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ELECTRICAL MACHINE WINDING TECHNICIAN

LEARNER GUIDE

National Vocational Certificate Level 2

Version 1 - September, 2018

NAVTTC

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Contents

Introduction

Welcome to your Learner's Guide for the **Electrical Machine Winding Technician** Program. It will help you to complete the program and to go on to complete further study or go straight into employment.
The **Electrical Machine Winding Technician** program is to engage young people with a program of development that will provide them with the knowledge, skills and understanding to start their career in Pakistan. The program has been developed to address specific issues, such as the national, regional and local cultures, the manpower availability within the country, and meeting and exceeding the needs and expectations of their customers.
The main elements of your learner's guide are:

- **Introduction:**
  - This includes a brief description of your guide and guidelines for you to use it effectively
- **Modules:**
  - The modules form the sections in your learner's guide
- **Learning Units:**
  - Learning Units are the main sections within each module
- **Learning outcomes**:
  - Learning outcomes of each learning units are taken from the curriculum document
- **Learning Elements:**
  - This is the main content of your learner's guide with detail of the knowledge and skills (practical activities, projects, assignments, practices etc.) you will require to achieve learning outcomes stated in the curriculum
  - This section will include examples, photographs and illustrations relating to each learning outcome
- **Summary of modules**:
  - This contains the summary of the modules that make up your learner's guide
- **Frequently asked questions**:
  - These have been added to provide further explanation and clarity on some of the difficult concepts and areas. This further helps you in preparing for your assessment.
- **Multiple choice questions for self-test**:

These are provided as an exercise at the end of your learner's guide to help you in preparing for your assessment.

ELECTRICAL MACHINE WINDING TECHNICIAN

Module-A
LEARNER GUIDE
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Module A: 0713001126 Perform on-site Inspection/testing of machine

Objective: This Module covers the knowledge & skills required to perform on site pre inspection / testing of Machine through taking feedback from the operator,Check Physical status/condition of Machine, Check data plate of machine for specifications**,** Conduct Megger test of the Machine, Carry out Transformer's oil test, Perform Total Turn Ratio Test of Transformer, Repair/Replace Terminal plate of Motor.

Duration: 110 Hours **Theory: 22 Hours** **Practice: 88 Hours**

Learning Unit	Learning Outcomes	Learning Elements	Materials Required
LU1.Take feedback from the operator	**The trainee will be able to:** • Perform site visit • Collect information from the machine operator regarding the fault • Record the data	• Importance of site visit; • Importance/Purpose of getting feedback from the operator • Symptoms of Electric Machine Faults and Importance of Data recording • Basic Concept of Electricity and communication	**Tools** **Consumables Items** • Led Pencil, Rubber, Sharpener, Writing Pad
LU2. Check Physical status/condition of Machine	**The trainee will be able to:** • Perform physical checking of machine by: ➢ Seeing ➢ Touching ➢ Smelling • Check for loose fitting • Check for open / loose/burnt connections	• Purpose of Physical Checking of Machine; Techniques of Physical Checking of Machine • Checking Techniques for loose fitting, loose /Flash/open/Burnt connection	**Tools** • Spanner Set Screw Driver Set • Allen key Set • Clamp Meter • Safety Belt • Ladder **Consumables Items**

	• Check for true connections as per circuit diagram	• Effects of loose connection • Understanding of Circuit Diagram and check true connection as per circuit diagram	• Hand Gloves • Safety Shoes • Safety Goggles
LU3. Check data plate of machine for specifications	**The trainee will be able to:** • Locate the Data/Name Plate of Machine • Read data of Machine • Record data of Machine	• Understanding location of Machine Data Plate • Understanding of Machine Specification	**Tools** • Magnifier Glass **Consumables Items** • Led Pencil, Rubber, Sharpener, Writing Pad • Anti-Rusting Lubricant(WD-40) • Sand Paper • Duster Cloth/Cotton Waste
LU4. Conduct Megger test of the Machine	**The trainee will be able to:** • Identify the required tools and equipment for conduct of Megger Test • Collect the required tools and equipment	• Identification of required Tools and Equipment for conduct of Megger Test • Disconnection Sequence of supply	**Tools** • Megger (Insulation Tester) with Leads • Screw Driver

