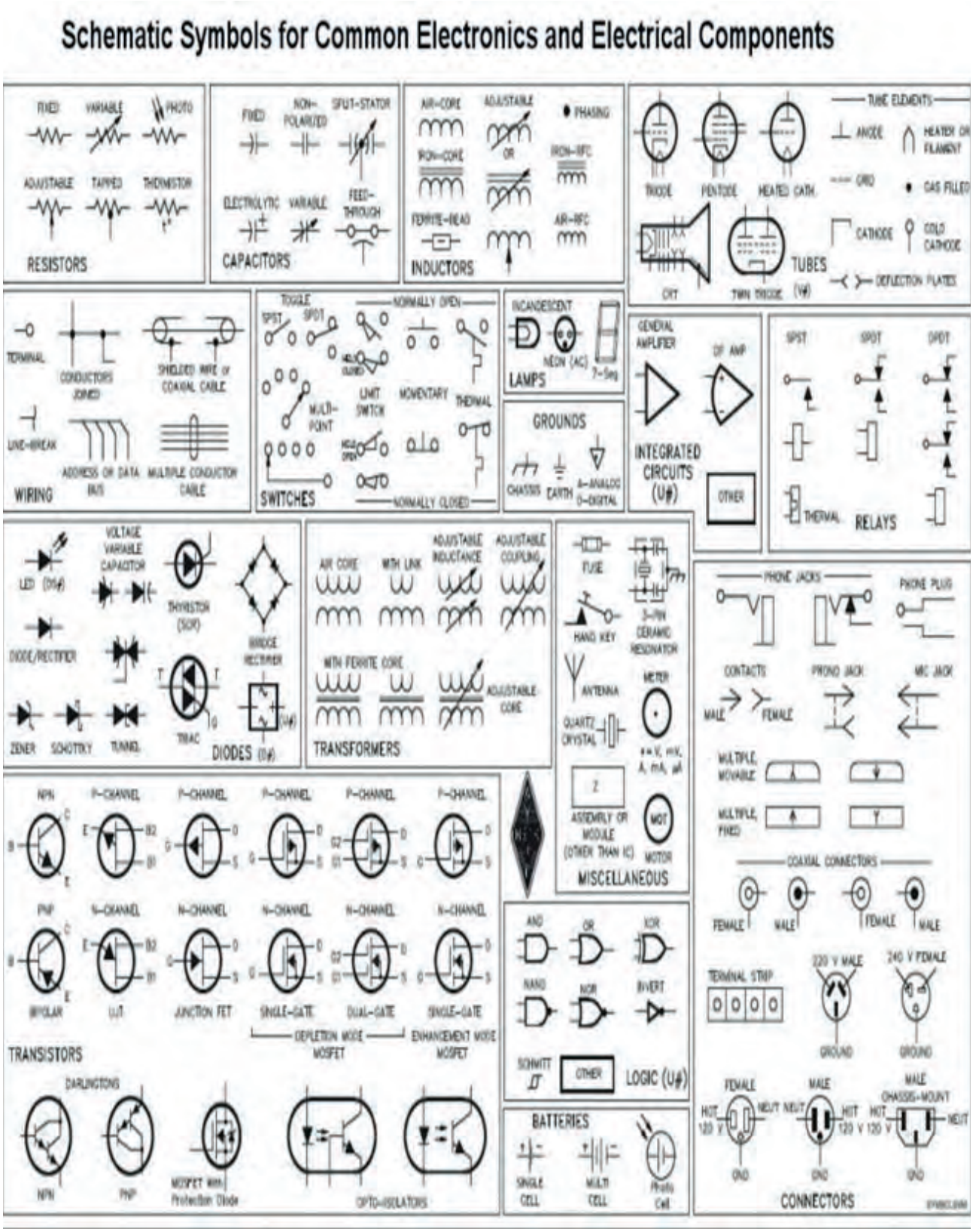


Figure 2.4_4: Schematic Symbols for Common Electronics and Electrical Components

- **D.C machine parts**

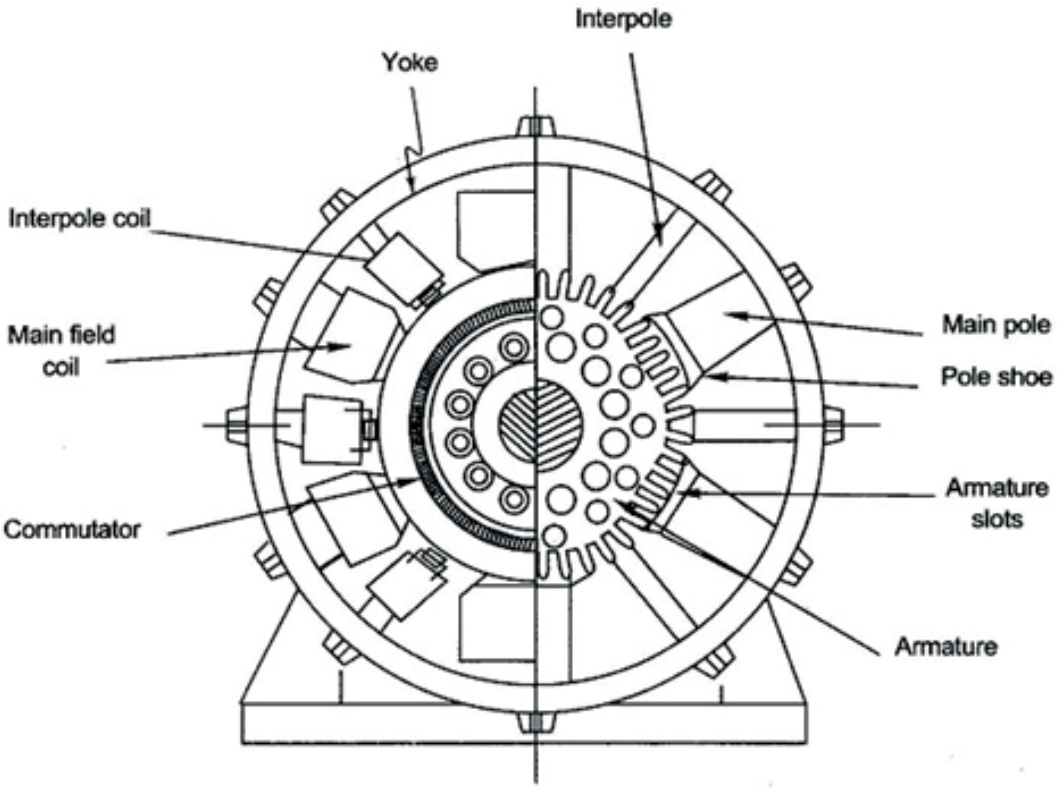


Figure 2.4_5: Cross Section of a D. C. Machine

- **A.C machine parts**

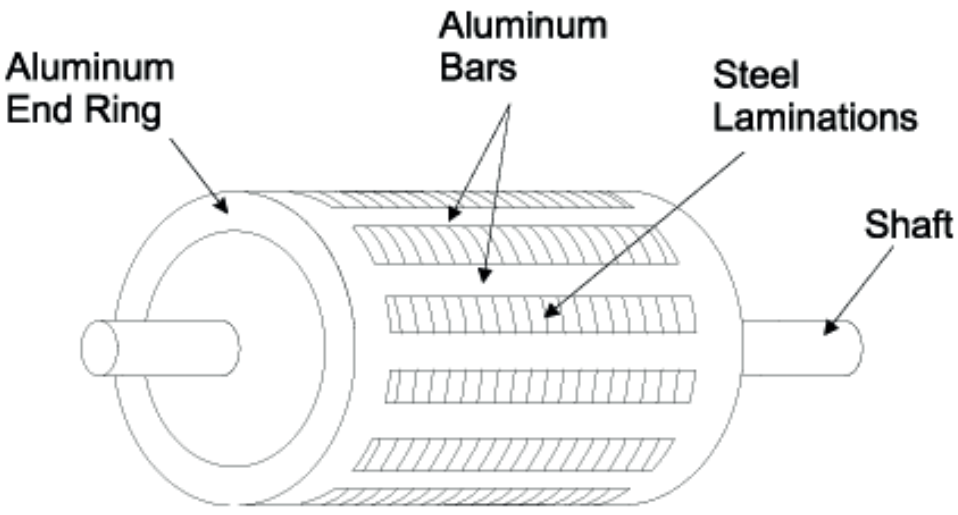


Figure 2.4_6: Cross Section of an A. C. Machine

- **A.C and D.C winding diagram**
  - **General windings**

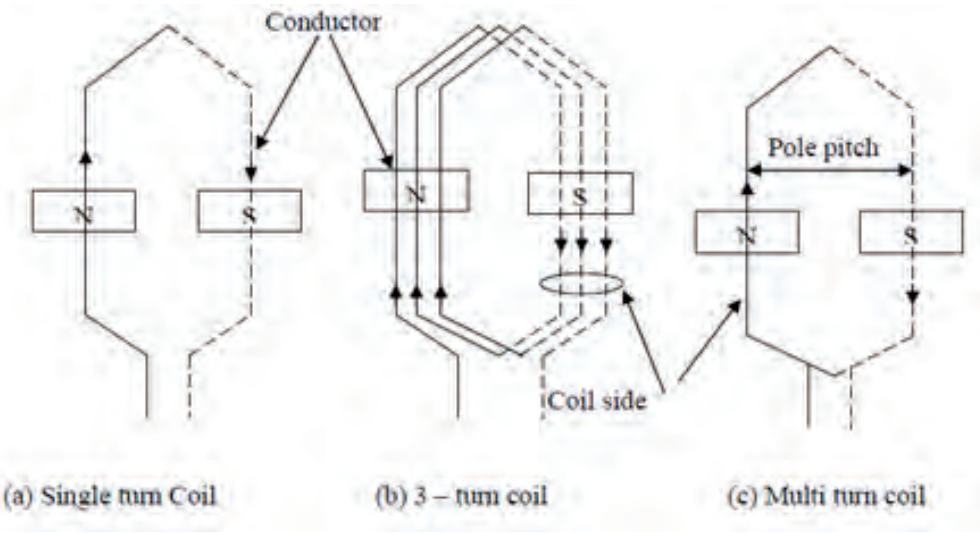


Figure 2.4_7: Windings (Coil Turnings)

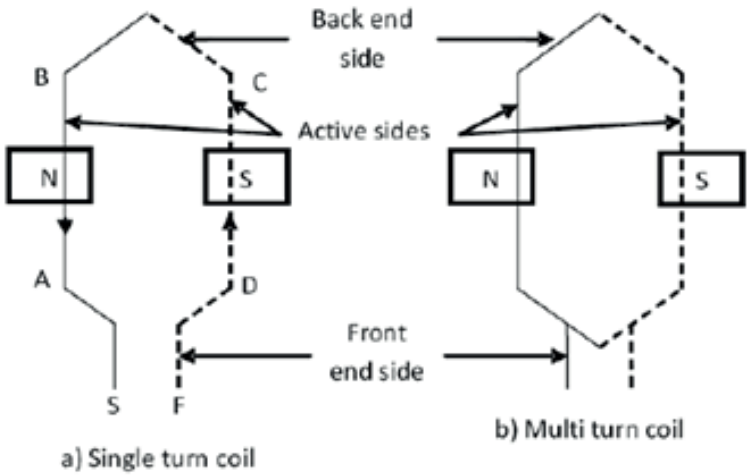


Figure 2.4 _8: Windings (Coil Turnings) 2

- **A. C. Winding**

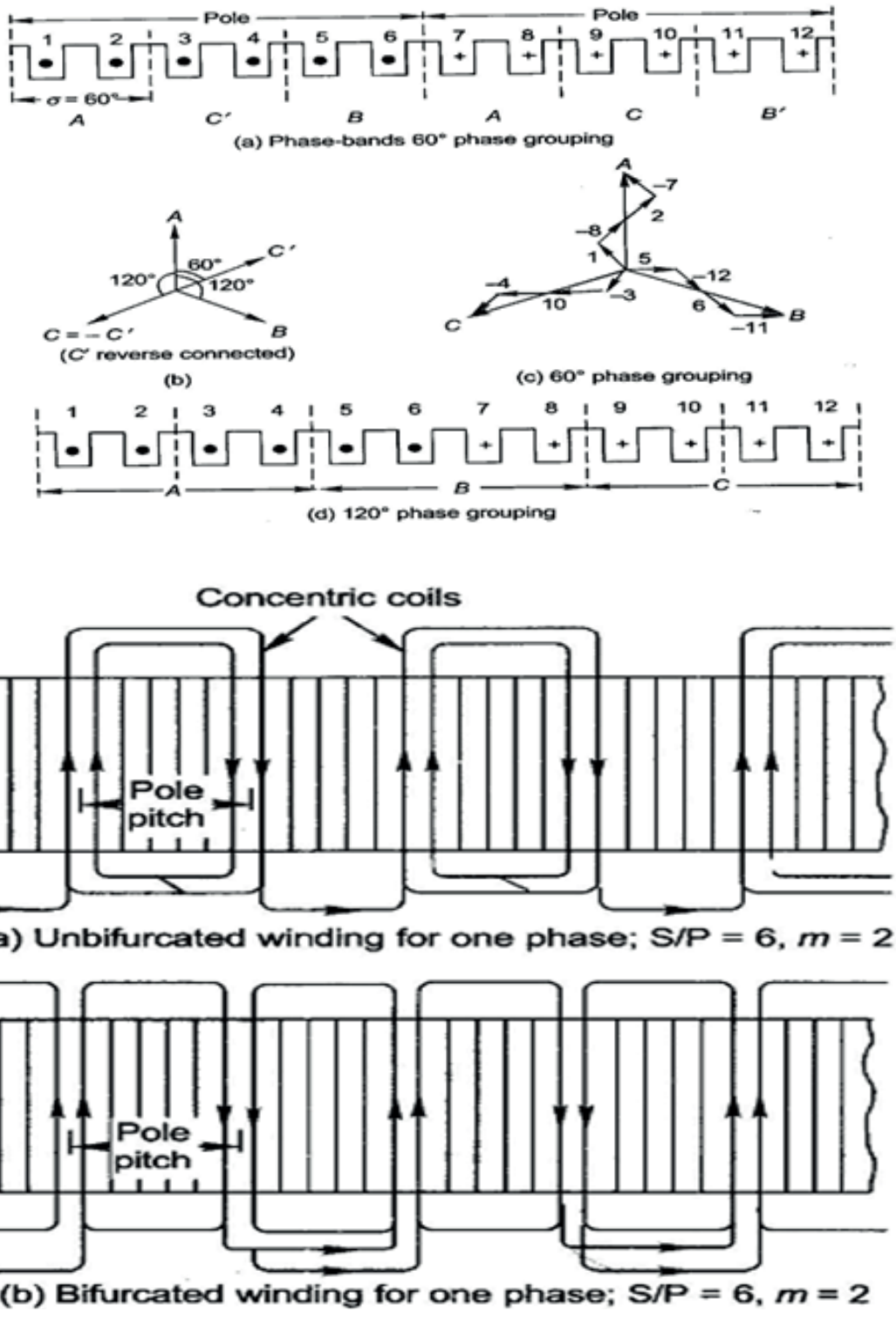


Figure 2.4_9: Single-layer winding with Concentric Coils

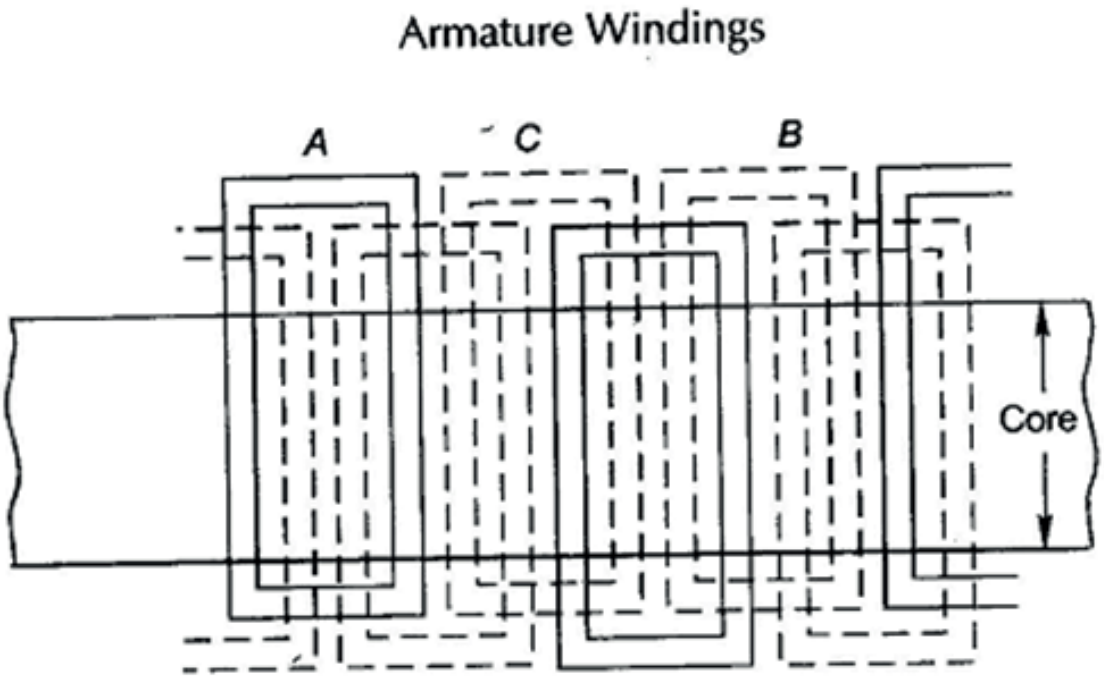


Figure 2.4_10: Unbifurcated winding with 2 plane overhang

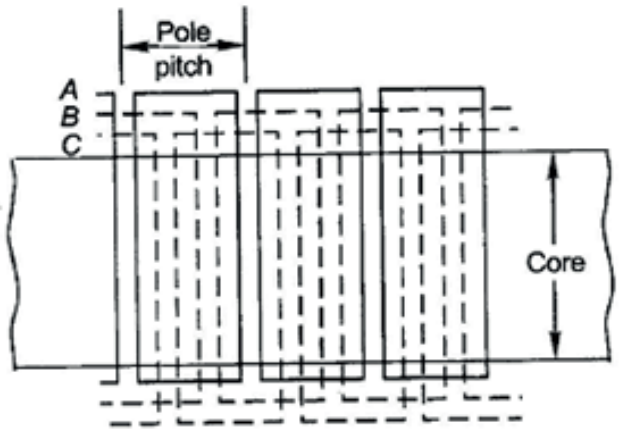
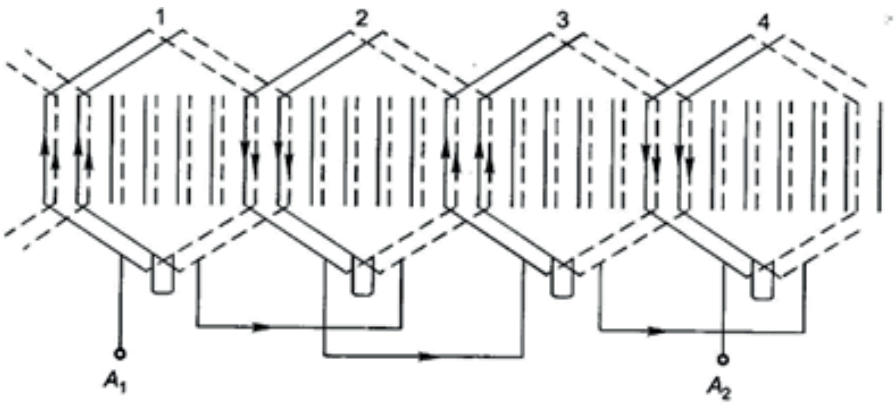


Figure 2.4_11: Bifurcated winding with 3 plane overhang



Double-layer lap winding; 4 poles, $m = 2$, $\sigma = 60°$ coil-pitch = 6 slots (full-pitch)