	• Disconnect the Supply Cables • Perform testing with Megger ➢ Ground/Earth Fault ➢ Short Circuit ➢ Open Circuit • Record test result	Cables • Use of Megger for conduct of Open, Short, Ground, Earth leakage tests	Set • Spanner Set • Combination Plier • Allen Key Set
LU5. Carry out Transformer's oil test	**The trainee will be able to:** • Identify the required tools and equipment • Collect the required tools and equipment • Disconnect the Supply Cables • Take Oil Sample for test • Perform oil testing ➢ High Voltage/Breakdown Test ➢ Moisture Test ➢ Flash Point Test • Record test results	• Recognition of the required tools equipment, PPEs and their use to carry out Transformer Oil Test • Methods to Take Oil Sample from Transformer • Understanding of Oil Testing Techniques for High Voltage, Break Down, Moisture and Flash Point Tests	**Tools** • Transformer Oil Testing Equipment • Sample Beaker • Screw Driver Set • Spanner Set • Combination Plier **Consumables Items** • Led Pencil, Rubber, Sharpener, Writing Pad • Duster Cloth/Cotton Waste
LU6.Perform Transformer Turn Ratio Test	**The trainee will be able to:** • Identify the required tools and equipment • Collect the required tools	• Recognition of the required tools, equipment and PPEs for Turn Ratio Test of	**Tools** • Single Phase TTR Meter **Consumables Items**

	• Disconnect the Supply Cables • Perform TTR Test • Compare TTR test result with the specifications as per Data Plate • Record test result	Transformer • Method of conducting TTR Test • Importance of Comparing TTR Test results with the nominal/Specified voltage and Turn Ratio	• Led Pencil, Rubber, Sharpener, Writing Pad • Duster Cloth/Cotton Waste
LU7. Check Terminals/Terminal plate of Machine	**The trainee will be able to:** • Inspect the Terminal Plate of Machine • Check the physical condition of nut bolts • Check space/gap between the terminals • Check the condition of linking strips for connection • Check the space condition for rusting/carbonizing between terminals	• Understand effects of rusting /Carbonizing, Inter Terminal space, condition of linking strips and nut bolts • Checking Techniques of rusting /Carbonizing, Inter Terminal space, condition of linking strips and nut bolts	**Tools** • Screw Driver Set • Spanner Set • Combination Plier **Consumables Items** • Duster Cloth/Cotton Waste • Sand Paper • Anti-Rusting Lubricant (WD-40)

LU1.Take feedback from the operator:

- **Importance of site visit:**

  It is very important to visit the site when you have received a maintenance or repair task of a heavy machine. This will help you to identify the faults, nature and causes of faults. Some faults can be rectified at site; this will avoid unnecessary transportation of heavy machine to workshop, which will save your time and money. There are many internal and external factors that combine to impact your bottom line. Site condition assessment evaluates everything from long-term equipment performance and maintenance history to work environments and seasonal weather conditions for deeper insight into how to be more productive.

- **Importance/Purpose of getting feedback from the operator:**

  It is a valuable resource for getting to know your machines inside out is to involve the machine operators. You're not likely to have the intimate knowledge of each machine's idiosyncrasies and quirks. Daily operators get a "feel" for the machine. Operator's sense when something's amiss and they'll tell you. Listening to them and appreciating their input is a wise preventive maintenance strategy.