Figure 2.4_12: Bifurcated winding with multi plane overhang

- **D. C. Winding**

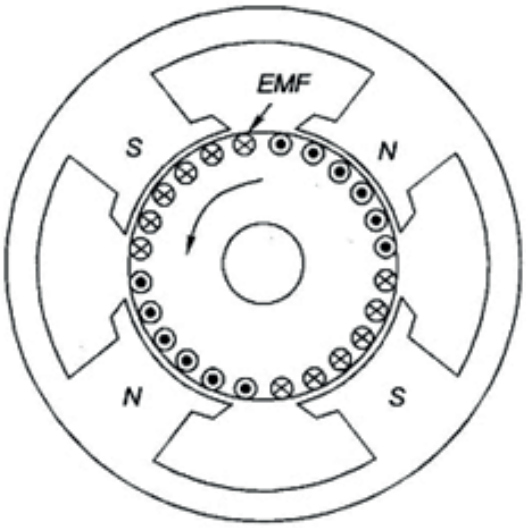


Figure 2.4_13: 4 pole D. C. Machine

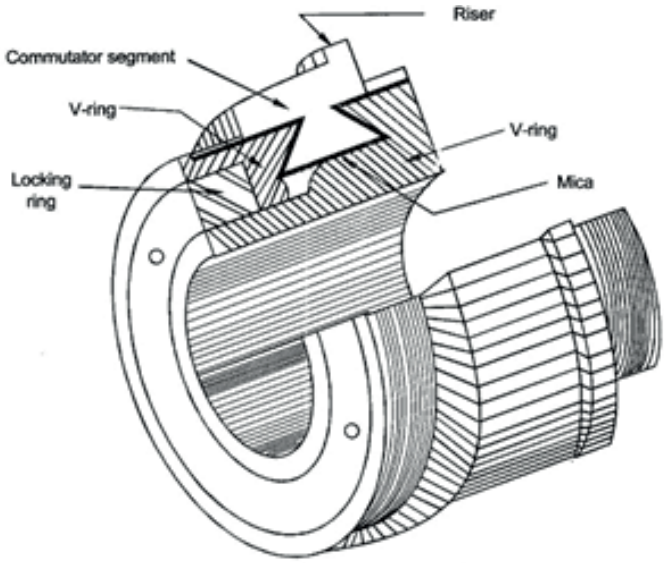


Figure 2.4_14: Commuter A. C

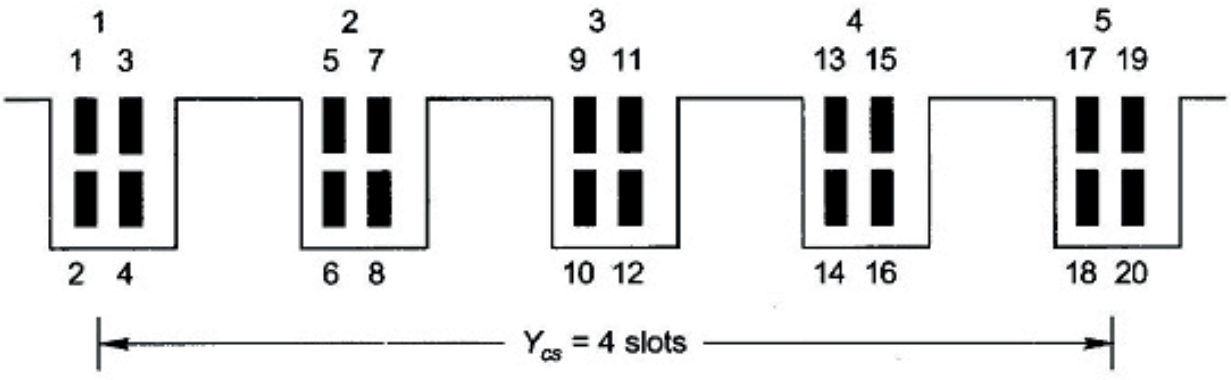


Figure 2.4_15: Coil-side Numbering Scheme

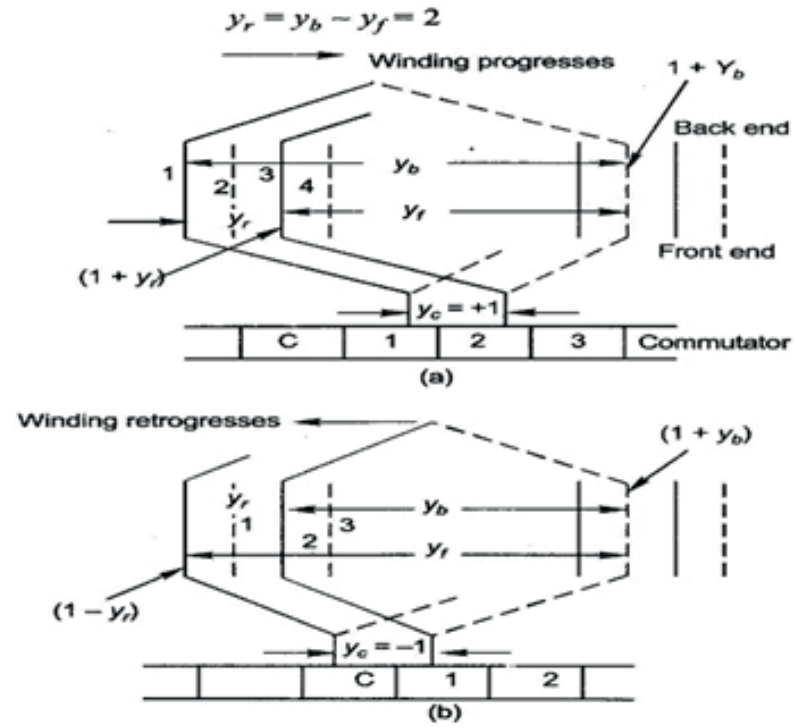
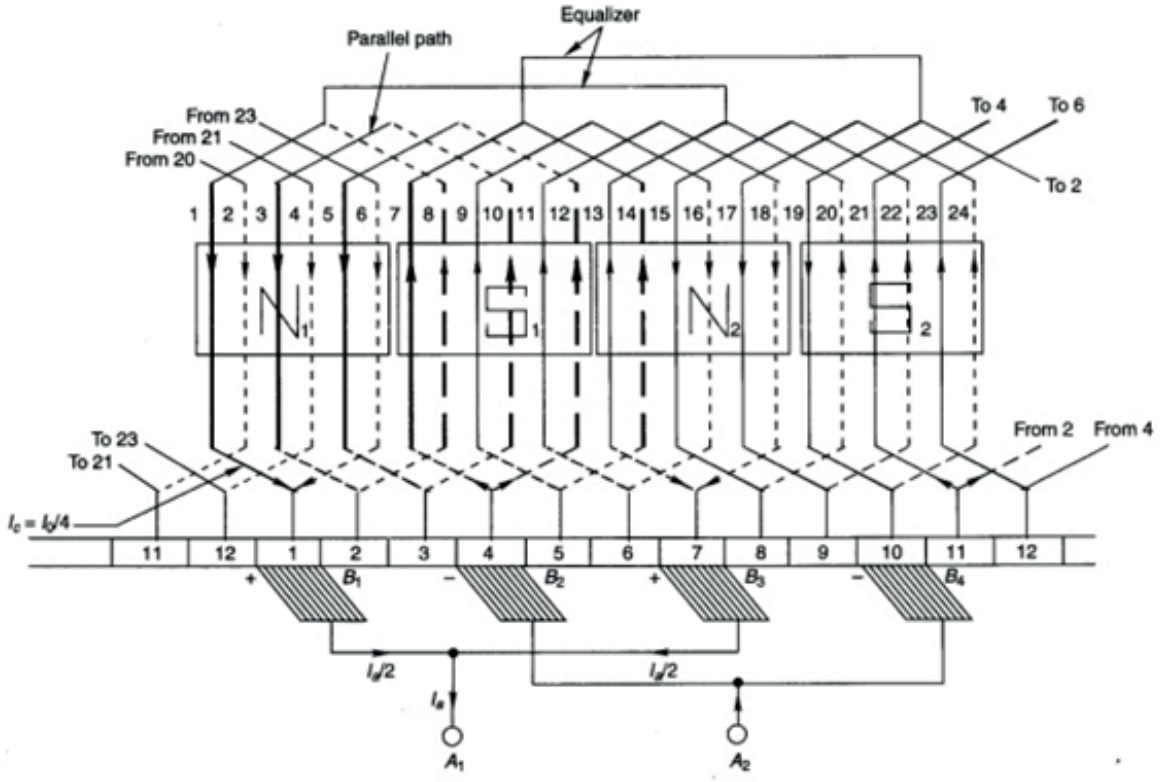


Figure 2.4_16: Lap Winding



Lap winding for 4-poles, 12-slot armature (single-turn coils, 2 coil-sides/slot)

Figure 2.4_17: Lap winding with multi plane overhang

Unit 2.5 Workshop Practices and Tools

Unit Objectives

At the end of this unit, you will be able to:

1. Elaborate on various tools used by industrial electrician
2. Define the specifications of those tools

2.5.1. Filing

Filing is an important part of the Fitting operations. The type of file that needs to be selected depends on the surface finish to be achieved by the Fitter. These usually include **Flat**, **Curved** and **Square** surfaces with a smooth finish. While conducting a particular Fitting activity, the Fitter must ensure how to mount the workpiece using appropriate Clamps, Clasps, Angle Plates and Fixtures.

The most common types of File, used in Fitting activities, are:

1. **Hand File -** These are the most common files, used for a rough finish. These are used for general work, have a parallel width and tapering thickness

Figure 2.5.1_1: Hand File

2. **Mill File -**These are single-cut and have an even thick rectangular cross-section

Figure 2.5.1_2: Mill File

3. **Flat File -** These are very similar to Mill Files, but come with double-cut

Figure 2.5.1_3: Flat File

4. **Square File -**Cut on all 4 sides and are gradually tapered, these files can be used for multiple tasks

Figure 2.5.1_4: Square File

5. **Three-square / Triangular File -**These files have gradually tapered and triangular cross sections and are used for fine filing

Figure 2.5.1_5: Three-square/Triangle File

6. **Round / Rat tail File -**These have round cross-section and taper gradually along the length. These are used for flaring round holes and cutting scalloped edges

Figure 2.5.1_6: Round/Rat tail file

7. **Half Round File -**These files have one flat and one convex surface

Figure 2.5.1_7: Half Round File

8. **Combination File -**These files are flat-sided or half-round and have 2-4 cutting surfaces. Such files can implement a combination of single or double cut

Figure 2.5.1._8: Combination File

9. **Diamond File -** Used generally on unusually hard materials like stone, glass and hard metals, these files have small particles of industrial diamond on their surfaces. These are the only files, which can be used extensively for forwarding and backward motions, without damaging the file

Figure 2.5.1_9: Diamond File

10. **Needle File -**These files are used where the surface finish is prioritized over metal removal rates. These are more suited to small workpieces

Figure 2.5.1_10: Needle File

11. Riffler File -These files come with an assorted variety of sizes, cross sections and profiles. Such varieties enable them to work on hard to reach or weirdly shaped regions

Figure 2.5.1_11: Riffler File

12. Escapement File- Commonly known as the Watchmaker's files, these come with an assortment of short and very thin files, with dimensions in the order of approximately 100–140 mm (4-51⁄2 in.) in length and 3–5 mm (1⁄8–3⁄16 in.) in width. These are mainly used for fine jewellery and watch/clock work

Figure 2.5.1_12: Escapement File

Filing is carried out using several methods and the shape of the file thus selected depends on the job the Fitter is working on. **Flat files** are used for achieving finish on **straight edges** or **Convex curves** such as the **outer edge of a disc** and **Curved files** are used on **concave curves** such as the inside of rings.

2.5.2. Hack Sawing

Types of Hack Saw Blades

- **4 teeth / 25 mm:** Best for cutting - Thick but soft material
- **6 teeth / 25 mm:** Best for cutting - All thick material
- **10 teeth / 25 mm:** Best for cutting - All material with medium and small dimensions
- **14 teeth/ 25 mm:** Best for cutting - Thin material

RECOMMENDED TEETH PER 25MM (TPI) FOR EACH MATERIAL TYPE

Material	Material diameter (mm)		
	10-30	30-100	100-250
	Teeth per inch (25mm)		
Free machining steel Building irons Structural steel	14-8	8-6	6-4
Heat-treated steel Nitridated steel	14-8	8-6	6-4
Unalloyed tool steel Alloyed tool steel	10-8	6-4	4
Spring steel	14-8	8-6	6-4
High temperature steel Stainless steel	8-6	6-4	6-4
Malleable cast iron to 200HB Gray iron over 200HB	8-6	6-4	4
Cast iron	10-8	8-6	6-4
Dural Bronze Aluminium Brass	6-4	6-4	6-4

Table 2.5.2_1: Recommended Teeth per 25 mm (TPI) for each material type - Saw

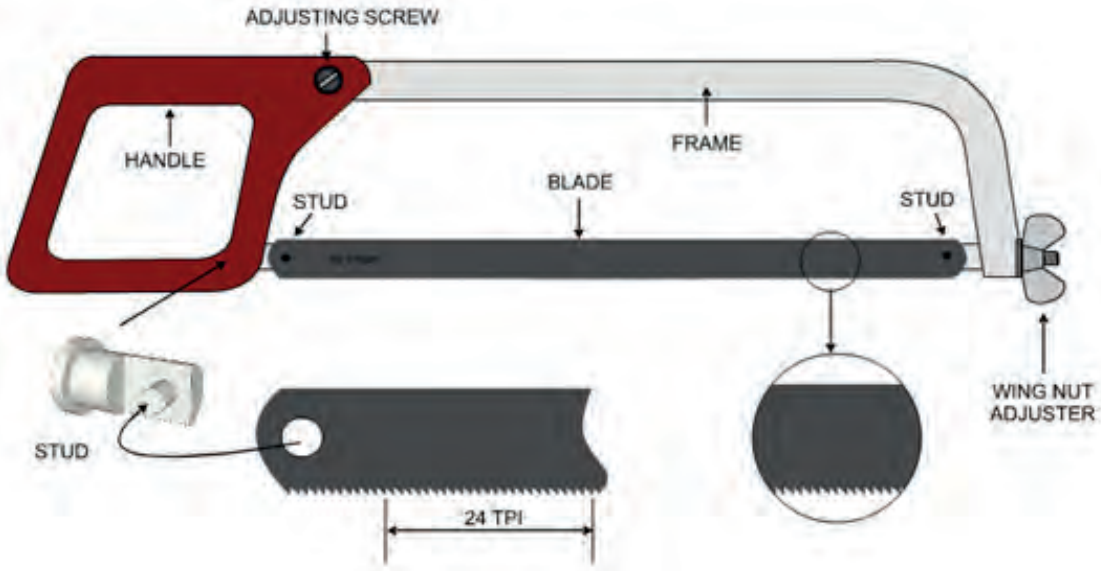


Figure 2.5.2_2: Specifications

2.5.3. Marking

- **Scribers:** There are generally 4 scriber types.

Knife edge scribers

- Flat knife blade
- One end - Straight point
- Length – 4” - 10” or 100-250mm

Figure 2.5.3_1:

Double-ended scribers

- One end - Straight point
- Angled points – varied

Figure 2.5.3_2:

Machinist’s scribers

- Shape – Similar to pens with clip
- Length – 6” - 8” or 150-200mm

Figure 2.5.3_3:

Pocket scribers

- Hexagonal head
- Replaceable tips
- Length – 4” or 100mm

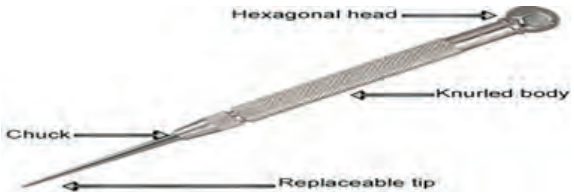


Figure 2.5.3_4:

- **Dot punch:** In case of punches, the similarity of dot punches is visible with that of Centre punches. However, the difference in relation to dot punches is the presence of sharper point ground. This comes to light when we hold the dot punch at a specific angle of 60˚. Running along a point (on the object), this does create grinding marks.

Figure 2.5.3_5:

- **Centre punch:** To create an indentation on the metal body, the centre punch comes to use. It is highly in use while drilling holes. The best thing about centre punch is that it helps in creating large enough dimples so that the drill tip can sit in the correct position. The angular point regarding the centre punch’s tip can be either 90˚ or 60˚.

Figure 2.5.3_5:

2.5.4. Drilling

Types of Drilling machine

- **Hammer drill:** This drill is in use for masonry and is quite same to that of an electric drill. The input power of most hammer drill is between 1100 watts to 600 watts.

Figure 2.5.4_1: Hammer Drill

- **Pistol-grip (corded) drill:** These are the drills that are currently used by electricians and plumbers. These drills are corded, and its motor is a universal motor.

Figure 2.5.4_2: Pistol-grip (corded) drill

- **Hand drills:** These are also called egg beaters. 3 of its types are:
  - Gimlet
  - Bit and Brace
  - Bow Drill

Figure 2.5.4_3: Hand Drills

The other drill types are:

- SDS Drills
- Braces drills
- Mill drill
- Radial arm drill press
- Geared head drill press
- Magnetic drilling machine
- Drill press
- Cordless drills
- Rotary hammer drill

Figure 2.5.4_: Magnetic drilling machine

2.5.5. Tapping

The method of tapping is basically creating thread beside the holes.

One can find a number of tap types.

- Spiral pointed taps is highly useful in deep hole tapping. It is also known as Gun taps.
- Spiral flutes have multiple helix options, and their utility is visible in blinding holes when moving any material out of a hole.

The other taps types are:

- Hand Taps
- Plug Taps
- Bottom taps

Tapping operation

- In a hole, the cutting of internal threads via cutting tools is known as tapping.

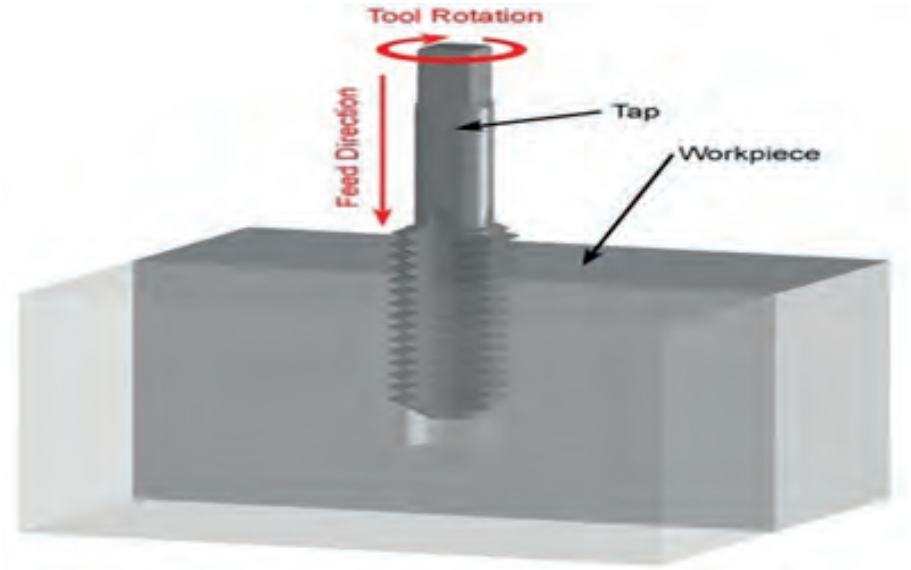


Figure 2.5.5_1: Tapping Operation

- The next step consists of trepanning in which the process of metal removal takes place with the help of a hollow cutting tool.
- Then again, the process of undercutting takes place where the dimension inside the hole increases.
- In this step, the large stock amount is removed concerning honing and lapping operations from super finished and hardened material.
- The process of lapping involves:

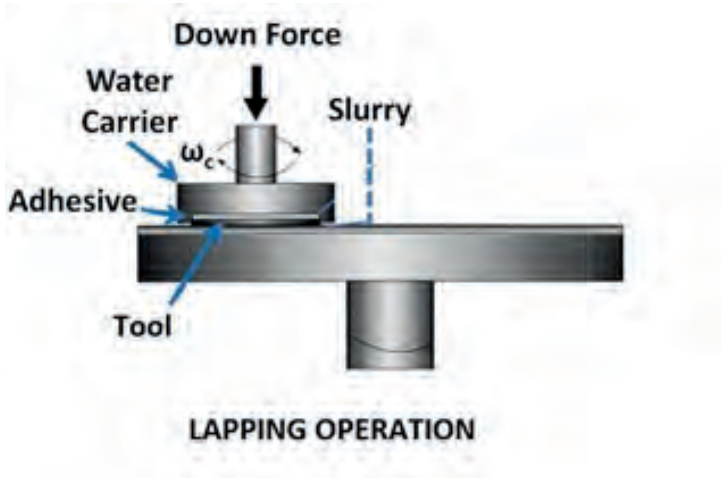


Figure 2.5.5_2: Lapping Operatrio

- The process of honing involves:

Figure 2.5.5_3: Honing Operation

2.5.6. Chisels

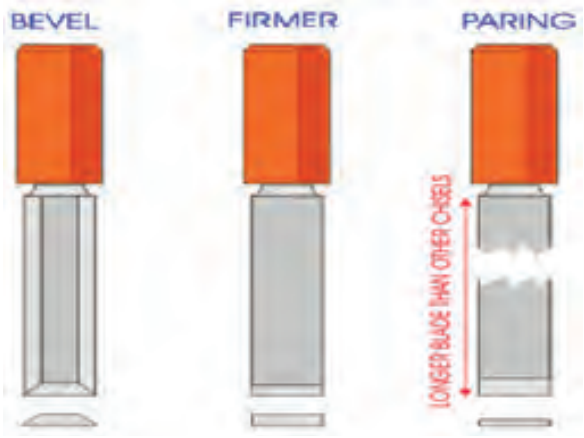


Figure 2.5.6_1: Chisel types

- Paring chisel is thinner and longer and is useful in working with longer joints.
- The firmer chisel has rectangular cross-sectional blades. It is useful in performing heavier work.
- The chisel that is useful in working in corner areas and finishing dovetail joints is a bevel edged chisel.

In case of **Wood Working**, the application is visible in:

- Butterfly joint - Helps in joining 2 wood slabs or flats in which the meeting points are the longer wood edges.
- Housing points - The other name for such joint is Dado joint, and its use is visible as the attachment of a shelf to that of a bookcase.
- Chopping - It becomes easier to remove wood chunks with the help of a chisel

In case of **Metal Working**, the application of cold chisel is visible in case of smoothing the metal after cutting it.

In **Aviation Industry**, the uses of chisels are commonly seen for producing and refurbishing blades of turbines.

2.5.7. Hammers

- **Power Hammers:** These are in use for fitting staples and nails. These are also known as **"Powered Nailers".**

- **Special Hammers:** These hammers come in variations.
  - Picture frame makers commonly use Sprig Hammer.
  - In confined spaces, driving nails and tacks becomes easier with the help of Upholsterer's hammer
  - For tapping and pressing veneers, the suitable hammer is Veneer hammer

- **Soft-faced Hammers:** The faces of these hammers may be in copper, plastic and even in rubber. There are also certain hammers in this category whose faces are interchangeable. This is an appropriate replacement for a mallet.

- **Sledge Hammer:** For breaking concrete or for mason work, sledgehammers are the appropriate tools. The weight of these hammers may be 6 Kg, 4.5 kg, and 3 kg.

- **Straight and Cross Pein:** These hammers have their utility in domestic areas. It is mostly used to shape metals.

- **Claw Hammer:** These hammers are the common tools that are present in most of the houses and popular for general work. The handle can be made of steel, glass-fibre, or even wood. If we consider on the general weight that is available in the market, it will be around 500 to 700 gms.

2.5.8. Spanners

- **Scaffold spanners;** These are useful for fitting work, and they have socketed heads (flexible).
- **Spark plug spanners:** These are useful in spark plug fitting. They are mostly in use in confined spaces like car engines.
- **Insulated Spanners:** These are mostly in use on electrical sites. As they have rubber insulation, working easily on live wires becomes possible.

The other types of spanners are:

- Flex-head spanners
- Box spanners
- Pin spanners
- Ratchet spanners
- Podgers
- Flare nut spanners
- Combination Spanners
- Immersion heater spanners
- Ring spanners
- Compression fitting spanners
- Open-ended spanners

Notes

Unit 2.6 How to Use Automation?

Unit Objectives

At the end of this unit, you will be able to:

1. Define Automation
2. Analyze how to use automation

The concept of **Automation** is widely used in the electrical sector, especially in power generating industry. Automation refers to the physical limits of electricity in terms of generation, transmission and distribution.

- The word 'Automation' is derived from ancient Greek words of "Auto" (means self) and "Matos" (means moving).
- In simple words, a machine that does not require human effort rather performs in itself or is self-dictated is called automation.
- Automation is a system, which is reliable, energy efficient and provides an integrated solution in power sector

Figure 2.6_1: Modicon m580

- Automation technique is applied in power sector thus ensuring that it has the right mix of technologies.
- The right mix of technologies will increase the growth opportunities in markets.
- With the advance technology in industries, mechanization is being replaced with automation.
- In mechanization, human effort is required to operate the manual machinery.
- While in automation, computerized effort is being taken which helps in maintaining high accuracy, precision.
- In short, automation is one step ahead of mechanization, ensuring superior performance.
- Industrial automation uses control devices like PC/PLCs/PACs etc. which help to control industrial processes and machinery by replacing as much as possible labour effort.
- In automation, control systems are the essential parts of this technique.
- Automated system requires special dedicated hardware and software products.
- Few benefits of automation are listed below:
- Helps in increasing labour productivity
- Helps to Improves product quality
- Reduces the cost of production
- Reduces the routine manual tasks
- Reduces risk factors like exposure to high temperature

Unit 2.7 Basics of Microprocessor, Micro Controller and its Applications and Functions

Unit Objectives

At the end of this unit, you will be able to:

1. Define Microprocessor and Micro Controller
2. Analyze where both are applied
3. Elaborate the functions of Microprocessor and Micro Controller

- The first microprocessor was the 4-bit Intel 4004 released in 1971, with the Intel 8008
- A **Microprocessor** is a computerised processor which combines the functions of a computer's central processing unit (CPU) on a single integrated circuit.
- The microprocessor is designed to perform arithmetic and logic operations making use of the data on the chip.
- The microprocessor is mainly of two types, **Intel 8085** and **Intel 8086.**
- **Intel 8085** is an 8-bit microprocessor, and Intel 8086 is a 16-bit microprocessor.
- The diagram shown below represents Intel 8085

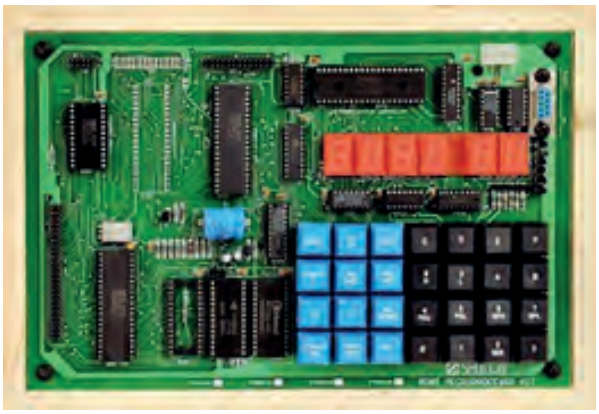


Figure 2.7_1: Microprocessor (Intel 8085)

- Microprocessor is used in different objects like switches and dimmers, electrical circuit breakers, smoke alarms, battery packs, power tools.
- Microprocessors are mainly classified into 3 categories:
  - Digital Signal Processors
  - Embedded Processors
  - Networking Processors
- **Micro controllers** are used in automatically controlled products and devices, such as automobile engine control systems, implantable medical devices, remote controls, office machines, appliances, power tools, toys and other embedded systems.
- Micro controllers are efficient metering systems used in homes and industrial applications

Micro controller is used in day to day life devices:

- Light sensing and controlling devices
- Temperature sensing and controlling devices
- Fire detection and safety devices

In Industrial control devices:

- Industrial instrumentation devices
- Process control devices
- Measuring volt meter
- Measuring current meter

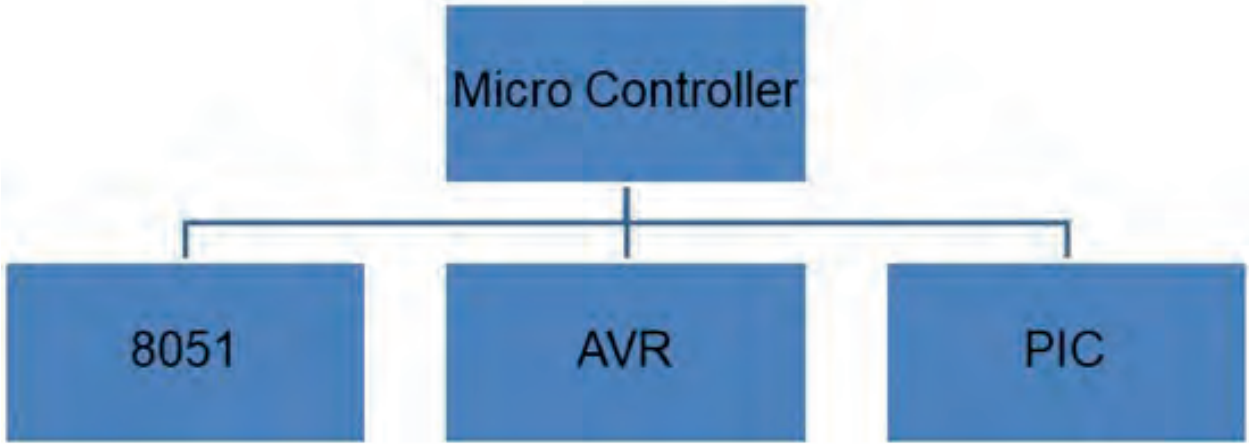


Figure 2.7_2: Sub-divisions of Micro Controller

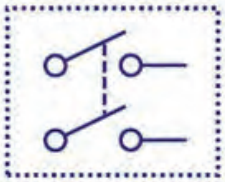
The difference between Microprocessor and Micro Controller are presented in the table below:

Microprocessor	Micro Controller
RAM, ROM, I/O, Timer are separately interfaced	RAM, ROM, I/O parts are all on a single chip
Designer decides on the amount of RAM, ROM, I/O ports	In this case, the amount is fixed
High cost	Low cost
General purpose	Single purpose
High speed	Low speed
Higher power consumption	Lower power consumption

2.7.1. Type of Switches

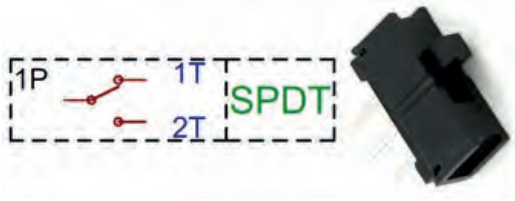
- **SPST:** Also known as single-pole, single-throw, this switch has 1 input and 1 output.

- **DPST:** It is known as double pole single throw. This switch has 2 output as well input.

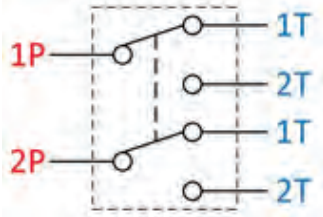

Symbol


DPST Switch

- **SPDT:** It is known as a Single pole, double throw. This switch has three terminals - 2 pins through which connection is made and 1 pin that is common.



- **DPDT:** It is known as double-pole, double-throw, this switch has 2 switches (SPDT) and may have 4 terminals.



- **Toggle switch:** These switches resemble mechanical lever or handle and have a locking mechanism.

- **Push button switch:** These are also known as a push button that has a simplified switch mechanism to control a process or a machine.

- **Limit switch:** These switches are essential in controlling the control system of machinery.

- **Selector switch:** This switch has one ON switch on the front panel and has varied contact combination.

2.7.2. Types of Circuit Breaker

- **MCB:** Also known as miniature circuit breaker, we can identify this as an electromagnetic device that is enclosed inside molded insulating material.

- **MCCB:** An abbreviated version of Moulded Case Circuit Breaker, we can see its utility in motor feeders, especially from 250 Amps - 800Amps.

- **ELCB:** An abbreviated version for Earth Leakage Circuit Breaker, its utility is visible in the tripping of circuit breaker on scenarios like fault due to leakage.

- **Air circuit breaker (ACB):** This is a specific device that provides protection from short-circuiting and overcurrent for those circuits ranging between 10 Amps and 800 Amps. Its appropriate application is visible in case of low voltage (especially under 450V).

- **RCCB:** An abbreviated version for Residual Current Circuit Breaker, we can identify it as an electrical wiring device that on detection of imbalanced electric current disconnects that circuit. This imbalance may occur between neutral conductor and phase conductor.

- **SF6:** SF6 or Sulphur Hexafluoride is kept under pressure gas, and its utility is visible as an excellent arc quenching medium.

- **Vacuum Circuit Breaker (VCB):** VCB offers the most insulating strength. This device has a longer life and is ideal in case of fault clearing.

Unit 2.8 Basics of PLC System and its Application in Electrical Control System

Unit Objectives

At the end of this unit, you will be able to:

1. Define Programmable Logic Controller
2. Analyze the various modules associated with PLC

A Programmable Logic Controller (PLC) is an electronic device that is used in many industries to monitor and control building systems and production processes.

- PLC is a special computer device, which is used in industrial control systems.
- PLC is the abbreviated form of Programmable Logic Controller.
- PLC'S are used in a multiple purposes due to having various features like sequential control, counters and timers, reliable controlling capabilities.
- PLC is mainly used for continuous monitoring the input values from sensors and produce outputs.

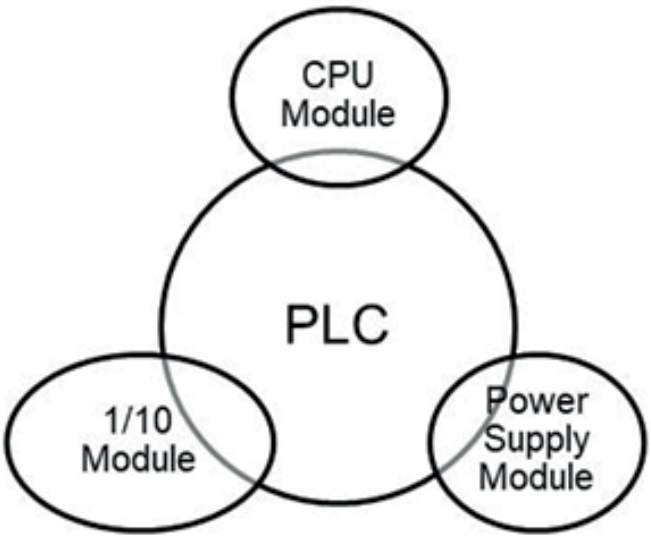


Figure 2.8_1: Programmable Logic Controller

CPU Module:

- CPU Module consists of a central processor and its memory.
- It is responsible for performing all necessary computation by accepting inputs and producing outputs and processing of data

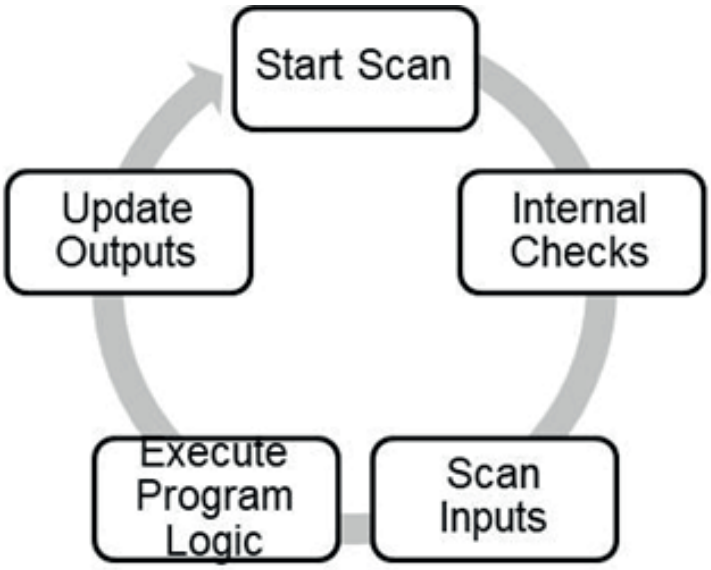
Power Supply Module:

This module supplies the required amount of power to the whole system by converting AC power to DC power as needed by the CPU and I/O modules.

I/O Modules:

The input and output modules of the PLC are used to connect the sensors and actuators to the system to detect the various parameters like temperature, pressure.

The operation of the PLC Scan Cycle which shows how the PLC works is shown through this cycle:



Unit 2.9 Application of Power Electronics and its Use in Different fields

Unit Objectives

At the end of this unit, you will be able to:

1. Define the different parts of Power Electronics
2. Define measuring tools and equipment

Power electronics is the study of transferring electric current to the circuits to control the flow of electrical energy.

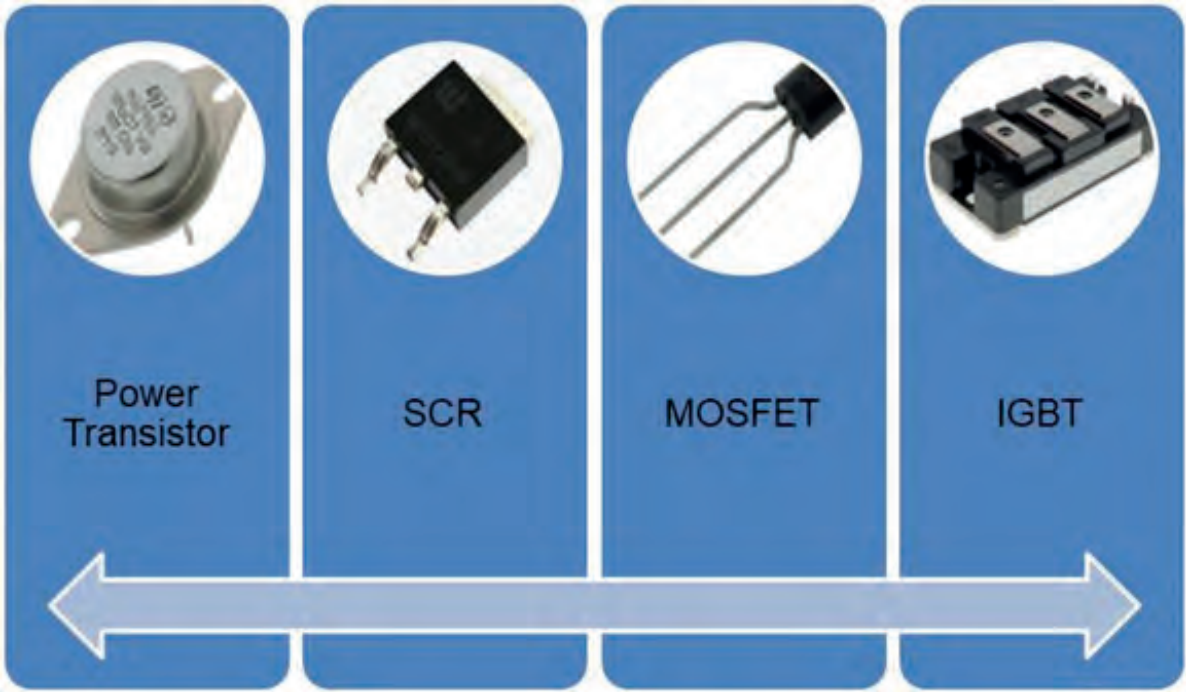


Figure 2.9_1: Different types of Power Electronics

Power Transistor: Power transistor is a three terminal semiconductor device used to increase and switch electronic signals and electrical power.

SCR: (Silicon Control Rectifier) is a four-layer solid-state current-controlling device.

MOSFET: It has an insulated gate, where the voltage determines the conductivity of the device.

IGBT: (Insulated gate Bipolar Transistor) is also a three-terminal power semiconductor device initially used as an electronic switch to combine high efficiency and fast switching together.

2.9.1. Measuring Instruments

1. **Digital multimeter**

   It is a testing tool that is useful in measuring electrical values (2 or more). The principal things that are measured by DMM are:

   - Resistance (ohms)
   - Current (amps)
   - Voltage (volts)

2. **Phase sequence meter**

   This meter is used in the detection of sequence about electric supply in the 3 phase electric circuits.

3. **Clamp-on multimeter**

   Clamp-on multimeter is one of the electrical test tools which are a combination of current sensor and basic digital multimeter. Probes of the clamp are useful in measuring voltage.

4. **Continuity tester**

   It is electrical testing equipment that helps in the identification of electrical path, established between 2 points. The components of this tester are:

   - Test Leads
   - Battery

5. Insulation tester (megger)

Megger is an electrical device that is helpful in measuring a wire's electrical leakage. In simple words, the utility of this device lies in the identification or verification of electrical insulation level of certain types of devices. These devices are:

- Generator winding
- Cable
- Motor

2.9.2. Measuring Equipment

- **CRO:** CRO or cathode ray oscilloscope is one of the excellent electronic test instruments which are used for obtaining waveforms. This acquisition is possible when the input signals are different. The name CRO is the current term that is in use. The previous term was Oscillograph.

  With the help of this instrument, analyses of these properties are possible:

  - Time interval
  - Distortion
  - Rise time
  - Frequency
  - Amplitude

Here is a block diagram of CRO which states the working of this instrument.

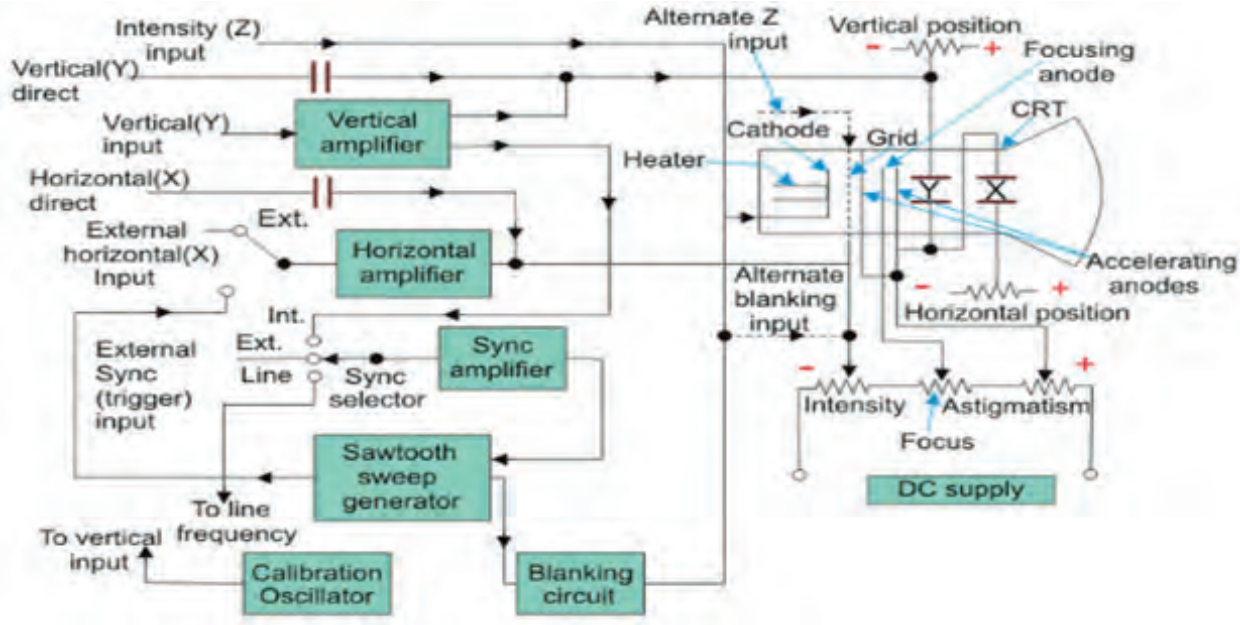


Figure 2.9.2_1: Block diagram of CRO

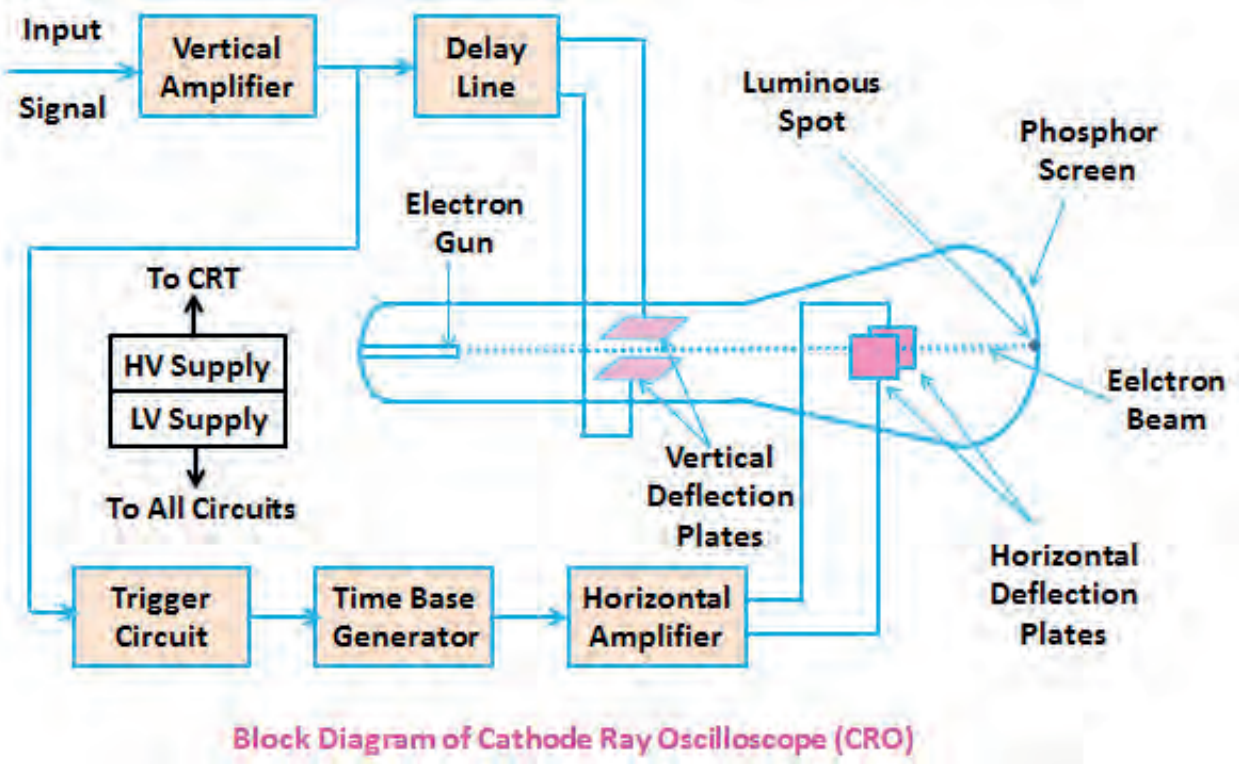


Figure 2.9.2_2: Block Diagram of Cathode Ray Oscilloscope

With the help of the above block diagram, we can see how the input signals enter via a vertical amplifier and after through the entire device comes out as an electron beam.

Utilisation of CRO

- It helps in measuring potential difference in voltmeter
- It is helpful for measuring the short time interval
- Its utility is the most in case of displaying various waveform types

- **Vibration Analyser:** A Vibration analyser is a device that inspects and tests vibration displacement, vibration velocity, and vibration acceleration in manufacturing production facilities, construction sites, product development laboratories, and many other sites.

  If we see any industrial machine or equipment, the basic characteristic is vibration coming from those. Normal wear and tear or any trouble in the equipment can take place if there is an increase in the normal vibration level.

  The main aspect of vibration analysis is in listening to the machine carefully. Vibration of a good machine follows a linear pattern. However, any problem in the machine will make the pattern to be in a different level. This issue may be due to bearing damage, misalignment or an imbalance in the machine.

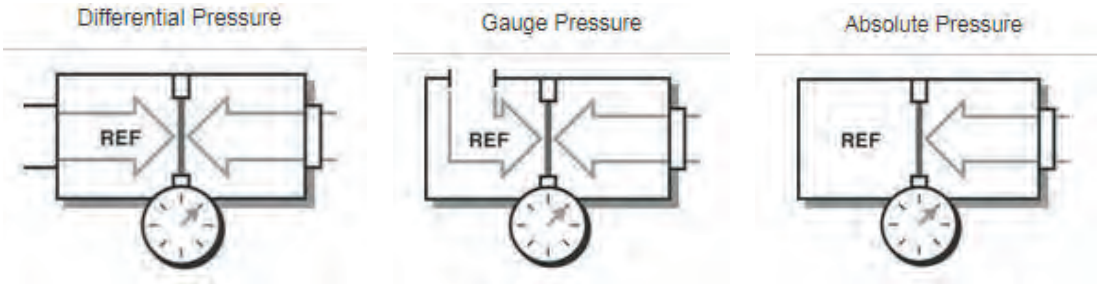
In vibration analysis, the signal form and methods include:

- Resonance analyses
- Phase measurement
- Orbit
- Time waveform
- Cepstrum
- Envelope analysis
- Order analysis
- FFT analysis

- **Pressure Measurement:** This is one of the most highly used procedures that are in use in process control industry.

  As per the pressure measurement methods, there are 3 measurement types.

  - Differential pressure
  - Gauge pressure
  - Absolute pressure



Where absolute pressure measures pressure in a vacuum, the other 2 measures pressure in the adjacent vessel or atmospheric pressure.

Measurement	Type	Value (nominal)
Atmospheric pressure	absolute	760 Torr (101.3 kPa)
Altitude	absolute	Look up table/calculate
Manifold pressure (vehicle)	absolute	100 kPa
Depth in water	absolute	Calculate
In vivo blood Pressure	absolute	80/120-mm (300 mm Hg, max)
Ex vivo blood pressure	gauge	80/120-mm (300 mm Hg, max)
Height of liquid column	gauge	Calculate
Intraocular pressure	gauge	15 mm Hg
Tire pressure	gauge	30 psi
Vacuum cleaner	gauge	760 to 25 Torr (100 to 3 kPa)
Liquid or gas flow	differential	Application dependent
Respirator	differential	4 kPa
Ventilator	differential	25 cm H_20
Spirometer	differential	4 kPa

Unit 2.10 Knowledge on Thermal Power Generation

Unit Objectives

At the end of this unit, you will be able to:

1. Define Thermal Power Plant
2. Elaborate the steps to generate Thermal Power

A thermal power plant is an industry/plant where the heat energy is converted to electric power. In this power plant, water is used as working fluid. Nuclear and coal-based power plants are categorized under this industry.

These following steps are used for thermal power plant operation:

Step 1: Coal is used as a fuel to boil the water

Step 2: Water is boiled to form pressurised steam.

Step 3: Pressurized steam is the force that causes the turbine to rotate at a very high speed.