- **Symptoms of Electric Machine Faults and Importance of Data recording:**

  The major faults of electrical machines can broadly be classified as the following:

  a) Winding faults resulting in the opening or shorting of one or more of a phase winding,
  b) Abnormal connection of the windings,
  c) Broken rotor bar or cracked rotor end-rings,
  d) Static and/or dynamic air-gap irregularities,
  e) Bent shaft (dynamic eccentricity) which can result in a rub between the rotor and stator, causing serious damage to stator core and windings
  f) Shorted rotor field winding, and
  g) Bearing and gear box failures.

These faults produce one or more of the symptoms as given below:

a) Unbalanced air-gap voltages and line currents,
b) Increased torque pulsations,
c) Decreased average torque,

d) Increased losses and reduction in efficiency, and
e) Excessive heating.

The diagnostic methods to identify the above faults may involve several different types of fields of science and technology. They can be described as:

a) Electromagnetic field monitoring, search coils, coils wound around motor shafts (axial flux related detection),
b) Temperature measurements,
c) Infrared recognition,
d) Radio frequency (RF) emissions monitoring,
e) Noise and vibration monitoring,
f) Chemical analysis,
g) Acoustic noise measurements,
h) Motor current signature analysis(MCSA),
i) Model, artificial intelligence and neural network based techniques.

- **Basic Concept of Electricity and communication:**

BASIC ELECTRICITY

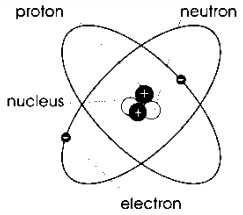
ATOM:

According to the modern electron theory, atom is composed of the three fundamental particles, which are invisible to bare eyes. These are the neutron, the proton and the electron. The proton is defined as positively charged while the electron is defined as negatively charged. The neutron is uncharged i.e. neutral in nature possessing no charge. The mass of neutron and proton is same while the electron is very light, almost 1/1840th the mass of the neutron and proton.

STRUCTURE OF AN ATOM:

All of the protons and neutrons are bound together into a compact nucleus. In atom the number of protons equal to the number of electrons. An atom as a whole is electrically neutral. The electrons are arranged in different orbits. The nucleus exerts a force of attraction on the revolving electrons and holds them together. All these different orbits are called shells and possess certain energy. The orbit which is closest to the nucleus is always under the tremendous force of attraction while the orbit which is farthest from the nucleus is under very weak force of attraction. The electrons which are revolving round the nucleus not revolve in a single orbit. Each orbit consists of fixed number of electrons. In general, an orbit can contain a maximum of $2n^2$ electrons where n is the number of orbit. So first orbit or shell can occupy maximum of 2×1^2 i.e. 2 electrons while the second shell can

occupy maximum of $2x2^2$ i.e. 8 electrons and so on. The exception to this rule is that the valence shell can occupy maximum 8 electrons irrespective of its number



ELECTRIC CHARGE:

In all the atoms, there exists number of electrons which are very loosely bound to its nucleus. Such electrons are free to wonder about, through the space under the influence of specific forces. Now when such electrons are removed from an atom it becomes positively charged. This is because of losing negatively charged particles i.e. electrons from it. As against this, if excess electrons are added to the atom it becomes negatively charged.

UNIT OF CHARGE:

The charge possessed by the electron is very small hence it is not convenient to take it as the unit of charge. The unit of the measurement of the charge is Coulomb. The charge on one electron is $1.602x10^{-19}$, so one coulomb charge is defined as the charge possessed by total number of ($1 / 1.602x10^{-19}$) electrons i.e. $6.24x10^{18}$ number of electrons. Thus, 1 coulomb = charge on $6.24\ x10^{18}$ electrons.

From the above discussion it is clear that if an element has a positive charge of one coulomb then that element has a deficiency of $6.24x10^{18}$numbers of electrons.

KINDS OF CHARGE:

There are two kinds of charge named as;

- Positive Charge
- Negative Charge

ELECTRICAL QUANTITIES:

ELECTRIC CURRENT:

The free electrons are responsible for the flow of electric current in conductor. A conductor is one which has abundant free electrons. The free electrons in such a conductor are always moving in random directions inside the piece of a conductor.