Step 4: After pushing through the turbine the low-pressure steam, it's going into the condenser.

Step 5: Condenser is the place where the steam is condensed back to its liquid form.

Step 6: The process is again then repeated.

The figure below represents the functional diagram of thermal power generation:

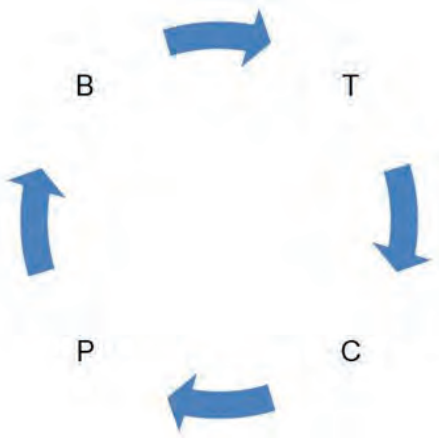


Figure 2.10_1: diagram of thermal power generation

In this figure:

T – Turbine

C – Condenser

P – Pump

B - Boiler

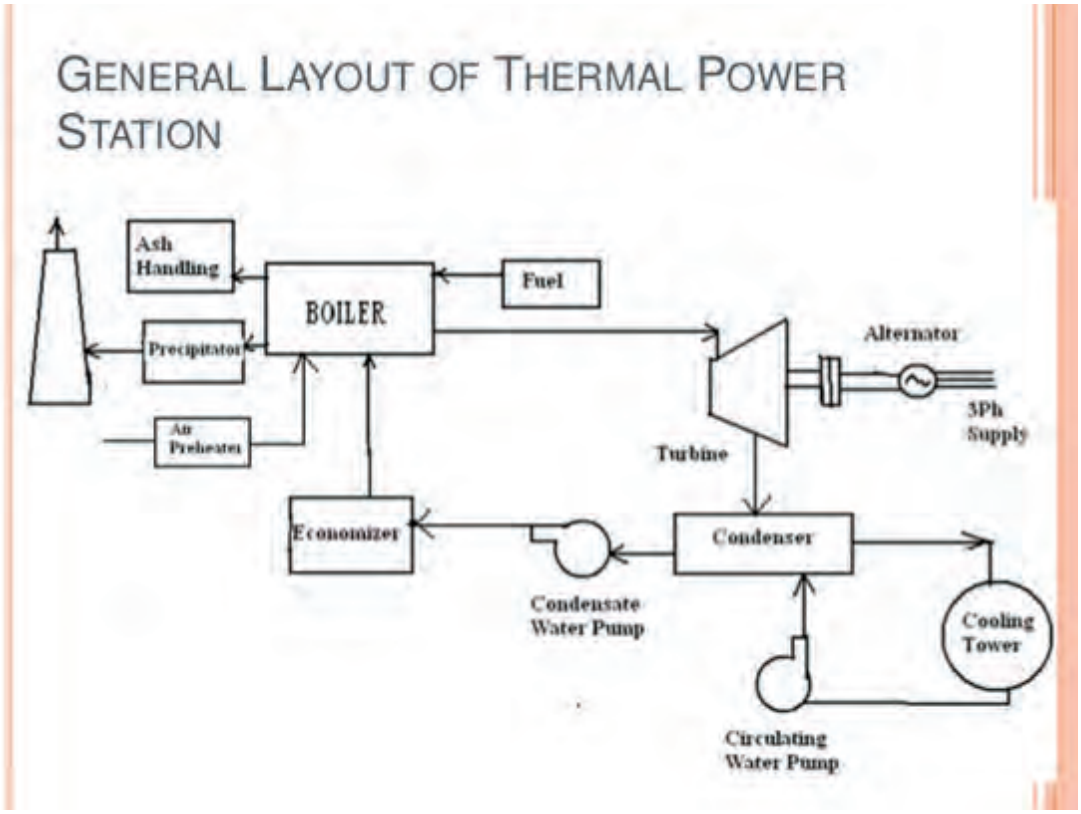


Figure 2.10_2: Layout of Thermal Power Station

Unit 2.11 How Mechanical Maintenance of Electric Motor is done?

Unit Objectives

At the end of this unit, you will be able to:

1. Demonstrate the Mechanical Maintenance process of Electric Motor
2. Demonstrate the cleaning method of Electric Motor

- In order to maintain electric motors, a checklist is initiated by the electrical staffs, which helps to increase the efficiency of the motors.
- Checklist consists of what are to be looked after at a regular basis and few important factors like cleaning, lubrication, inspections and testing of the motors.
- Mainly, the brushes and the commutators of an electric motor are prone to wear and tear.
- Inspections of bearings are to be done on a regular basis.
- Bearing failure is one of the most common causes of electric motor failure.
- Bearing problems include:
  - Insufficient lubrication
  - Worn bearings
  - Hot motors
  - Excessive loading
  - Rough environment
  - Replacement with wrong motor type
- Checking the bearings daily with the help of a stethoscope reduces the chances of wear and tear in bearing, or reduces the bearing failure problem
- With the help of the thermometer, the temperature of the bearing can be checked
- If the parts of the electric motor are wrongly assembled or disassembled, it will result to explosions or even fire hazards.

Cleaning of electric motors is recommended to be performed by experienced/trained electrician. Cleaning can be done in the following procedure by:

- Disconnecting the motor and removing it from the mounting
- Wiping all dirt from outer surface of motor
- Disconnecting wires of the motors keeping in mind the position of the terminals.
- Removing motor pulley, using a gear puller
- Marking end bells with centre punch
- Using proper tools like screwdriver, tester etc.
- Using a soft faced hammer
- Carefully removing the end connected to the starting switch.
- Using very fine sandpaper to clean points. It should be noted that emery clothes are to be strictly avoided.
- Non-flammable cleaning fluids should always be used to clean all parts.

Basics of gear pear and belt drives are elaborated in the form of a table of comparison:

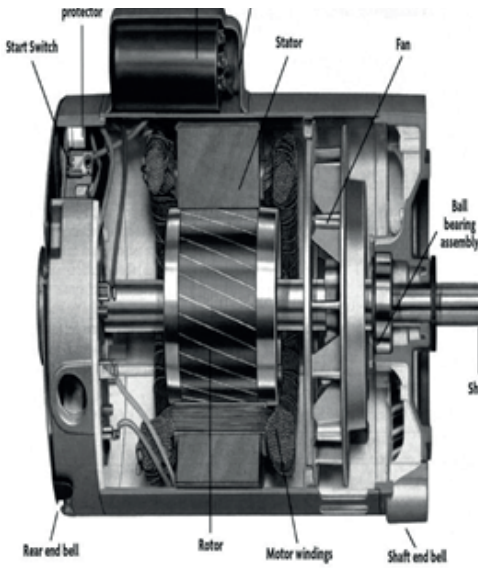
Belt Drive	Gear Drive
It is a method of transferring rotary motion between two shafts	Gears are machines elements which is used to transmit a rotary motion between shafts
It has a chance of having high risk factor associated with it	It has a chance of having low risk factor
It is very quiet in operation	It is noisy in operation
It has a low life expectancy	It has a much greater life expectancy
High speed	Low speed

Unit 2.12 Removing and fixing bearings, Aligning Couplings

Unit Objectives

At the end of this unit, you will be able to:

1. Define the concept of Bearings
2. Demonstrate the steps of removing and fixing bearings
3. Define Aligning Couplings
4. Elaborate the types associated with the coupling alignment

The electric motor should be entirely disconnected. No current should flow through it. After this, we require locating the bolts or screws located around the motor's edge. This ensures that the two halves of the motor are together inside the casing. The expected number of bolts or screws to be present should be either six or four.	
Remove the bolts or screws with the help of a wrench or screwdriver. It is better to keep them in a safe place.	
Gently pry the motor casing's two halves with the help of a flat head screwdriver. The first thing that we need to lift is the motor's top half and then continue with the bottom half. Due to presence of internal wiring that connects the halves; complete separation of the halves is not possible.	
With the help of one hand hold the armature's one end. The same goes for the other end with the other hand. Directly lift the armature up and keep it aside. The armature is visible in the central part. We can identify it as the central spindle with many wires winding in the middle. We can expect brushes when lifting up the armature. These brushes are directly in contact with the commutator.	
The next step is to find out the location of bearings. It should be at the motor casing's back or front. The bearings are 4 in number. Gently pry out all the 4 bearings with the help of flat head screwdriver (small). It is important not to scratch their seating area.	
Clean the bearing sleeves with the help of a clean and dry cloth and some engine oil. Removal of any excess oil is a must.	

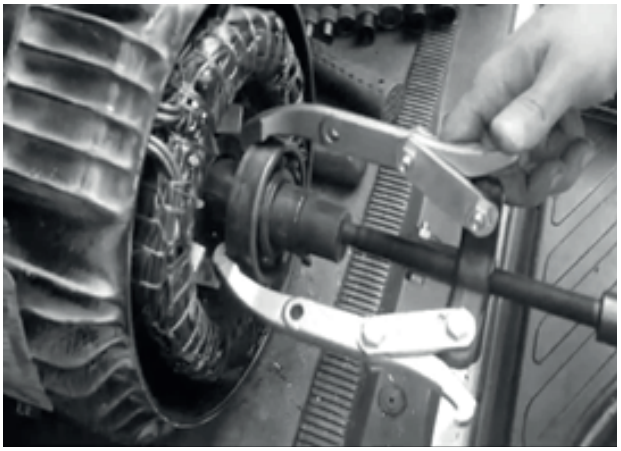
After the clean-up, put back the bearings back to the sleeves. With a gentle push insert them to their respective seating.	
Push apart the motor brushes. Do it with the help of fingers and on the motor casing's bottom half replace the armature. To attach it with the commutator, release the brushes.	
To bed perfectly with the lower brushes, carefully rotate the armature. Switch the motor casing's top half. Now put back the bolts or screws and carefully tighten them. Connect it back with the electricity supply and turn the electric motor on.	

Table 2.13:

A coupling is a specific device that helps connecting 2 shafts to transmit power. This connection is made basically with the help of shaft ends.

In case of transmitting power, the use of coupling alignment comes to light. There are number of variables in which the coupling design comes to use. Some of the variables are:

- Specific gravity
- Horsepower
- Torque
- Head pressure
- Shaft sizes

Figure 2.12_1: Fixturlaser Laser Kit

Coupling has 2 important categories.

- Flexible
- Rigid

In case of flexible couplings, they can slightly flex, thereby giving a chance of smaller misalignments. The types associated with the coupling alignment comprises of:

- Elastomeric couplings (minimizing friction between coupling components)
- Gear couplings (lubricated female teeth and male teeth)
- Disc pack couplings (gives laminated effect)

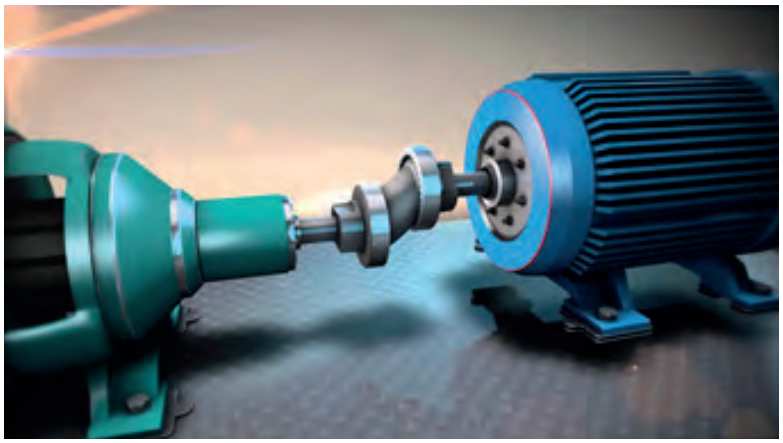


Figure 2.12_2: Shaft Alignment

In case of rigid coupling, the level of change in the coupled shafts is 0. The position in this case is relative axial. The driver of this coupling generates torque of huge amount.

Unit 2.13 Diagnose Electrical Installations and Identify Problems

Unit Objectives

At the end of this unit, you will be able to:

1. Demonstrate the method to diagnose Electrical Installations
2. Define the issues related to Electrical Installations

- **Bad connections and Equipment failure**

  Any problem outside the motor may result in shortening the lifespan of the device. The same goes with the internal section of the motor too. The first step should begin with inspecting the moor's bearings. The location of the bearings is basically at the motor's ends.

  The cursory check can begin with its placement on a flat and solid surface. On the motor's top section, place your hand and with your other hand spin the rotor or the shaft. Carefully look out for any unevenness, scraping or rubbing of the spinning rotor.

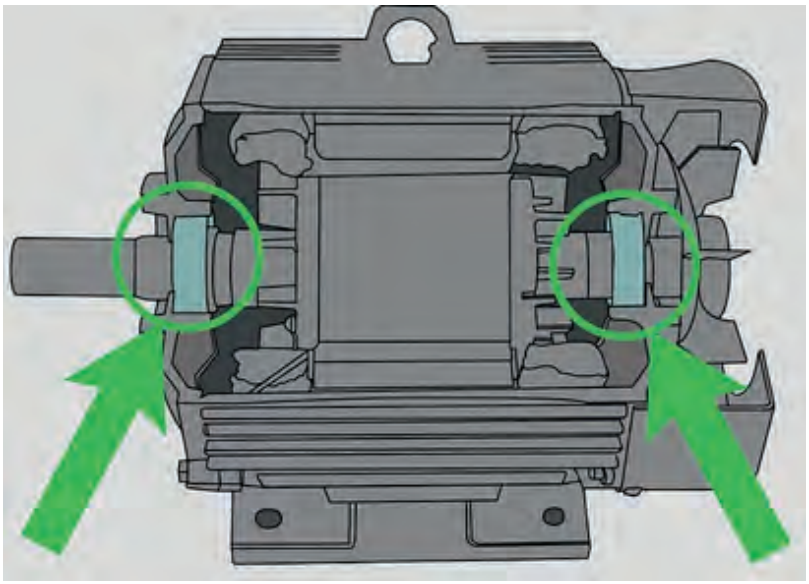


Figure 2.13_1: Electrical Motor

- **Incorrect wiring**

  In case of incorrect wiring, the change will be visible in the resistance value. To check this value, the use of ohmmeter is helpful. Set the ohmmeter to the Ohms or Resistance test setting. With utmost care and to the appropriate jacks, place the test probes.

  It is better to select the highest scale. Preferable one will be R X 1000 or anything similar. Next, by touching the 2 probes with each other, set the meter to zero. If possible, adjust the needle's position to move it towards zero.

  Identify the frame's metal part and the ground screw and press the test probe. The ground screw can be of a hex head type and green in colour.

Figure 2.13_2: A couple of Clamp-On Ammeters

- **High loop impedance**

  This test is performed at distribution board. The test sequence has 3 important test sequences.

  - In the first step, you need to take help of a multifunctional tester. In that you need to select the option of Earth Fault Loop Test or Earth Fault Loop Tester.
  - In the second step, the test that requires to be performed should be on incoming side. This is related to the installation.
  - The first test lead connection is with Line terminal

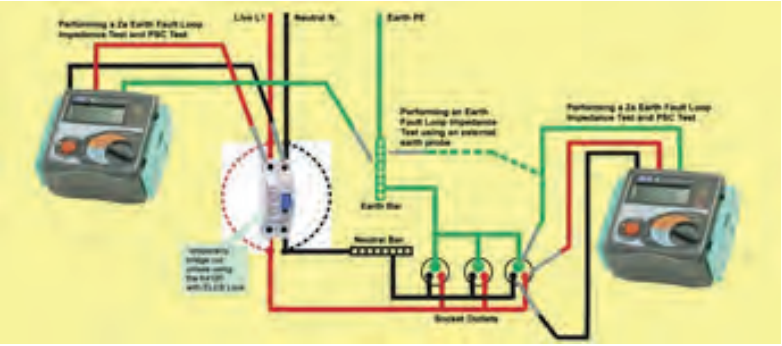


Figure 2.13_3: Impedance Test

  - The second test lead connection is with Neutral terminal
  - The third test lead connection is with incoming Earth conductor
  - The third test is related to pressing the button 'TEST'.

Unit 2.14 Install Metal and Plastic Conduits/Flexible Conduits

Unit Objectives

At the end of this unit, you will be able to:

1. Define the installation process of conduits
2. Demonstrate metal conduits

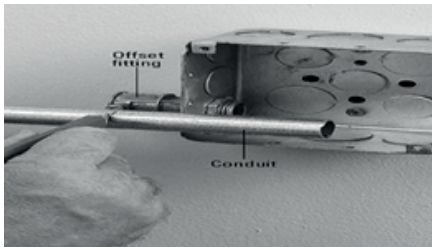
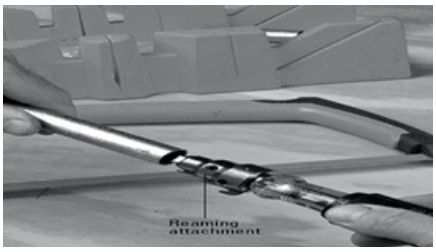
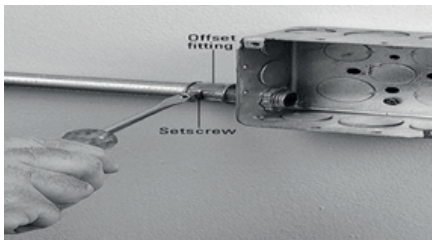
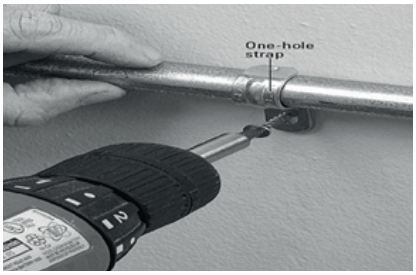
	Secure the metal boxes with screws and fix it to the wall. In case of wire exposure, take the help of handy boxes. These boxes have metal covers and rounded edge.
	After the installation is complete, measure the metal conduit and then cut it as per requirement. Instead of taking the help of a tape measure hold it firmly and then mark it.
	With the help of a hacksaw cut the conduit. It is better to avoid the use of tubing cutter, leading to damage in wire insulation.
	For a good fit, slide the conduit inside the fitting. Tighten firmly the setscrew. Test it well to ensure that its connection is tight. Remember to keep ample room for the wires to slide easily inside the conduit. Normally, for 5 or less wires 1/2-inch conduit is more than enough
	With 1 or 2 hole strap secure the conduit. The distance should be a minimum of 6 feet. It should be within each box (distance – 2 feet). The straps should be closer if the conduit is larger.

Table 2.14_1: Information about metals

Unit 2.15 Troubleshoot Electrical Installations and Identify Faults

Unit Objectives

At the end of this unit, you will be able to:

1. Analyze the Troubleshooting steps for Short and open circuits
2. Analyze the Troubleshooting steps for incorrect polarity
3. Demonstrate Insulation resistance and earth continuity faults
4. Analyze the Troubleshooting steps for incorrect program on programmable devices

Short and open circuits

- **Troubleshooting steps**
  - Examine the circuit's schematic diagram for a general overview.
  - Carefully open its control panel. With the help of a voltmeter check the voltage.
  - At the terminals X1 and X2 present at the control transformer's secondary section, check its voltage. Absence of correct voltage shows it as an issue in power circuit. Another issue in power circuit is possible if contractor isn't energized or there is no tripping of OL. This can take place during the presence of correct voltage.
  - At the fuse's upper portion, basically in the control circuit, check terminal X1s voltage. Do the same with the terminal X2.
  - Inspect the voltage at X2s neutral link and X1s fuse.
  - Below the control fuse you will find wires. Check wire 1's voltage of that area and wire 2 regarding the neutral link.

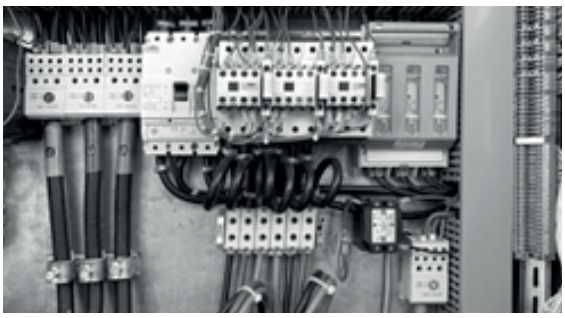
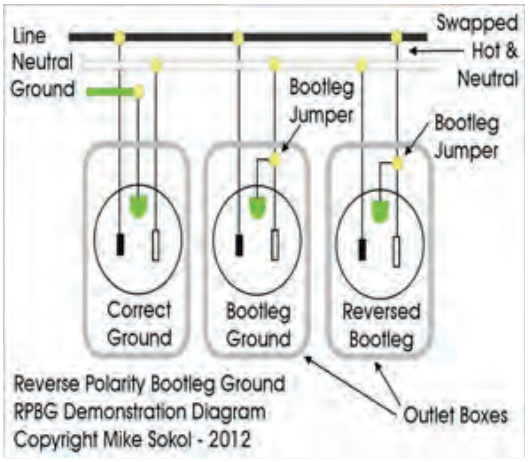


Figure 2.15_1: Short and Open Circuits

Incorrect polarity

With the help of plug-in type voltage tester, check the receptacles.	
When you are able to identify the receptacle(s) with incorrect polarity, you need to keep the tester plugged in. moving from the receptacle, your next step should be finding the line that delivers voltage - circuit breaker. Now, turn that off.	
When you are sure that there is no current passing from the circuit, unscrew the screws that holds the receptacle by taking out the cover plate. Pull it out gently. With the help of a touch-style voltage tester, find and switch off the power passing through any extra wires.	

Check the receptacle carefully. Neutral white wire + Copper screw = Receptacle with incorrect or reverse polarity Feed black wire + silver screw = Neutral side	
Remove black and white wires to the respective sides of receptacle. For proper connectivity, the black wire requires to be connected with copper-colour or dark screw. In case of silver screw, the connected wire will be white in colour. Brittle or damaged wires require immediate removal stripped with wire strippers and insulated properly.	
In the screw terminals, wrap electrical tape in strips. This is for added safety so that the receptacle is secured properly.	
After re-inserting the plug-in tester back inside the receptacle you need to turn on the circuit breakers. When you check it, you should see the indicator of the tester showing proper wiring.	

Insulation resistance and earth continuity faults

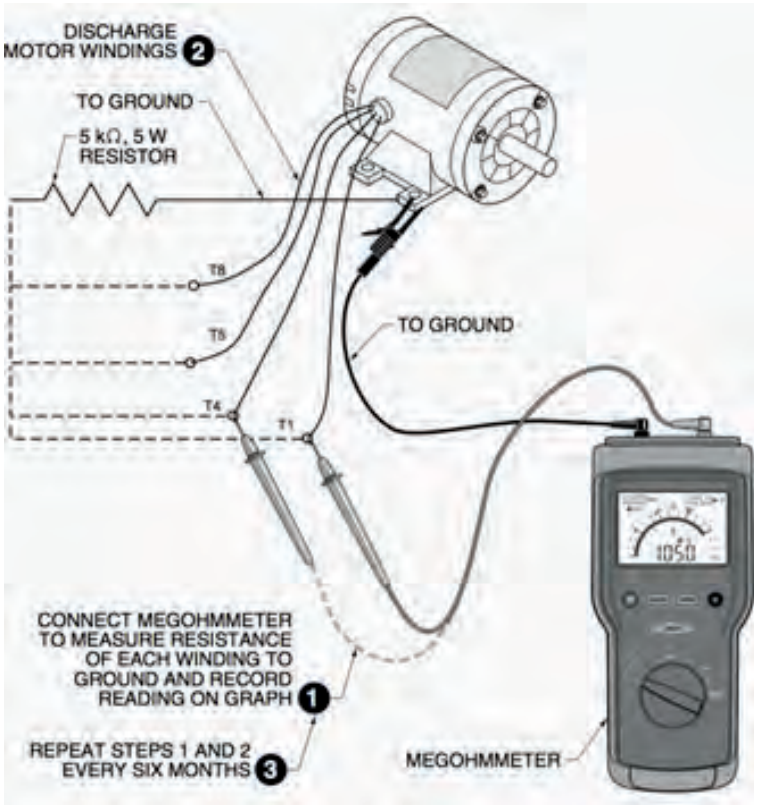


Figure 2.15_2: Insulation Resistance - Test of Motor

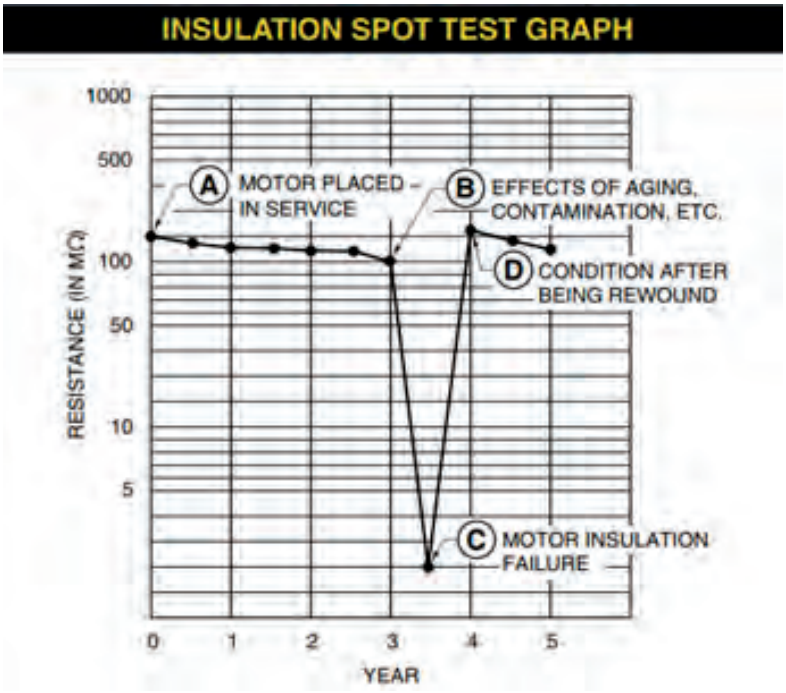


Figure 2.15_3: Insulation Spot Test Graph

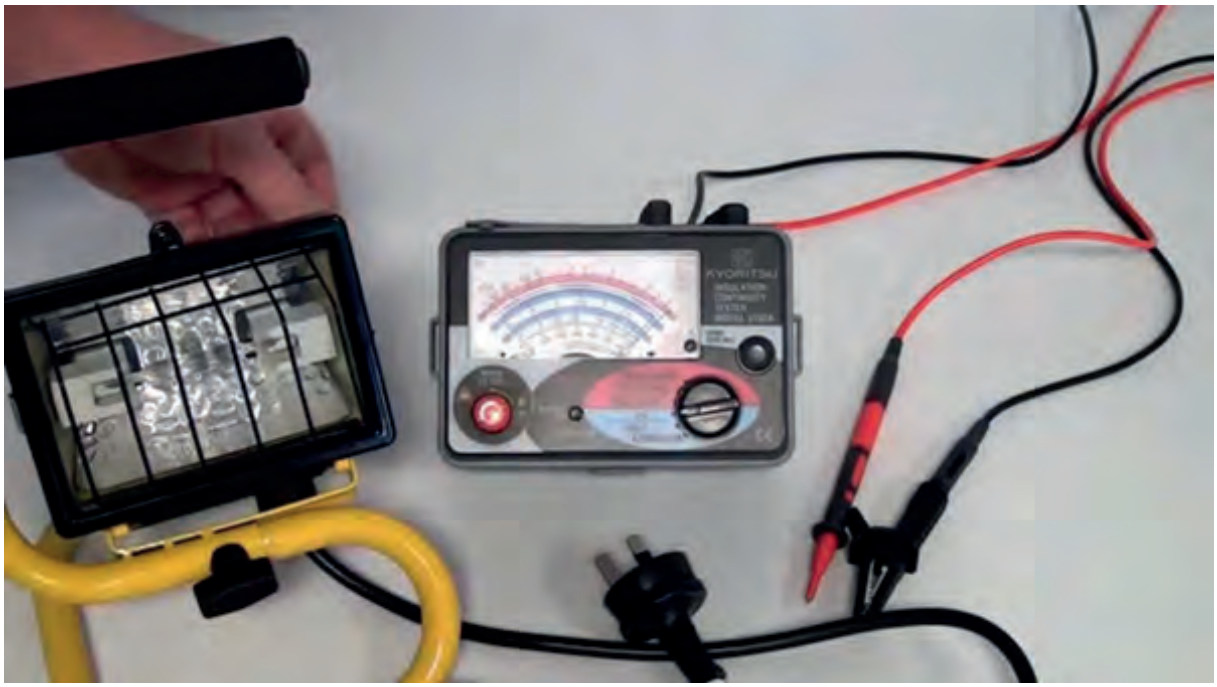


Figure 2.15_4: Earth Continuity Faults Demonstration

Incorrect program on programmable devices

- **Hardware troubleshooting**
  - The first and important step in this troubleshooting process is to recognise what the issue is and the source that is causing the problem
  - You can find it out with the help of careful observation of the process or the machine. Another option is inspecting the diagnostic LED indicators present on I/O modules, Power Supply, and the CPU.

- **Troubleshooting Controller**
  - The first step is to recognize the status of CPU LED indicators as well as the Power Supply
  - In the troubleshooting tables, try to match the status LEDs with that of processor LEDs
  - When the appropriate table matches perfectly with that of the status LEDs, the next step is to simply move it. This movement is related to identifying the probable causes and error descriptions
  - This step of action requires being used for all the steps. The continuation will only end until all the probable cause come to light.

Summary

- The word 'Automation' is derived from ancient Greek words of "Auto" (means self) and "Matos" (means moving).
- In simple words, a machine that does not require human effort rather performs in itself or is self-dictated is called automation.
- A Microprocessor is a computerized processor which combines the functions of a computer's central processing unit (CPU) on a single integrated circuit.
- Microprocessor is designed to perform arithmetic and logic operations making use of the data on the chip.
- Microprocessor is mainly of two types, Intel 8085 and Intel 8086.
- PLC is a special computer device, which is used in industrial control systems.
- IGBT: (Insulated gate Bipolar Transistor) is also a three-terminal power semiconductor device initially used as an electronic switch to combine high efficiency and fast switching together.
- A thermal power plant is an industry/plant where the heat energy is converted to electric power.

Notes

Notes

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3. Industrial Electrical Wiring

Unit 3.1 Wiring, Components used in wiring

Unit 3.2 Basic principles of fluid/ hydraulic system

Unit 3.3 Installation methods

Unit 3.4 Type of distribution equipment for power distribution

Unit 3.5 Programmable Logic Controller

Unit 3.6 Ability to Splices and Terminates Electrical Conductors

Unit 3.7 Transformers

Learning Outcomes

After attending the session, you will be able to:

1. Define the concept of Wiring
2. Define electrical wiring accessories
3. Define different types of wiring system
4. Define basic principles of fluid/ hydraulic system
5. Define the installation methods of instrumentation conductors and cables, grounding and bonding, florescent lights, and LED
6. Define the type of distribution equipment for power distribution
7. Define programmable logic controller
8. Elaborate the ability to splices and terminates electrical conductors
9. Define the various aspects of Transformers

Unit 3.1 Wiring, Components used in wiring

Unit Objectives

At the end of this unit, you will be able to:

1. Define what wiring is
2. Define the types of 3-Phase Electrical Power
3. Define the areas where wiring is performed
4. Define the various wiring Tools and Accessories

Smart industrial wiring is based on 3-phase electrical power. This allows less workload to be placed on each wire involved and at the same time allowing them to work together to give the maximum output. With 3-phase electric, the wires and the motor is smaller compared to single-phase motor. These factors allow greater efficiency and longer lasting motors and wires.

There are four types of 3-phase electrical power:

- Common 3 Wire
- Common 4 Wire
- 3 Wire with Grounded Hot Leg
- Special 4 Wire

For all types 3-phase electrical power we need a voltage meter in order to determine the actual voltages that are available.

Industrial wiring runs through metal conduits, armoured cable, or a raceway.

In case of new wiring for all electrical services can be easily installed before the walls are finished. In existing buildings, installation of a new system, such as a security system or home theatre, may require additional effort to install concealed wiring.

Services commonly found include:

- Power points (wall outlets)
- Light fixtures and switches
- Telephone
- Internet
- Television, either broadcast, cable, or satellite

High-end features might include:

- Home theatre
- Distributed audio
- Security monitoring
- Security CCTV
- Automation
- Energy management
  - Power and telecommunication services generally require entry points into the home and a location for connection equipment.
  - For electric power supply, a cable is run either overhead or underground into a distribution board.
  - How services are connected will vary depending on the service provider and location.

3.1.1 Wiring Tools and Accessories

When it comes to electrical projects, large or small, having the right tools for the job makes the project a lot easier and potentially safer.

While there are numerous specialty electrical tools available, some are a must-have in the electrical toolbox.

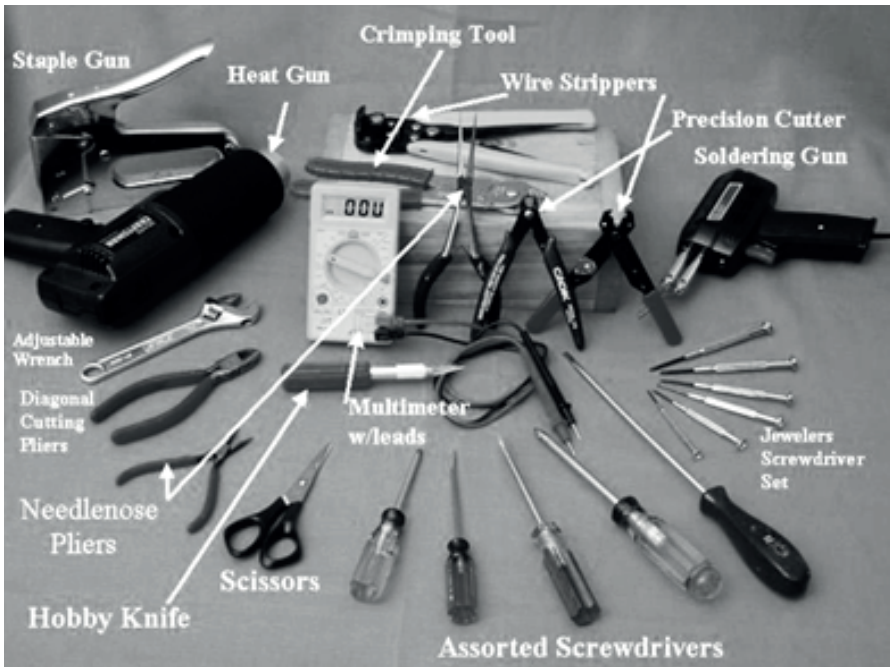


Figure 3.1.1_1: Wrining tools and accessories

- **Personal protective equipment (PPE):** Personal protective equipment (PPE) refers to protective clothing, helmets, goggles, or other garments or equipment designed to protect the wearer's body from injury or infection.

- **Circuit Testers:** You need to have a voltage tester of some type for electrical work, and one that you trust is working properly. The important thing is to ensure that it is working so you can verify that you have the power off on any circuit you may be working with. Check it on a known live source before trusting it to determine if your circuit is dead.

- **Screwdrivers:** It is essential to have a good quality set of screwdrivers. It is best to purchase them in a complete set rather than individually, as this will save you money, and increase the chances that you will have the driver that best fits the need.

  A basic set of screwdrivers should include the 3 main types of screwdriver heads.
  - The Standard blade tip
  - The Phillips tip
  - The recessed square shank or Robertson tip

- You need at least two sizes of each, but a full set would include:
  - Standard blade
  - Phillips Tip
  - Square Recess Tip (Robertson)
- **Cordless Screwdriver/Drill:** If you are going to take on any project beyond the most basic of jobs, such as, for example, changing out an individual receptacle or switch, you should have a good cordless drill and driver tool, along with a complete set of screwdriver bits and drill bits. This will save you a lot of time and when used properly, a power driver can be used in place of a screwdriver for most jobs.

- **Electric Drill:** For larger projects, with a lot of drilling required, (wood studs, etc.), an electric drill is more practical. Using rechargeable batteries, these drills are available with similar features to an AC mains-powered drill. They are available in the hammer drill configuration and most have a clutch, which aids in driving screws into various substrates while not damaging them.

- **Knife:** You will need to have a good knife, and I prefer a standard utility knife, stripping large gauge wire, and for many other jobs as well.

- **Wire Strippers:** Have a good quality wire stripper. I prefer a T-Stripper with a wire cutter, light-duty plier nose, and holes for bending termination loops on wires. A combination crimper, cutter, stripper, bolt cutter and more, like those found in automotive electrical repair kits can be very handy as well, but the multi-purpose aspect means that the wire stripping function is compromised.

- **Lineman's Plier:** A lineman's plier or a bull nose plier with a wire cutter, and at least 8"or 9" handles is also an essential part of the electrical tool list. We use these for cutting, bending, twisting wires, etc.

- **Diagonal Pliers;** Also known as side-cutters, a standard duty diagonal plier should also be a part of your kit.

- **Hammer:** Have a good quality, 16oz. claw hammer. You will need this for driving staples, nails, etc.

- **Nut Drivers:** A good set of nut drivers is not essential, but come in very handy for certain jobs where a wrench or a socket set isn't practical.

- **Tape Measure:** Have a good quality, locking tape measure and a 25'length, 1" blade is maybe over-kill, but will come in handy for other projects around.

- **Pump Pliers:** These are very handy, and essential if you are working with conduit, such as EMT, flexible conduit, or teck cable.

- **Pipe Wrench:** It would be essential if you are working with conduit, especially rigid or EMT conduit.
- **Electrical Tape:** Every electrical tool kit should have at least a roll of black electrical tape, and having a few colours like red and blue helps as well for identifying wires, etc.
- **Duct Tape:** Every tool kit, electrical or otherwise, must have the universal repair tool that is a roll of duct tape!
- **Bandages:** No matter how careful you are accidents happen. Just do all you can to protect yourself and minimize the potential for injury. Have a first aid kit handy, in case of any emergency.
- **Keyhole saw:** Great for cutting out openings for outlet boxes in drywall, panel board, etc.
- **Hacksaw:** A saw with a narrow fine-toothed blade set in a frame, used especially for cutting metal.
- **Power Saw:** For cutting studs, blocking and reinforcing boxes, etc.
- **Wood Chisel**: One uses it when working with wood construction.
- **Conduit Bender:** If working with conduit, you will need a hickey bender or any bending tool designed for the conduit you are working with.
- **Fish Tape, and/or Fishing Tools:** A fish tape is very handy, and essential if working with conduit. A fish tape or fishing tools are required if you are installing electrical in existing walls or ceilings and are trying to minimize the damage you may cause by cutting as few access holes as possible.
- **Flashlight/Headlamp:** For when you need some extra light for dark places, or when the power is off while working on existing systems.

Notes

Unit 3.2 Basic principles of fluid/ hydraulic system

Unit Objectives

At the end of this unit, you will be able to:

1. Define Basic Hydraulic Principles
2. Define Pascal's Law

In earlier days, heavy weights were lifted with the help of pulleys, levers, block and tackles, etc. Mechanical linkages like cams, levers, couplings, and gears helped in the movements for a ship's rudder or steering a vehicle by making the system complicated. These mechanical methods of operation however, had several limitations. They also involved huge man power and long working hours. As the population and technology increased, the demand for quicker and easier to operate equipment increased. To cater to this need, hydraulic machines were introduced.

3.2.1 Basic Hydraulic Principles

- A simple hydraulic system consists of hydraulic fluid, pistons or rams, cylinders, accumulator or oil reservoir, a complete working mechanism, and safety devices.
- These systems are capable of remotely controlling a wide variety of equipment by transmitting force, carried by the hydraulic fluid, in a confined medium.
- Modern developments in hydraulics have involved many fields in engineering and transportation.
- These systems transfer high forces rapidly and accurately even in small pipes of light weight, small size, any shape, and over a long distance.
- These systems play a vital role from small car's steering to supersonic aircraft's manoeuvring devices.
- More powerful and accurate systems are also used in manoeuvring huge ships.

3.2.2 Pascal's Law

Pascal's Law, framed by Blaise Pascal, states that "Pressure applied to any part of a confined fluid transmits to every other part with no loss. The pressure acts with equal force on all equal areas of the confining walls and perpendicular to the walls." This is the basic principle for any hydraulic system.

Unit 3.3 Installation methods

Unit Objectives

At the end of this unit, you will be able to:

1. Define the installation methods for Instrumentation of Conductors and Cables
2. Define the installation process for Grounding and Bonding

3.3.1 Instrumentation Conductors and Cables

1. After the cabling is done by raising it above the floor, you can have proper access for its maintenance. Added to it, you can also find an organised layout.
2. To reduce the chances of wire exposure in the humid atmosphere, it is better to cut the cable at the end and seal it with a sealing or a protective cap
3. The location of the equipment and the cable entries to it should be outside. It is important that the wash down areas is located at the lower section (below). The only entry should be from the side and not from the top. You also require maintaining the fact that drip nose should be in provision to the side entry.
4. For the machineries requiring future adjustments presence of extra cable length is a must. This is to provide calibration and maintenance when the equipment is dismounted without cable disconnection.
5. It is in the trefoil formation that the three-phase AC (Single core cables for this purpose) will run. In one of the ends earthing of the braided armour is visible. In case the installation of the equipment is in the hazardous areas, it's on its end the braided earthing will take place. In this aspect, spare cables are also required to be installed.
6. It is imperative to avoid the installation of single core cables via the magnetic material zone.

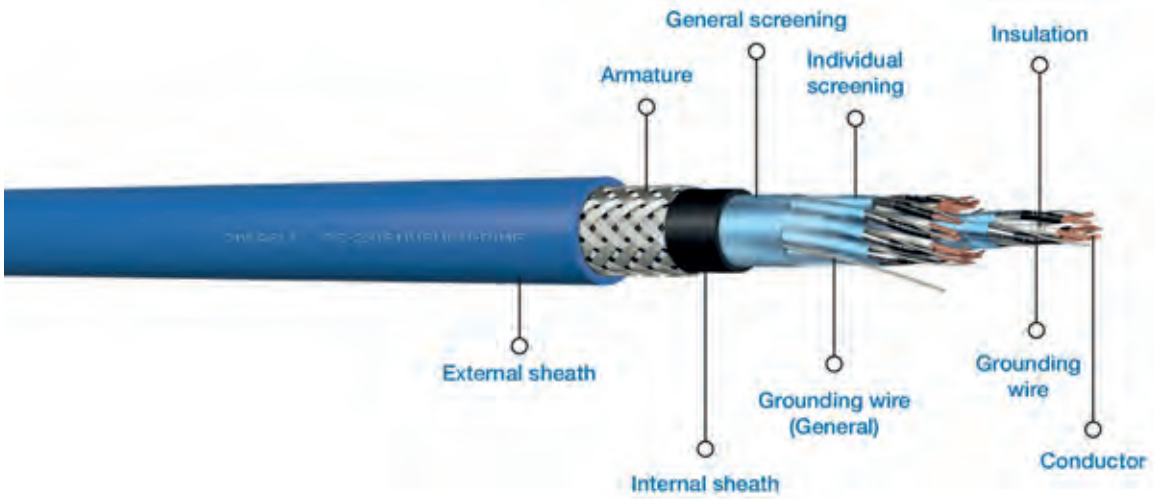


Figure 3.3.1_1: Cable Instrumentation

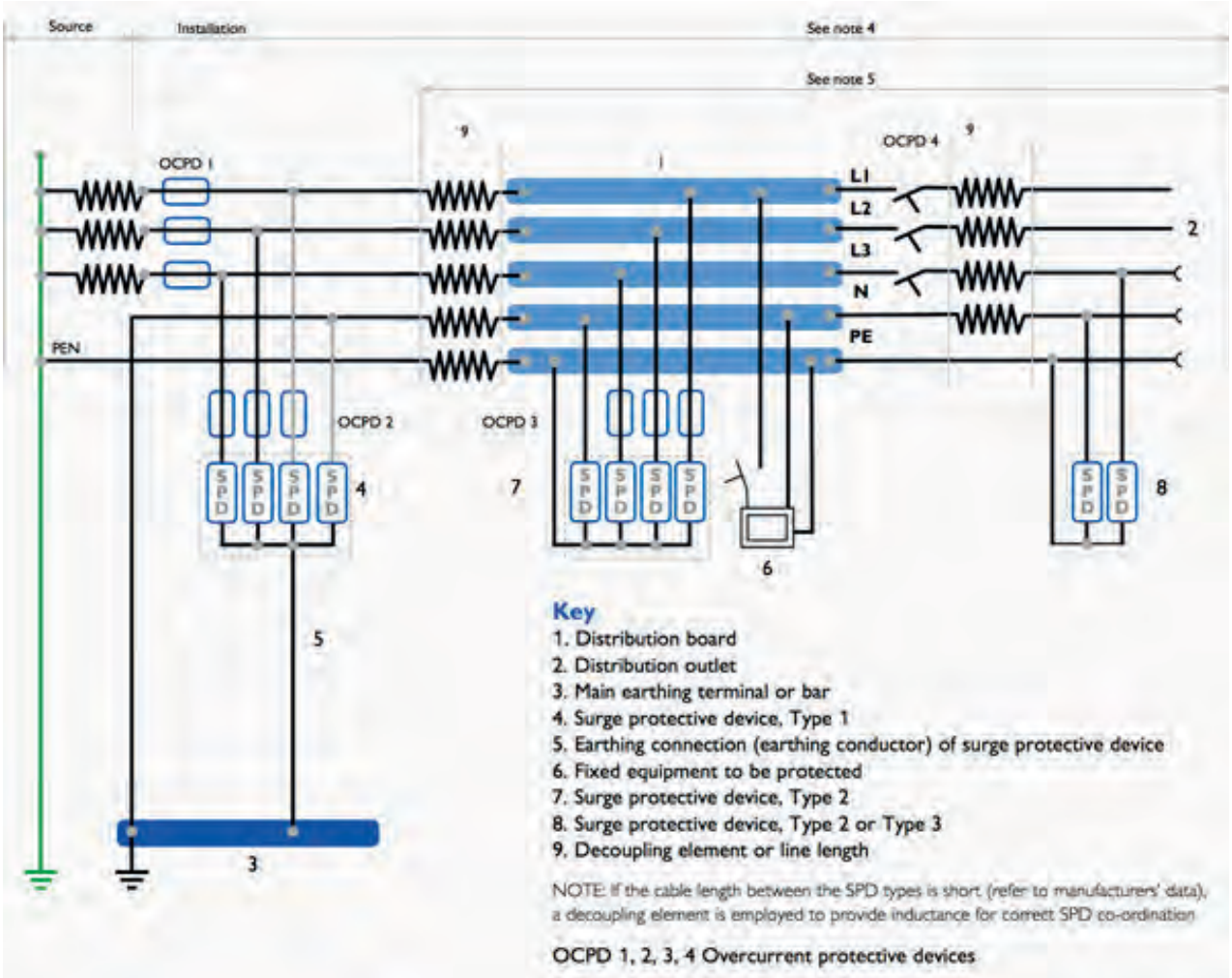


Figure 3.3.1_2: SPDs and TN-C-S Earth Configurations (Cable Instrumentation)

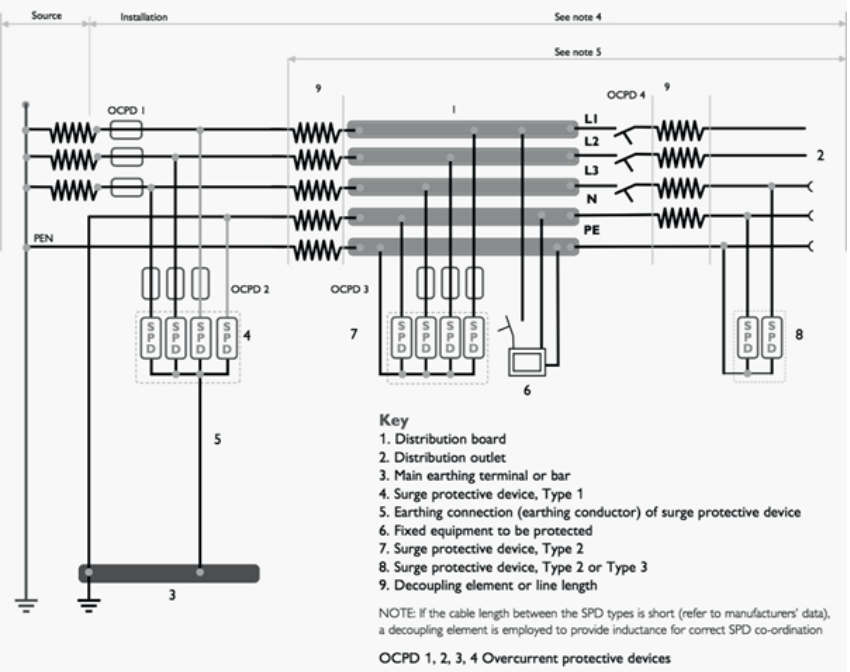


Fig.3.3_2: SPDs and TN-C-S Earth Configurations (Cable Instrumentation)

Grounding and Bonding

When it comes to the installation of electrical wiring system inside any building, bonding and grounding are considered to be the elements of huge importance.

The term grounding basically states about the connection from the conductive body to that of earth (ground), whereas the terminology 'bonding' states it to be the connection that establishes electrical conductivity and continuity.

Here you can see installation process in the form of images.

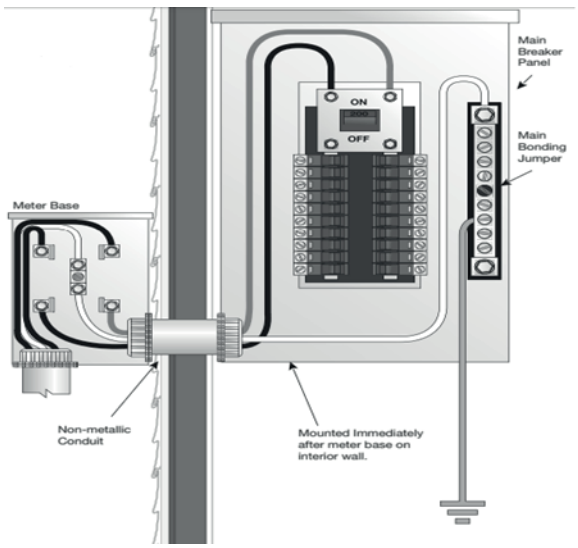


Fig.3.3_3: Grounding and Bonding:

Step 1

Here you can see installation process in the form of images.

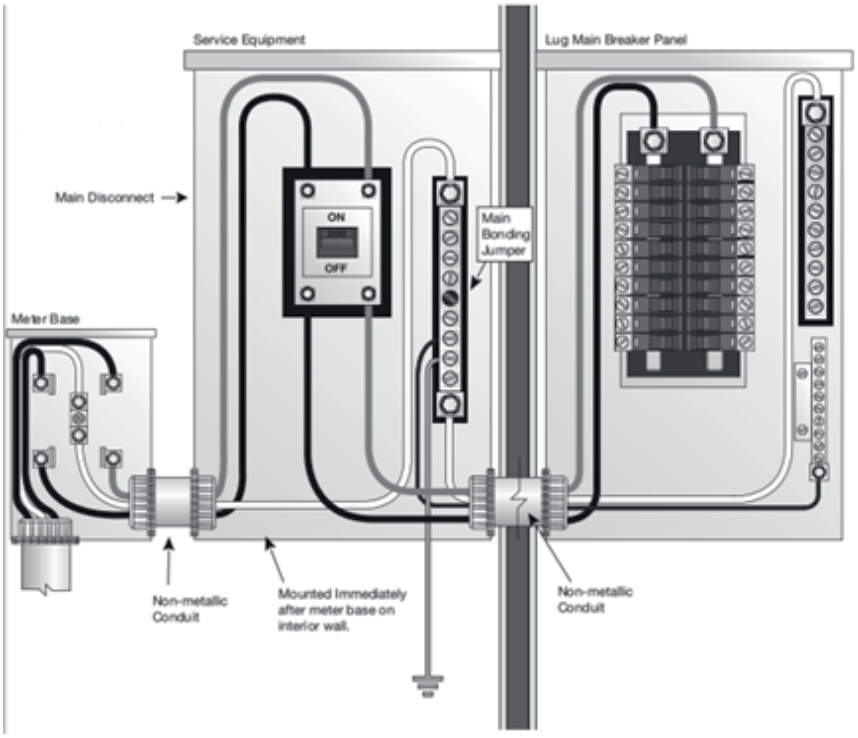


Fig.3.3_4: Grounding and Bonding:

Step 2

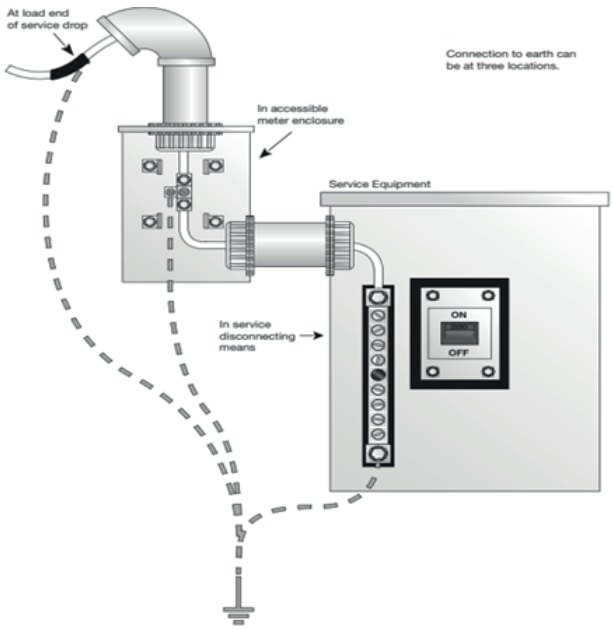


Fig.3.3_4: Grounding and Bonding:

Step 3

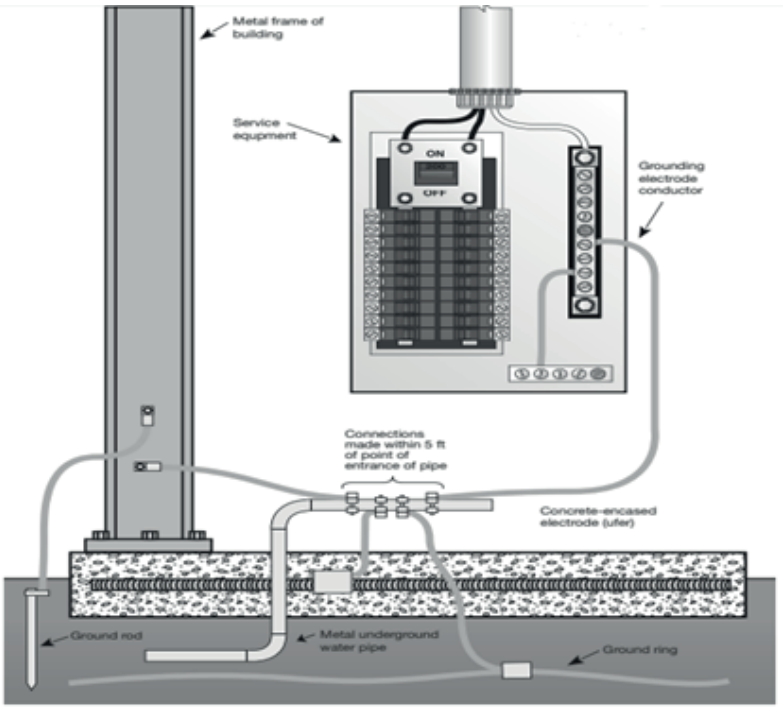


Fig.3.3_5: Grounding and Bonding:

Step 4

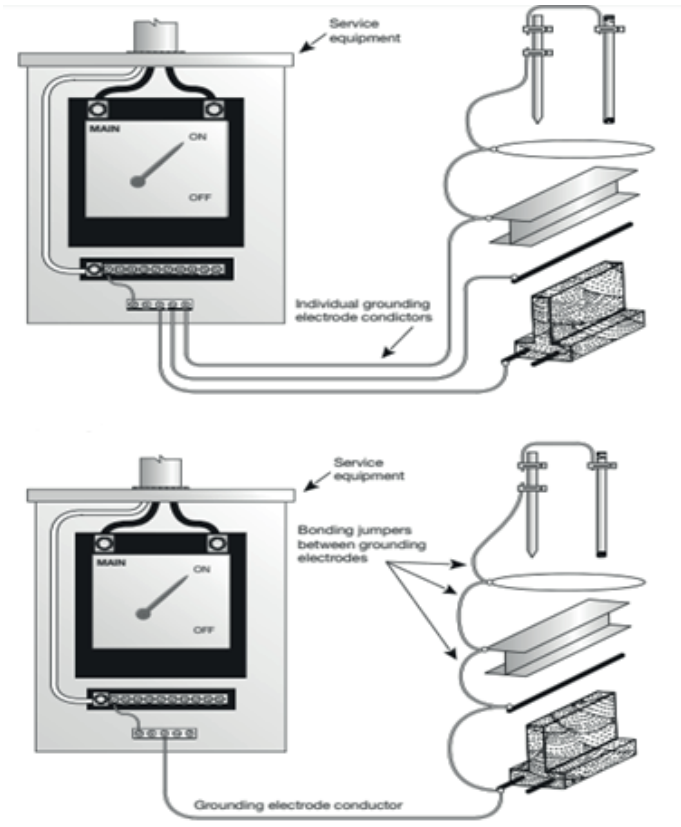


Fig.3.3_6: Grounding and Bonding:

Step 5

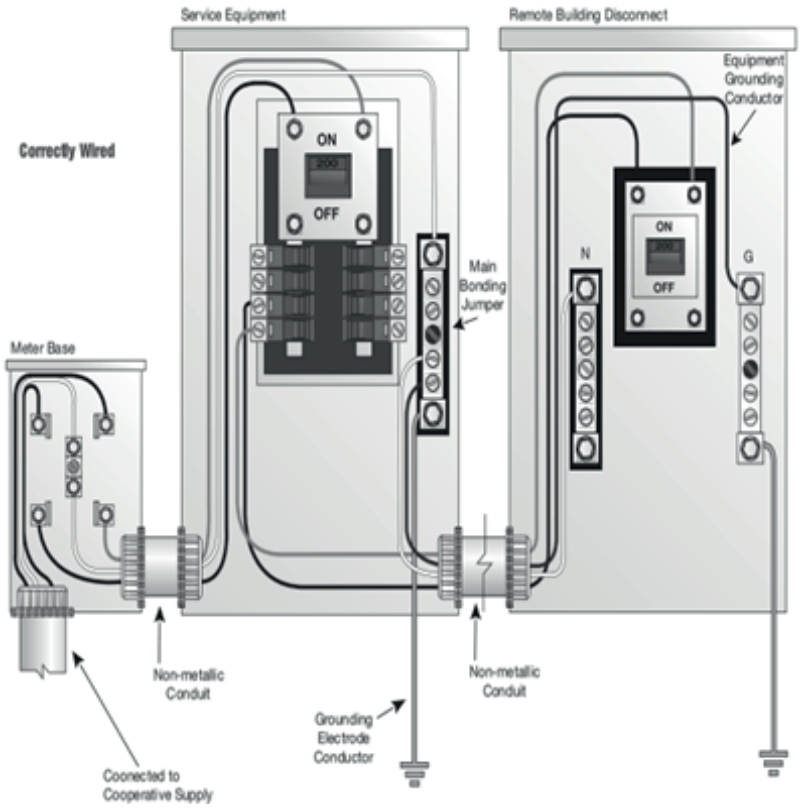


Fig.3.3_7: Grounding and Bonding

Step 6

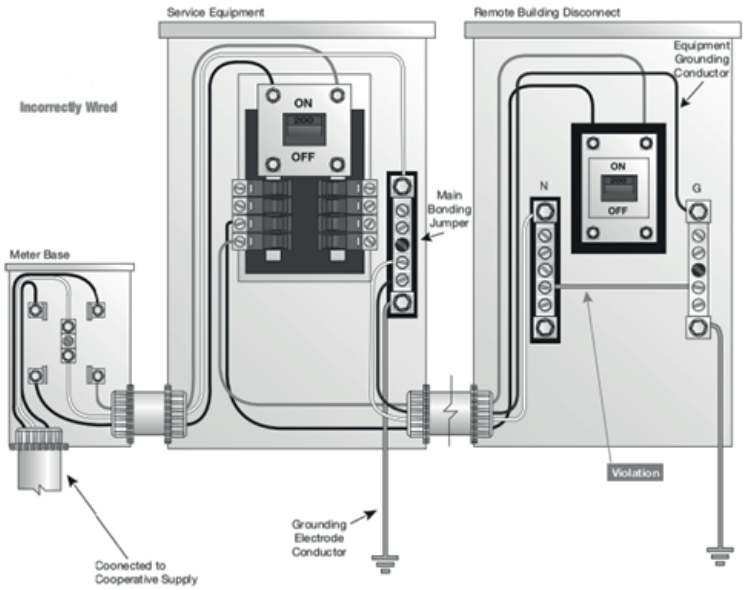


Fig.3.3_8: Grounding and Bonding

Step 7

Here you can see installation process in the form of images.

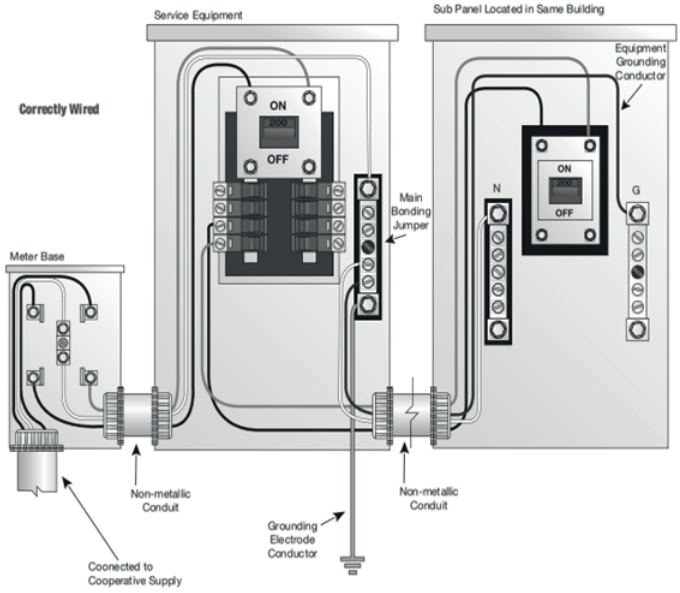


Fig.3.3_9: Grounding and Bonding

Step 8

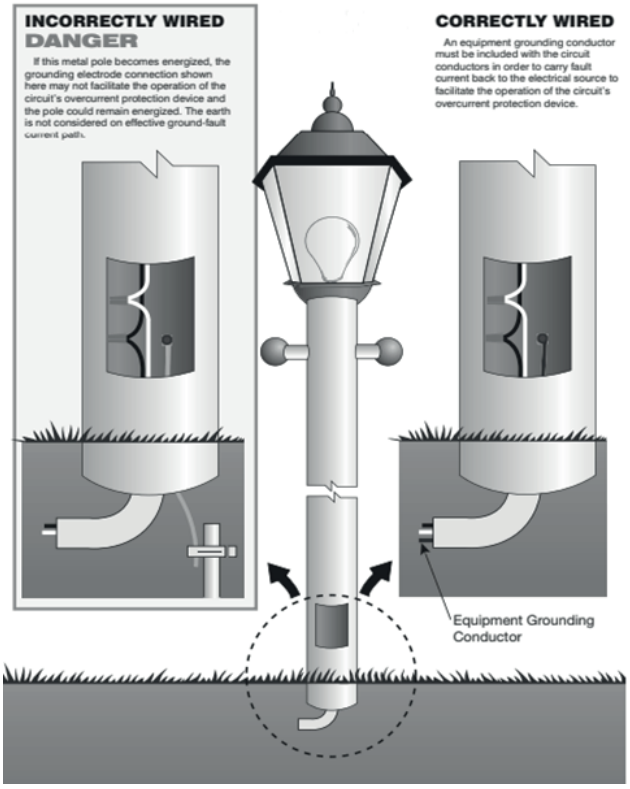


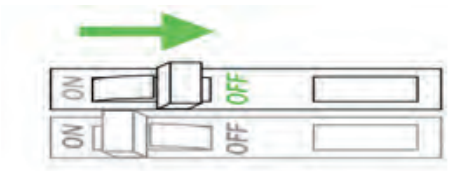
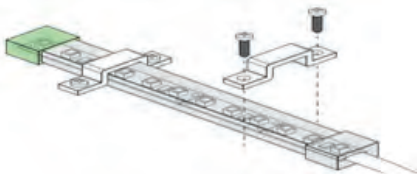
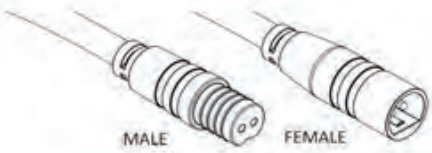
Fig.3.3_10: Grounding and Bonding

Step 9

3.3.3. Installing Fluorescent Lights

	To take out wire nuts, shut down the main power.
	From fixture wires, separate the house wires.
	The cable clamp is attached to the fixture. So loosen and remove the holding element – locknut and the screws.
	In case the fixture seems to be loose, and the wires misplaced, guide those back through the hole.
	It is better to mark the position of the ceiling joists. Now create a new mark for fixing up the new fixture. The screws should be in line with joists.
	Take the help of a screwdriver and hammer for opening the pre-cut knockout hole. You can see it in the fixture's top section.
	With a plier, twist-off the piece.
	Through the hole, thread the wires.
	Put back the cable clamp to the opened fixture with the locknut.
	Now screw the mounting screws back to the joists and wire the fixture.
	With the help of grounding screw, join the ground wires to the fixture.
	Connect black fixture to black house wire. The same goes for the white one.

3.3.4. Installing LED Strips

At the circuit breaker, turn the power off.	
Next, determine the place where to install the LED	
Roll out the strip light and then cut as per your desired length.	
Test the connection with the help of class 2 LED driver.	
Mount the LED tape light in a dry location. You can do it by peeling off the adhesive backing. Then remove the backing along the edge of the connector.	
Fasten it with tape light fasteners. Remember, not to place fasteners on resistors or LED chips.	
Take the help of female and male wet location connectors and attach those with wet location tape.	
With the help of copper wiring, attach the lighting control of LED.	
At the circuit breaker, turn the power on.	

Unit 3.4 Type of distribution equipment for power distribution

Unit Objectives

At the end of this unit, you will be able to:

1. Define the different distribution equipment types
2. Demonstrate the specifications of each type

As per the power supply systems:-

The differentiation of electrical systems differs on the grounds of:

- System earthing type like TN, TN, IT
- Live conductors numbers and types like N resp. L+, L- L1, L3, L2
- Type of current like 3(N) AC, DC, AC

To determine the supply system's properties and behaviour, selection of earthing system type is important. In addition to it, it also is in relation with system usage and its problems like:

- Electromagnetic compatibility
- Downtimes and maintenance
- Installation outlay
- availability and supply reliability of power

IT system

In this system, one can see complete isolation of all live conductors. This is in relation to earth or the connection at a certain point to earth. The connection is through impedance.

A small current leakage can flow when insulation fault occurs. The reason can be by system leakage capacitances. There is no tripping of upstream fuses. In case of single-pole direct earth faults, maintenance of voltage supply is also done.

TN system

It has 2 sections. The first part is the conductive part (exposed) that is in connection to point through protective earth conductors and the other one is in direct connection to the earth.

There are 3 TN type systems:-

- TN-C-S: protective and Neutral functions are in association to a single conductor.
- TN-C: protective and neutral earth conductors are in association to a single conductor
- TN-S: the separation of protective earth conductor runs throughout the system.

Unit 3.5 Programmable Logic Controller

Unit Objectives

At the end of this unit, you will be able to:

1. Define the history of PLC
2. Elaborate your understanding of PLC

It is a specialised computer or device that is useful in controlling various processes and machines. The common terns that PLCs are in association with comprises of:

- Communications
- Software
- Memory
- Central processing unit

The working of PLC is possible with the help of certain components categorised in 3 core areas.

- The input/output section (I/O)
- CPU (central processing unit)
- Rack and power supply

Now sizes and shapes of PLCs are varied. While the majority of them are working in the controls systems, others can even fit inside a shirt's pocket.

- The invention of PLC was made by Dick Morley in the year 1969.
- The model that first came to light was 084.
- PLC model 184 came to be known as the commercial successful PLC. The designer of the model was Michael Greenberg who introduced it in the year 1973.

The internal section of the PLC comprises of:

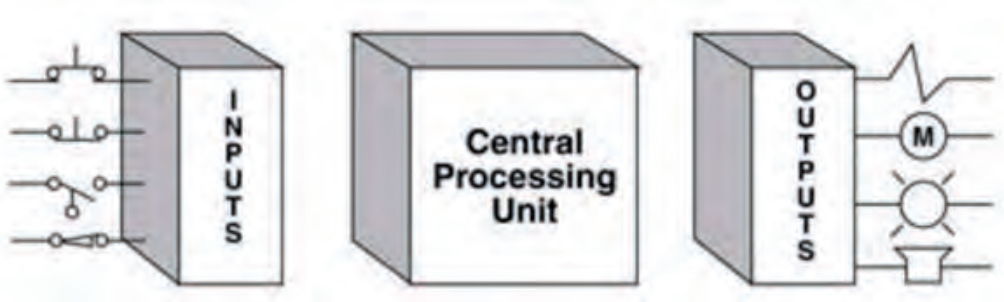


Figure 3.5_1: internal section of the PLC

Its operation system consists of:

- Input Scan
- Program Scan
- Output Scan
- Housekeeping

Figure 3.5_2: Operation system of PLC

Unit 3.6 Ability to Splices and Terminates Electrical Conductors

Unit Objectives

At the end of this unit, you will be able to:

1. Define terminations and splices
2. Define tightening torques and right splice

In any electrical system, terminations and splices are critical components. As per the requirement of the code, one requires to follow the instructions set by the manufacturer when its application is performed to the terminal devices or the installation of the electrical equipment takes place.

Suppose there is a terminal device on whose label you can see it clearly written as "Suitable for 18-2 AWG Stranded", it is necessary for you to use only those conductors that are stranded.

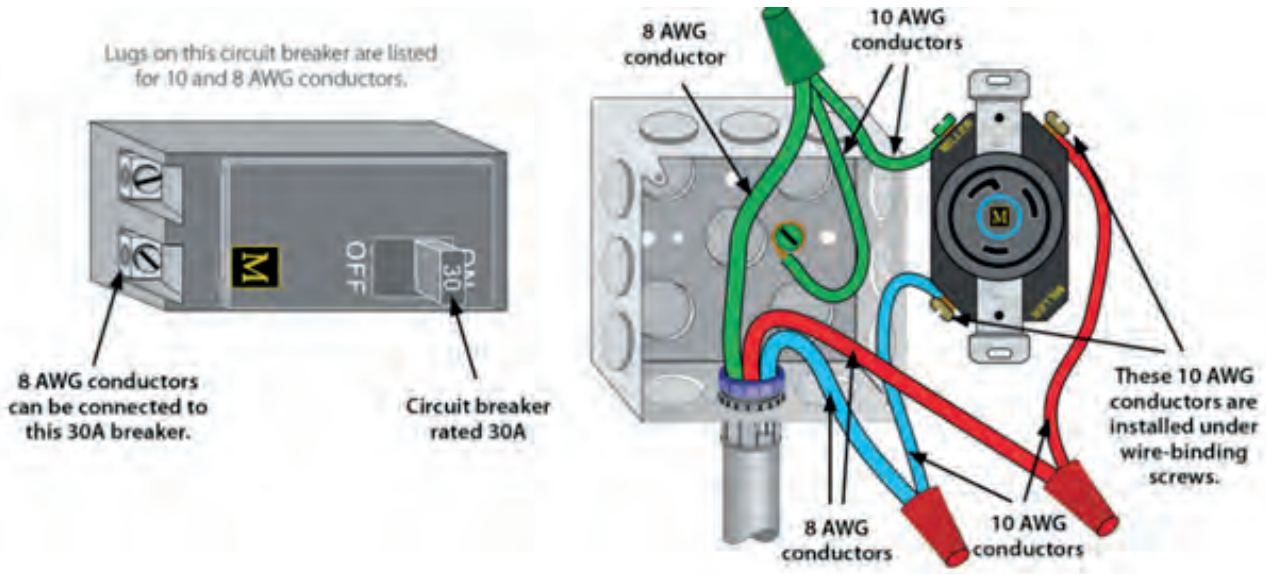


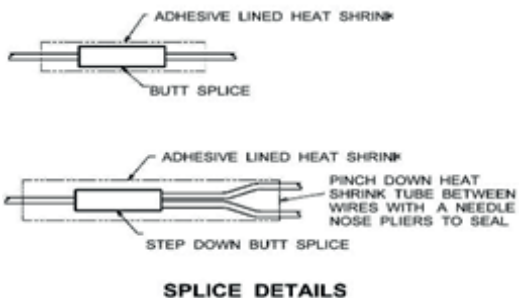
Figure 3.6_1: Jumper wire terminating under wire bending screws

Tightening torques

By avoiding any damage to the conductors, the terminals should be sure that the connection is good. Now there is a myth in this case which states that there is a drop of contact resistance with the situation of over-torque. Well, this isn't the case. With over-torque there is a dramatic rise in contact resistance.

Right splice

Use of correct splicing device is a must. An incorrectly selected listed splicing device can exothermically weld the connection. The application that is listed for use in this area comprises of underground burial application.



SPLICE DETAILS

Unit 3.7 Transformers

Unit Objectives

At the end of this unit, you will be able to:

1. Define the basics of transformers
2. Define the working principles and maintenance of transformers

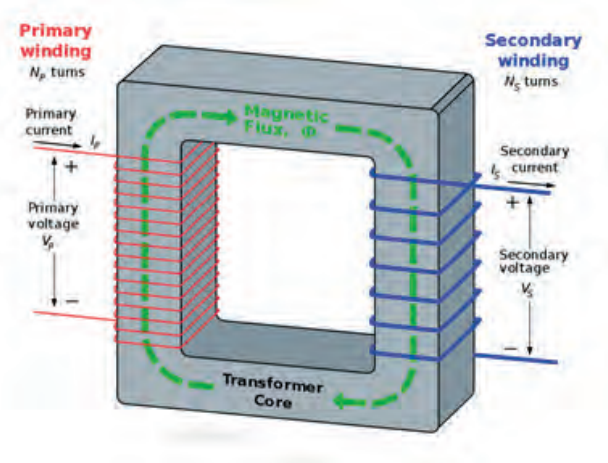
3.7.1. Types of transformer and its use

There are basically two categories of transformers.

1. **Single phase**
   - The machine Transformer states it to be a heavy-duty device that converts electrical energy without a direct electrical connection.
   - This energy conversion is visible from 1 circuit to another circuit.
   - This energy conversion is also possible due to mutual induction that takes place in between 2 windings.
   - Without any frequency change, a transformer can convert electricity from 1 circuit and carry it on to the other.
   - However, in this case, we can see a slight alteration in the form of voltage levels (different voltage levels).

This Type Of Transformers Has 3 Main Parts.

- **Magnetic Core –** its reference is inclined towards magnetic flux, whose production is possible due to primary winding.
- **Secondary Winding –** Due to the transformer's mutual induction, this winding gives the desired output voltage
- **Primary Winding –** production of magnetic flux is visible when it is connected to an electrical source, and it takes electrical power



2. **Poly phase**

   Poly phase transformer is also known as Three-phase Transformer. These type of transformers are commonly in use to serve the purpose of power distribution systems. These transformers are specially built with few specific ideas in mind.

- Less weight compared to its modular counterparts
- High performance added to less material requirement

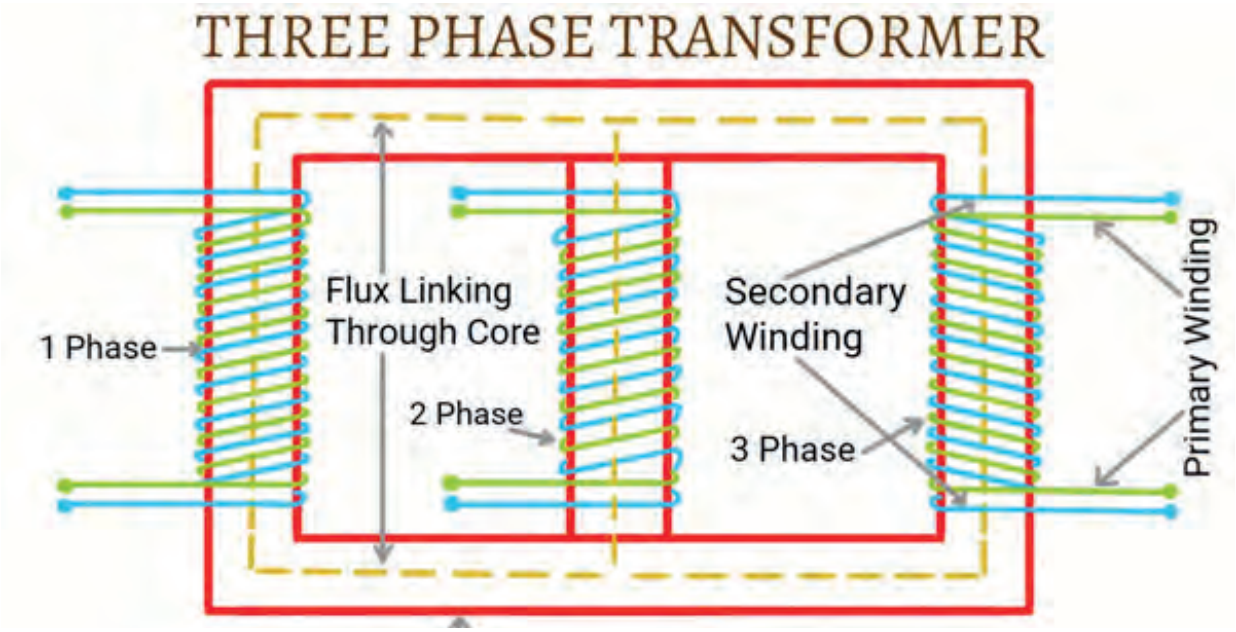
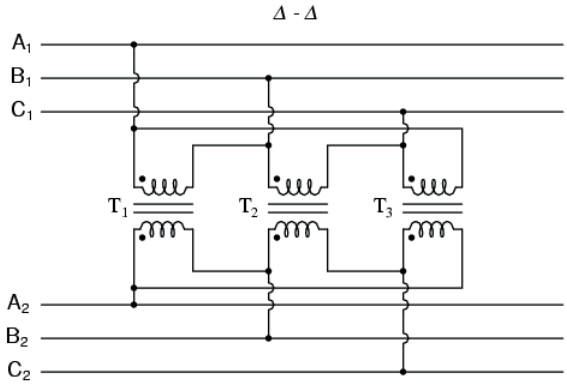


Figure 3.7_1: Three Phase Transformer

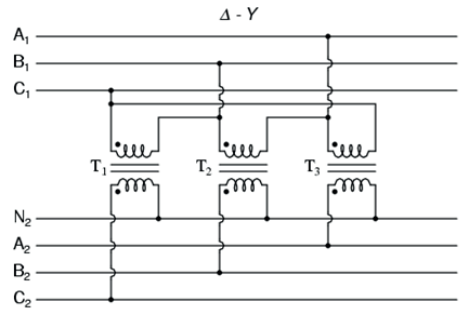
The windings of these transformers are as:

Primary – Secondary

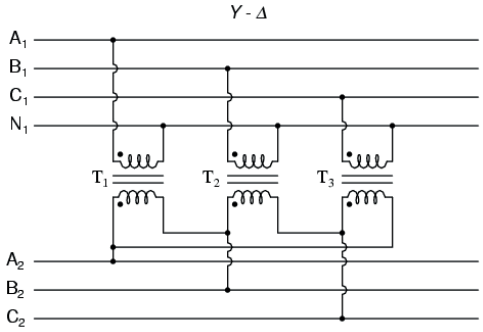
- **Δ – Δ (Phase Wiring)**



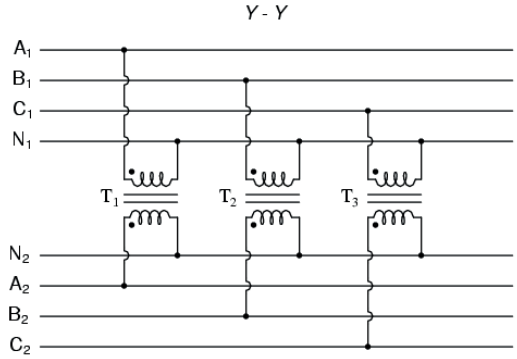
- **Δ – Y (Phase Wiring)**



- **Y – Δ (Phase Wiring)**



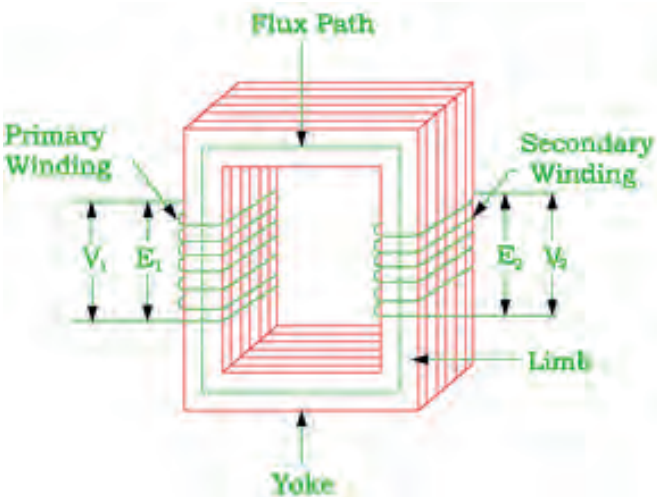
- **Y – Y (Phase Wiring)**



3.7.3. Working Principle and Construction

Behind a transformer's working, the phenomena taking place between the 2 windings of the transformer is mutual induction. There are 2 inductive coils present in a transformer.

- Secondary winding
- Primary winding



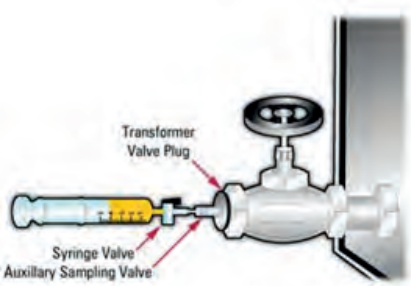
You can get a clear idea from this diagram →

- The link between these 2 windings is magnetic. However, the differential aspect is in consideration to electrical connection.
- The production of alternating magnetic flux is possible around the winding when there is a connection between alternating voltage source and primary winding.
- The link between the two winding takes place due to the magnetic path provided by the core of the transformer.
- The flux in link with the secondary winding is known as main flux or the useful flux.
- In case the flux is not in connection with the secondary windings, it is known as leakage flux.
- Induction of EMF is visible in secondary winding when flux production is alternating. This process is thoroughly explained in the Faraday's law of electromagnetic induction.

3.7.4. Maintenance of Transformer

On daily or **Monthly Basis**, the things that require close check-up:

- Oil leakage from any part of the transformer
- In breather, silica gel's colour
- Reading Magnetic Oil Gage (MOG) of conservator tank and main tank



On a **yearly basis**, the things that require close check-up:

- For 132 KV transformer, annual maintenance and execution of Dissolve Gas Analysis regarding transformer Oil
- In case the transformer is above 132 KV, DGA should be performed with an interval of 2 years
- In case the transformer is below 132 KV, DGA should be performed once in two years
- With the help of battery operated megger (range of 5 KV), one should check a transformer's polarisation index and insulation resistance
- It is important to have annual maintenance regarding the functioning of Buchholz relay and Pressure Release Device
- Transformer top cover also requires proper checking, especially the pockets for Winding Temperature Indicator and Oil Temperature Indicator. If the oil level is low, it requires a refill

Summary

- Smart industrial wiring is based on 3-phase electrical power.
- This allows less workload to be placed on each wire involved and at the same time allowing them to work together to give the maximum output.
- For all types 3-phase electrical power, we need a voltage meter in order to determine the actual voltages that are available.
- Personal protective equipment (PPE) refers to protective clothing, helmets, goggles, or other garments or equipment designed to protect the wearer's body from injury or infection
- For larger projects, with a lot of drilling required, (wood studs, etc.), an electric drill is more practical.
- Have good quality, locking tape measure and a 25'length, 1" blade is maybe overkill, but will come in handy for other projects around.
- Every tool kit, electrical or otherwise, must have the universal repair tool that is a roll of duct tape!
- Pascal's Law, framed by Blaise Pascal, states that "Pressure applied to any part of a confined fluid transmits to every other part with no loss.

Notes

Notes

Scan the QR codes or click on the link to watch the related videos

https://www.youtube.com/watch?v=YkMUz2cqib4

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Transforming the skill landscape

HSSC
HYDROCARBON SECTOR
SKILL COUNCIL

4. Work effectively in a team

Unit 4.1 Different Types of Information that Colleagues might need

Unit 4.2 Importance of helping colleagues

HYC/N6103

Key Learning Outcomes

By the end of this session, you will be able to:

1. Demonstrate the types of information that colleagues might need.
2. Analyze the importance of helping colleagues

In an electrical industry, employees require to work together as a team as it demands technical understanding, communication skills and leadership ability. This team work paves the way for a successful industry. It is not necessary that each employee is well acquainted with all the technical aspects of electrical work. Working together not only helps in increasing the work efficiency of the employees but also will help to create synergy for problem solving. Not only working together, communication skill is also required in any sector to communicate with each other.

- Communication skills and working together is needed to pass on different types of information that colleagues might need while operating electrical works and the importance of providing this information when it is required will help in reducing work stress, increase work efficiency.
- Planning and prioritizing are two of the most important elements to successful management.
- Communicating one on one helps in creating team building.
- Team work often leads to quick problem solving which reduces the wastage of time.
- When working in a team, any engineer having depth of knowledge of a certain technique/machines/ how to deal with the fault can obviously help others in dealing with the matter too.
- Teamwork has the advantage of having different people with different mind-set.

There are obviously certain benefits of teamwork:

- There are certain benefits of effective teamwork:
- Improvements in employee's confidence, attitudes, motivation and personal satisfaction.
- Acquires greater clarity in expressing ideas through group discussion.
- It helps in having more efficient use of resources.

Any task or errand in the Electrical Industry or Workshop is impossible without proper teamwork. Lack of teamwork can be destructive and can foil the entire assignment or project. This would, in turn, lead to delayed delivery of project and loss of client relationship.

Effective Communication is a two way information sharing process that involves one party sending a message that is easily understood by the receiving party. Communication skills are very important in Engineers day to day life. For an engineer communication skill is just like oxygen without which he can't survive.

Unit 4.1 Different Types of Information that Colleagues might need

Unit Objectives

At the end of this unit, you will be able to:

1. Define the various types of Information shared among colleagues
2. Analyze the importance of communication

In electrical industry, different types of information are to be shared among colleagues.

- Colleagues should educate each other of the various equipment needed for electrical maintenance.
- It is not necessary that employees working in an electrical industry possess knowledge of all the electrical appliances, though it is required to be known by each.
- Employees should help each other knowing the basic hand tools, various piers, Wire strippers

4.1.1 Importance of communication

1. Acknowledge Individual Contributions In Real Time
   - Team members should acknowledge each other's ideas rather than taking credit. Sharing of ideas increases productivity and thus is profitable for all.
   - Celebrating one another's achievement is equally important to maintain a strong bond within the team

   - 2. Establish Channels for Cross-Functional Communication
   - Lack of information sharing is not due to a lack of willingness.
   - Often it comes down to a basic inability to effectively communicate knowledge with the right people.
   - As organizations grow, communication channels can become convoluted and employees may not understand how to share what they know with all of the people who could benefit from their insights and experience.
   - This can result in lost time and productivity - and thereby money - particularly when multiple individuals or groups working on related issues at the same time fail to share breakthroughs or results.

Unit 4.2 Importance of helping colleagues

Unit Objectives

At the end of this unit, you will be able to:

1. Analyze the reasons for helping colleagues
2. Demonstrate the reasons with explanations

Six reasons for why it is important to help colleagues:

1. Builds Confidence

If we praise out co-worker who has done a good job, not only will it boost their confidence and give them a sense of pride in their work, but will also heighten their engagement and eagerness to maintain a high standard too.

2. Improves Positive Communication

Being a helpful person has its own benefits as people are more likely to feel more at ease around you, be honest with you and speak up when they have a query or complain.

3. Develops Team Spirit

A supportive environment undoubtedly makes for a better working atmosphere. It helps to create a sense of community and team spirit, which works as a reminder that everyone is striving towards one unified goal.

4. What Goes Around Comes Back

Offering your support, help and expertise will never go unnoticed and it will make people want to offer you the same in return.

5. Health Benefits

Getting along with your colleagues will have a positive impact on your health. With ample amount of time spent with your co-workers, their social support can be of great value to your mental wellbeing, by reducing stress and helping to maintain a balanced emotional state.

6. Improves Morale

Helping your colleagues will make you feel positive and you will be always appreciated. Closer relationships with them will result positively as people are drawn closer to you and care about you. When you improve your work-life, the positive benefits will affect your personal life too.

7. Develops Networking Opportunities

Your support and help to your colleagues will give you a reputation that you actually want. Your investment in others will definitely pay off down the road with a network of people who will willingly support and develop your career.

Notes

Summary

- Communication skills and working together is needed to pass on different types of information that colleagues might need while operating electrical works and the importance of providing this information when it is required will help in reducing work stress, increase work efficiency.
- Planning and prioritizing are two of the most important elements to successful management.
- Any task or errand in the Electrical Industry or Workshop is impossible without proper teamwork
- Effective Communication is a two way information sharing process that involves one party sending a message that is easily understood by the receiving party.
- Colleagues should educate each other of the various equipment needed for electrical maintenance.
- It is not necessary that employees working in an electrical industry possess knowledge of all the electrical appliances, though it is required to be known by each.
- Team members should acknowledge each other's ideas rather than taking credit. Sharing of ideas increases productivity and thus is profitable for all.
- As organizations grow, communication channels can become convoluted and employees may not understand how to share what they know with all of the people who could benefit from their insights and experience.
- If we praise out co-worker who has done a good job, not only will it boost their confidence and give them a sense of pride in their work.
- Being a helpful person has its own benefits as people are more likely to feel more at ease around you, be honest with you and speak up when they have a query or complain.
- Offering your support, help and expertise will never go unnoticed and it will make people want to offer you the same in return.
- Closer relationships with them will result positively as people are drawn closer to you and care about you.
- Your support and help to your colleagues will give you a reputation that you actually want.

Notes

Scan the QR codes or click on the link to watch the related videos

https://www.youtube.com/watch?v=fUXdrl9ch_Q

Skill India
कौशल भारत-कुशल भारत

सत्यमेव जयते
GOVERNMENT OF INDIA
MINISTRY OF SKILL DEVELOPMENT
& ENTREPRENEURSHIP

N·S·D·C
National
Skill Development
Corporation
Transforming the skill landscape

HSSC
HYDROCARBON SECTOR
SKILL COUNCIL

5. Health, Safety and Security Procedures

Key Learning Outcomes 

After attending the session, you will be able to:

1. Define the safety rules
2. Define the Safety Precautions
3. Define the different Safety Sign
4. Define the General Safety of Tools and Equipment
5. Demonstrate how to treat an injured person victimized for getting electrical shock
6. Define the Personal Protective Equipment
7. Elaborate safe working practices with tools and machines at various hazardous sites
8. Define the various dangers associated with the use of electrical equipment
9. Define the aspects related exposure to toxic materials
10. Demonstrate the aspects related to fire, extinguishers, and rescue techniques applied during a fire hazard
11. Demonstrate how to create content of written accident report
12. Define potential injuries and ill health associated with incorrect manual handling
13. Define personal safety and health issues related to the movement of a person by others

Unit 5.1 Safety Rules

Unit Objectives

At the end of this unit, you will be able to:

1. Define the reason for electric shocks
2. Demonstrate the statistics associated with it

Fires in Electrical Circuits and Precautions:

While working with electrical tools and equipment, chances are that there might be short circuit, which might further lead to fire. So it is important for you to know which electrical component holds what percentage of fire.

According to the National Fire Protection Association,

- Lamps, light fixtures and light bulbs and fixed wiring have the largest share among the major types of electrical distribution equipment.
- Cords and plugs account for the largest share of civilian deaths.
- Many avoidable electrical fires can be traced to misuse of electric cords, such as overloading circuits, poor maintenance, and running cords under rugs or in high traffic areas.
- In urban areas, faulty wiring accounts for 33% of residential electrical fires.
- Fifteen percent of residential electrical fires start in the bedroom. Replace worn, old, or damaged appliance cords right away.

Unit 5.2 Safety Precautions

Unit Objectives

At the end of this unit, you will be able to:

1. Define the safety precautions for electrical devices
2. Define the Do's and Dont's to avoid shock

- Repair or replace the frayed cords on all electrical devices.
- Never have extension cords across doorways or under the carpets.
- Wall sockets and extension-cord receptacles with plastic safety covers are highly recommended in homes with small children.
- Have additional circuits or outlets added by qualified electricians to avoid extension cords.
- Always follow manufacturer's instructional manuals.
- Never overload the outlets.
- Always plug in one high-wattage outlet at a time.
- If you feel that switches have become hot, shut them off.
- When possible use cube tapes
- Have smoke alarms installed to avoid accidents

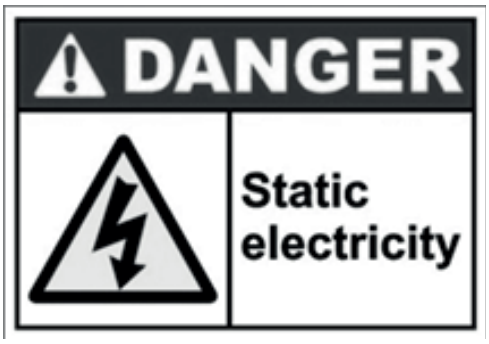
Unit 5.3 Safety Signs

Unit Objectives

At the end of this unit, you will be able to:

1. Define what a safety sign is
2. Identify few important safety signs

Safety Signs are crucial in any work environment. The primary importance of displaying Safety Signs is to prevent injury and ensure that all staff and visitors are well aware of the possible dangers and hazards in certain situations and/or environments.



Notes

Unit 5.4 General Safety of Tools and Equipment

Unit Objectives

At the end of this unit, you will be able to:

1. Define the various safety tools and equipment
2. Define the functions of each safety tool and equipment

Electrical work can't be done without the right tools. As basic tools have been improved over the years and new specialized tools are developed, the list of tool choices for electricians has expanded to a good extent.

Here is a list of tools:

Tools	Functions
Pliers 	A small tool with two handles for holding or pulling small things like nails, or for cutting wire.
Screwdrivers 	A screwdriver is a tool, manual or powered, for turning, driving or removing screws. A typical simple screwdriver has a handle and a shaft, and a tip that the user inserts into the screw head to turn it.
Wire strippers 	A wire stripper is a small, hand-held device used to strip the electrical insulation from electric wires.
Fishing tools 	Tape materials are suited to any type of job. Fish pole wire-installation tools facilitate wire pulling in drop ceilings, down walls or under raised floors.
Measuring devices 	Laser measuring tools are becoming more popular, but no electrician's tool belt is without a basic tape for simple measurements. Those with rare earth magnetic tips that stick to iron and steel surfaces permit fast, one-person measurements.

Unit 5.5 How to treat a person who has been injured by an electrical shock?

Unit Objectives

At the end of this unit, you will be able to:

1. Demonstrate the treatment method for a person suffering from an electric shock
2. Define the Emergency Disaster Management number

Electrical shocks always needs emergency medical attention, even if the person seems to be fine afterwards:

a. Separate the Person from Cu rrent's Source

To turn off power:

- Unplug an appliance if plug is undamaged or shut off power via circuit breaker, fuse box, or outside switch.

If you can't turn off power:

- Stand on something dry and non-conductive, for example dry newspapers, telephone book, or wooden board.
- Try to separate the person from current using non-conductive object such as wooden or plastic broom handle, chair, or rubber doormat.

If high voltage lines are involved:

- The local power company must shut them off.
- Do not try to separate the person from current if you feel a tingling sensation in your legs and lower body. Hop on one foot to a safe place where you can wait for lines to be disconnected.
- If a power line falls on a car, instruct the passengers to stay inside unless explosion or fire threatens.

b. Do Cardiopulmonary Resuscitation, if Necessary

When you can safely touch the person, do Cardiopulmonary Resuscitation if the person is not breathing or does not have a pulse.

c. Check for Other Injuries

- If the person is bleeding, apply pressure and elevate the wound if it's in an arm or leg.
- There may be a fracture if the shock caused the person to fall.

d. Follow Up

- A doctor will check the person for burns, fractures, dislocations, and other injuries.
- An ECG, blood tests, urine test, CT scan, or MRI may be necessary.
- The person may be admitted to the hospital or a burn center.

e. Call up for 108 for Emergency Disaster Management.

Unit 5.6 Personal Protective Equipment

Unit Objectives

At the end of this unit, you will be able to:

1. Define the Personal Protective Equipment
2. Demonstrate how equipment is kept at the workplace

PPE or Personal Protective Equipment protects the user against health or safety risks at work. It can include items such as safety helmets, gloves, eye protection, high-visibility clothing, safety footwear and safety harnesses. It also includes respiratory protective equipment.

What can be done to ensure proper use of Personal Protective Equipment?

- It is important that all personal protective equipment are safely designed and constructed
- To encourage the workers, equipment should fit comfortable
- When engineering, work practice, and administrative controls are not feasible or do not provide sufficient protection, employers must provide personal protective equipment to their workers and ensure its proper use.

Where to find all the general health and safety equipment in the workplace?

When it comes to health and safety equipment, industrial electrician take ample measures and precautions before using them. Now there is a factor that an aspiring electrician should know – the place where such safety equipment is kept. From industrial arcs to testers, ammeters, everything is of importance.

In every work place there is a separate section or room where safety equipment is kept. Their categorisation is as follows:

In the Tools section, you will find:

- Tool belt
- Ammeter
- Voltmeter
- Insulated screwdrivers
- Plier
- Mini drill

In the PPE section, you will find:

- Safety footwear
- Noise reduction tools
- Earplugs
- Safety gloves
- Safety glasses
- Full-face respirators
- Face shields
- Hard hats

In the Safety section, you will find:

- Vacuum anchors
- Speciality anchors
- Shock absorbing lanyards
- Rope grabs
- Rescue harness
- Rope connector
- Cable Climbing System
- Rope Control Handle

In the Signs section, you will find:

- Sign Supports
- Security signs
- No smoking signs
- Emergency and fire signs

Notes

Unit 5.7 National Electrical Code

Unit Objectives

At the end of this unit, you will be able to:

1. Define National Electrical Code
2. Define the codes related to Indian Standards

The National Electrical Code describes the laid down norms of several Indian Standards dealing with all the aspects which are related to the practice of electrical installation. Several product standards also exist and compliance with relevant Indian Standards is desirable. Therefore we would recommend that every single part or section of the code must be read along with the relevant Indian Standards. Few examples of Indian Standards are:

732: 1989
Code of practice for electrical wiring installations

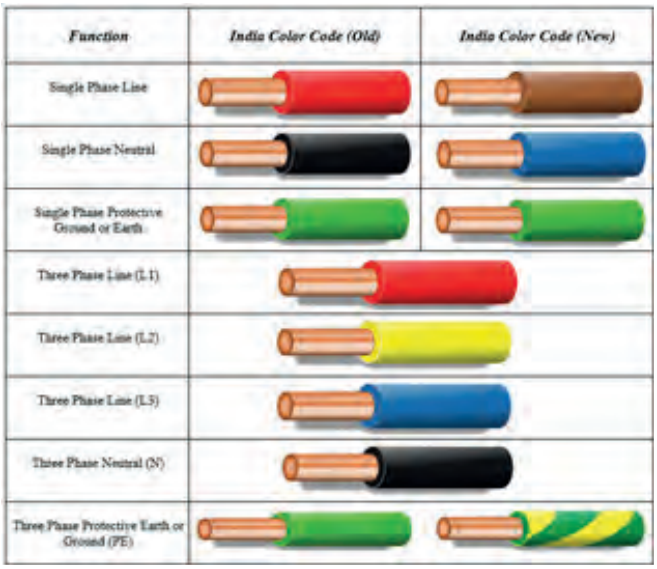
1255: 1983
Code of practice for installation and maintenance of power cables upto and including 33 kV rating

1646: 1997
Code of practice for fire safety of buildings (general): Electrical Installations

3043: 1987
Code of practice for earthing

4051: 1967
Code of practice for installation and maintenance of electrical equipment in mines

5571: 2000
Guide for selection of electrical equipment for hazardous areas



Unit 5.8 Safe Working Practices with Tools and Machines at Various Hazardous Sites

Unit Objectives

At the end of this unit, you will be able to:

1. Define the safe working practices at hazardous sites
2. Define the Do's and Dont's to follow while working at hazardous sites

- Avoid using equipment that has broken plugs, damaged insulation, or frayed cords.
- When fiddling with lives wires and electricity, avoid using wet hands. This increases the chances of electric conductivity (current).
- The tools that you are working with should be insulated.
- It is better to turn of the connection from the mains when dealing with the receptacle.
- Goggles and insulated rubber gloves should always be in use when working on any electrical circuit or branch circuit.
- When working at a specific height, that too on a receptacle, make sure that the ladder is not made up of aluminium or steel. This can give the person working on the receptacle a major shock. It is better to use ladders made up of:
  - Fibreglass
  - Wood
  - Bamboo

- Different countries have different wire codes. One should have a clear idea regarding the wire of the specific country they are residing.
- It is a better option to use circuit breakers with appropriate current rating. The same goes for fuses too.

Unit 5.9 Various Dangers Associated With the Use of Electrical Equipment

Unit Objectives

At the end of this unit, you will be able to:

1. Analyze the dangers associated with Electrical Equipment
2. Analyze Electrocution, Fire and Flammable Items

As per the report of OSHA in the year 2007, nearly 5% of the deaths in this job field are caused due to electrocution. In the year 2014, the percentage took a rise to 6.4%.
Some of the dangers that can take place in the work site are due to:

- Damaged tools
- Overload circuits
- Overhead power lines
- Exposed electrical parts
- Wet conditions
- Damaged insulation
- Inadequate wiring
- Improper grounding

- **Electrocution**

One of the prominent dangers in this line of job is electrocution or shock. In most cases, the resultant can be fatal. In case the person suffers from a non-fatal shock, the result can be grievous – serious burns in the internal tissues and skin. Now, the severity can also cause heart damage.

- **Fire**

The other danger can be fire. Any unchecked faulty wiring can easily lead to the occurrence of fire. This can not only damage the site but also can be the reason for loss of lives.

- **Flammable items**

The third danger is related to the use of flammable and explosive items required in the line of work. It may be in the form of petrol or kerosene that is used for cleaning the ball bearings of electric motors.
Datums and Features

Unit 5.10 Exposure to Toxic Materials and Fire

Unit Objectives

At the end of this unit, you will be able to:

- Demonstrate what happens when in contact with Toxic Material
- Demonstrate the remedial actions to save a person from toxin exposure
- Define the different classes of fire
- Define the different types of extinguisher

As the name suggests, toxic materials are poisonous. And being poisonous in nature, they can either be fatal or cause serious damages in case the preventive actions are not taken on time. Now, the exposure to toxic materials can be in 3 forms.

They can be:

i. Inhaled (entering the body through nose)
ii. Directly in contact with skin
iii. Ingested (consumed)

The toxic materials can be:

- Lead
- Flux
- Solvents

The symptoms in this case will be:

- Seizures
- Partial or complete loss of responsiveness
- Burning sensation
- Stomach Cramping with bouts of excruciating pain
- Nausea
- Vomiting (and in times with blood-stains)

Now, where there are problem, their solutions come side by side. In such situations, the person giving first aid requires to be calm and take certain preventative actions.

Some of the essential actions are:

- Using insulated equipment
- Wearing protective clothing, goggles, masks, shoes and gloves
- Ensuring the place has enough ample ventilation

Remedial action

- The foremost thing that one should do is to provide immediate first aid. However, it is to be remembered that the victim should not be given any kind of fluid (water, milk) until doctors from Poison control unit gives a green signal.
- Aside to this, there are a few things a person can perform to the victim of toxic material exposure.
- Remove the victim from the toxic zone or vicinity
- Call for an ambulance
- Remove contaminated clothing
- Splash water in the eyes
- If ingested, do not try to make the victim puke (vomit)
- Wash their mouth with water
- In case the victim's breathing has stopped, give CPR (Cardiopulmonary resuscitation)
- In case of burning due to toxic material, apply burn gel or water gel on that area.
- Avoid any cream based or oil based lotion or ointment

Even though giving first aid is the right thing to do in the first place, it is also important that another of the electrician should report the incident to their supervisor.

There are various classes of fire.

- Class F – fires related to cooking oils
- Class E – fires related to electrical equipment (fuse boxes)
- Class D – fires related to flammable metals (magnesium, titanium)
- Class C – fires related to flammable gases (propane, methane)
- Class B – fires related to flammable liquids (paint, diesel)
- Class A – fires related to solid materials (paper, wood)

Causes of fires:

i. Spontaneous ignition

This is a resultant of spontaneous heating. The reason of its occurrence is related to the increase in the material's temperature. Spontaneous combustion or ignition takes place only when the material or item reaches its ignition temperature.

ii. Electrical heating and Sparking

This mode of fire occurrence is one of the most dangerous ones amongst all other causes of fire. There are numerous reasons for the occurrence of fire in this category.

- Static discharge
- Overloaded circuits
- Extension cords
- Overloaded outlets
- Wires with incorrect or no coding
- Exposed wiring

iii. Loose fires

Again loose fires are also one of the prominent reasons. It can be due to the fault of the electricians who smoke at the work place or welding without any precaution

iv. Chemical fires

In the industrial sites, the use of chemicals is a common sight. And with the presence of chemicals, the chances of accidental combustion and knocking down any flammable liquid can take place. This is again a reason to start a fire. The main aspect of chemical fires is – the liquid is not the real reason to start a fire, its vapour is!

5.10.1. Techniques of using the different fire extinguishers

Water fire extinguisher

- Utilisation of these is on Class A fires
- These have RED labels
- Lift the extinguisher, aim it at the fire's base and use it in a sweeping motion

Water mist fire extinguisher (dry water mist)

- Utilisation of these is on Class F, C, B, A fires
- These have RED writing on WHITE labels
- Lift the extinguisher, aim it at the fire's base and use it in a sweeping motion

Powder Fire Extinguisher

- Utilisation of these is on electrical fires as well as classes A, B, C fires.
- These have BLUE labels
- Lift the extinguisher, aim it at the fire's base and turn it on.

Dry powder fire extinguisher

- Utilisation of these is on Class D fires
- These have BLUE labels
- Lift the extinguisher and aim it at the fire's base

Wet chemical fire extinguisher

- Utilisation of these is on Class F fires in addition to class A and B fires
- These have YELLOW labels
- Lift the extinguisher, aim it at the fire's base and use it in slow circular motions

Foam fire extinguisher

- Utilisation of these is on Class A and B fires
- These have CREAM labels
- Lift the extinguisher, aim it at the fire's base and use it in a sweeping motion for class A and at the top of the burning liquid for class B.

CO2 fire extinguisher

- Utilisation of these is on Class B fires
- These have BLACK labels
- Lift the extinguisher, aim it at the fire's base and use it across the area otherwise your skin can freeze

Different materials used for extinguishing fire

- Sand
- Non-flammable blanket
- Water
- Condensed aerosol fire suppression
- Foam
- Flame inhibitor liquids like Halon
- dry powder
- CO2

Rescue Techniques Applied During a Fire Hazard

There are basically 3 methods with the help of which people can be rescued from a building engulfed in a blazing fire. 2 of the important steps that we will discuss now also come under the best safe lifting and carrying practices.

- **Conventional technique**
  - This is a good method if the open area is close by.
  - The first rescuers will make the victim sit reach under armpits, and finally grab the wrist.
  - The other rescuer will cross the ankle (victim), pull up that person's legs on his shoulder.
  - Finally, on the count of 3, both will lift the person up and move out.

- **Fast strap**
  - In case the victim is completely disabled to move out of the blazing building or area, the rescuers require following this method.
  - One of the rescuers will place their knee between victim's shoulder and head.
  - Pin the loop of webbing to the ground with the help of the knee. This acts as an anchor.
  - With the non-dominant hand hold the other end of the webbing and make a loop.
  - With steady hands pull in victim's hand from the loop, tie it securely and finally clip the webbing loops
  - There are various classes of fire.

Unit 5.11 Content of Written Accident Report

Unit Objectives

At the end of this unit, you will be able to:

- Define a written accident report
- Analyze what to include as Written Accident Report content

In the present times, there is provision of special incident reporting form in which one can easily write an accident report. However, if such forms are not available, one should remember to include this information as the content.

- In the 1st section, you need to record the basic things related to the accident like:

  - Date of accident
  - Time
  - Specific location
  - Accounts of witnesses
  - Their names
  - Event that caused that accident
  - What other electricians were doing at that moment
  - Circumstances like PPE, materials, equipment, tool
  - Environmental conditions
  - Specific injuries
  - Person(s) who gave first aid

- In the 2nd section, it is mandatory to give a complete description including necessary details and relevant facts. The use of language should be formal.
- In the 3rd section, the person writing the content requires signing it with the current date.
- P.S. It is essential that a photocopy of the written accident report be made before submission.

Unit 5.12 Potential Injuries and Ill Health Associated With Incorrect Manual Handling

Unit Objectives

At the end of this unit, you will be able to:

- Define the Long-term injuries
- Analyze the Superficial injuries or Short-term injuries

Long-term injuries

Major damages in this scenario are related to the body's musculoskeletal system. This causes due to wear and tear in areas like:

- Blood vessels
- nerves
- ligaments
- joints
- bones
- tendons
- muscles

The disorder is commonly called musculoskeletal disorders. This can also occur due to abrupt bending, turning and twisting the torso, neck, back

Superficial injuries or Short-term injuries

This may occur when lifting or loading heavy objects at awkward angle. This can cause cuts, fractures, bruises, strain in the muscles, etc.

Unit 5.13 Personal Safety and Health Issues Relating to the Movement of a Person by Others

Unit Objectives

At the end of this unit, you will be able to:

- Analyze the importance of Personal Safety and Health Issues
- Elaborate the consequences or potential impact to a person who is moved incorrectly

Where it is a humane act to help fellow colleagues or electricians during tough times and situations of medical emergencies, it is also important that the individual should also maintain their own personal safety.

In industrial work site, the accidents can be due to various reasons. Fires and electric shocks are the common cases that are visible in most cases. However, accidents due to toxic chemicals or chemical burns are also the other reasons that can cause accidents.

In this case, the blistered area of the victim contains traces of chemicals. There is a higher possibility of that toxic material to transfer in the rescuer's skin.

So, it is important that the rescuers should maintain certain precautionary measure and a detailed check-up after transferring the victim to the hospital or even to the ambulance.

Potential Impact to a Person Who is Moved Incorrectly

When transferring a person (victim) to the hospital, it is important that the movement should be appropriate. Now, the movement can signify anything and you may get confused with the aspect. So, here's the simple explanation.

Broken bone

A person with a broken bone or a sprained leg is obviously in excruciating pain, and it is necessary that to transfer that person to the ambulance, correct method is applied.

The person with a broken bone should be laid on a flat surface and apply an ice pack. Take a long cylindrical item like a stuck and wrap it with the help of a bandage or cloth around the broken area. An incorrect movement in that situation can cause permanent distortion of that area.

Severe cut

In this case, it is important to wash the area carefully. A tourniquet should be applied on that area to stop bleeding. An incorrect movement in this case can cause not only excessive blood loss but also may increase the chances of infection, leading to gangrene.

Electric shock

In this case, if the victim is moved inappropriately, there are chances that breathing if the person may cease, leading to instant death.

5.13.1. Standard Operating Procedure While Working

The applicability of this SOP is for all industrial electrician and electrical system.

In case of Earthing:

- The requirement of this process is for dissipation of generated static electricity. It is also helpful in the detection of any current leakage. The utility is visible with the help of ELCB. This terminates the connection between the equipment and electric supply.
- It ensures the provision of earthing in consideration to electric equipment. The situation in this case is mostly towards the chances of existence of static generation.
- It is better not to detach any earthing connection.
- It is a beneficial aspect to check the status of earthing equipment on a quarterly basis.

In general condition:

- Until the reasons for blown fuse do not come to light, don't replace it.
- It is better not to work on live circuits. The work should be done only with the presence of artificial respiration and first aid as safety precautions.
- Until you are sure that the conductor or electrical gear is earthed and isolated, don't tamper with any of it.
- Without being familiar with the circuit, don't touch switches or work on it.
- It is best not to touch any wires or circuits in case you are injured or are not wearing any protective gears.
- Don't use any extinguisher on electrical machinery without knowing which of it suits the actual purpose. It is better to use CO2 extinguisher or DCP.

5.13.2. Reporting Structure within Organization

When we talk about organizational structure, we mostly understand the elements that make a difference in the structural aspect of a company. The two things in focus are:

1. The methods in which the work gets coordinated
2. The behaviour ideal in a workplace

The reporting structure mainly depends on the structural aspect of the company. Now the structural aspect of the company lies on 4 elements.

- Departmentalisation
- Hierarchical Levels
- Formalization
- Centralization

The reporting structure mainly gets counted in the hierarchical level. If we keep the organisation's structure to be constant, we will find the management level to have several layers. The levels may start from the level of frontline employees and may continue till the top level. In the top level, the person to hold the reign is usually the owner of director of the company.

Now, if we consider the "Span of Control" concept, the person to whom most employees (electrician included) is a single manager. This span of control is usually small in case of tall structures. This gives the managers more scope to monitor the activities of employees and provide appropriate supervision.

Notes

Summary

- Lamps, light fixtures and light bulbs (28%) and fixed wiring (22%) account for the largest share of fires among major types of electrical distribution equipment.
- Laser measuring tools are becoming more popular, but no electrician's tool belt is without a basic tape for simple measurements. Those with rare earth magnetic tips that stick to iron and steel surfaces permit fast, one-person measurements.
- Fifteen percent of residential electrical fires start in the bedroom. Replace worn, old, or damaged appliance cords right away.

Notes

Scan the QR codes or click on the link to watch the related videos

https://www.youtube.com/watch?v=L4sUQZta8Rw

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6. Annexure

Sl No.	Module No.	Unit No. and Name	Topic Name	Page No.	URL	QR Code (s)
1	Module 1	Introduction	Basic Concept of Electricity	3	https://www.youtube.com/watch?v=a_o0fX_UXG0	Basics of Electricity
2	Module 1	Introduction	Types of Wire Joints and Uses	10	https://www.youtube.com/watch?v=-Km-brSe65O4	Types of Electrical joint
3	Module 2	Job Requirement and Related Processes	Basics of Engineering Drawing	19	https://www.youtube.com/watch?v=dKNnTx-wSS-Q	Engineering drawing
4	Module 2	Job Requirement and Related Processes	Understanding Projections, Dimensioning and Tolerance	24	https://www.youtube.com/watch?v=RYQUXGSEsV0	Geometric Dimensioning & Tolerancing (GD&T)
5	Module 2	Job Requirement and Related Processes	Computer Generated CAD for Electrical Drawing	40	https://www.youtube.com/watch?v=JB9vRvrM-4QA	Electrical Layout in AutoCAD
6	Module 2	Job Requirement and Related Processes	Basics of PLC System and its Application in Electrical Control System	70	https://www.youtube.com/watch?v=twBJpe-Jh_Cc	PLC Panel Basics
7	Module 2	Job Requirement and Related Processes	Knowledge on Thermal Power Generation	77	https://www.youtube.com/watch?v=7vKn-GuA-UaM	THERMAL POWER PLANT

Sl No.	Module No.	Unit No. and Name	Topic Name	Page No.	URL	QR Code (s)
8	Module 2	Job Requirement and Related Processes	How Mechanical Maintenance of Electric Motor is done	79	https://www.youtube.com/watch?v=dsV-zwUD0z8Q	What are motor maintenance types ?
9	Module 2	Job Requirement and Related Processes	Install Metal and Plastic Conduits/ Flexible Conduits	85	https://www.youtube.com/watch?v=I1NGU3T-t9cA	How to install flexible steel conduit with connector
10	Module 2	Job Requirement and Related Processes	Troubleshoot Electrical Installations and Identify Faults	86	https://www.youtube.com/watch?v=w96nZp-PPl0Y	Electrical troubleshooting on Lubrication unit. Basic electrical fault finding
11	Module 3	Industrial Electrical Wiring	Basic principles of fluid/ hydraulic system	100	https://www.youtube.com/watch?v=YkMUz2c-qib4	Hydraulics - Basic Physical Principles
12	Module 3	Industrial Electrical Wiring	Type of distribution equipment for power distribution	110	https://www.youtube.com/watch?v=s65M-mFUfcrM	Electrical Distribution System
13	Module 3	Industrial Electrical Wiring	Transformers	114	https://www.youtube.com/watch?v=j-cY4QN7awEc	

Sl No.	Module No.	Unit No. and Name	Topic Name	Page No.	URL	QR Code (s)
14	Module 4	Work Effectively in a team	Team Work	121	https://www.youtube.com/watch?v=fUXdrl-9ch_Q	good team-work and bad teamwork
15	Module 5	Health, Safety and Security Procedure	Fire Safety	129	https://www.youtube.com/watch?v=L4sUQZ-ta8Rw	ABC'S OF Fire extinguisher

Notes

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