The small electrical effort, externally applied to such conductor, makes all such free electrons to drift along the metal in a definite particular direction. This direction depends on how the external electrical effort is applied to the

conductor. Such an electrical effort may be an electrical cell, connected across the two ends of a conductor. Atoms, when they lose or gain electrons, become charged accordingly and are called ions. Now when free electron gets dragged towards positive from an atom it becomes positively charged ion. Such positive ion drags a free electron from the next atom. This process repeats from atom to atom along the conductor. So there is flow of electrons from negative to positive of the cell, externally through the conductor across which the cell is connected. This movement of electrons is called an Electric current. The movement of electrons is always from negative to positive while movement of current is always assumed as from positive to negative. This is called direction of conventional current.

AMPERE:

A current of 1Ampere is said to be flowing in the conductor when a charge of one coulomb is passing through any given point in one second. Now 1 coulomb is $6.24x10^{18}$numbers of electrons. So 1 ampere current flow means flow of $6.24x10^{18}$ electrons per second across a section taken anywhere in the circuit.

ELECTRIC PRESSURE OR POTENTIAL DIFFERECE:

When two similarly charged particles are brought near; they try to repel each other while dissimilar charges attract each other. This means, every charged particle has a tendency to do work. The electric potential at a point due to a charge is one volt if one joule of work is done in bringing a unit positive charge.

Let us define now the potential difference. It is well known that, flow of water is always from higher level to lower level; flow of heat is always from a body at higher temperature to a body at lower temperature. Such a level difference which causes flow of water, heat and so on also exists in electric circuits. In electric circuits flow of current is always from higher electric potential to lower electric potential. So we can define potential difference as "The difference between the electric potentials at any two given points in a circuit is known as Potential Difference This is also called voltage between the two points mid measured in volts. The symbol for voltage is V.

RESISTANCE:

The electrical resistance of an electrical conductor is the opposition to the passage of an electric current through that conductor. The SI unit of electrical resistance is the ohm (Ω) and is denoted with the letter R.

The concept of resistance is analogous to the friction involved in the mechanical motion. Every metal has a tendency to oppose the flow of current. Higher the availability of the free electrons, lesser will be the opposition to the flow of current. The conductor due to the high number of free electrons offers less resistance to the flow of current.

The unit 1 ohm can be defined as that resistance of the circuit if it develops 024 calories of heat, when one ampere

current flows through the circuit for one second.

CONDUCTANCE:

The inverse quantity of resistance is called conductance, it is the indication of ease with which an electric current passes through material. Conductance is measured in Siemens (S) or mho (Ʊ). It is denoted with letter G. G = 1 / R

GENERATION OF VOLTAGE:

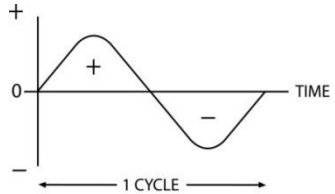
Electricity generation is the process of generating electric power from other sources of primary energy. The fundamental principles of electricity generation were discovered during the 1820s and early 1830s by the British scientist Michael Faraday. Electricity is generated by the movement of a loop of wire, or disc of copper between the poles of a magnet.

VOLTAGE SOURCES:

Electricity is most often generated at a power station by electro mechanical generators, primarily driven by heat engines fueled by chemical combustion or nuclear fission but also by other means such as the kinetic energy of flowing water and wind. Other energy sources include solar photo voltaic and geothermal power and electrochemical batteries.

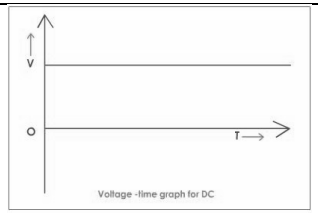
ALTERNATING CURRENT (AC):

Alternating current (AC) is a current whose direction and quantity is changing continuously; it is represented by the sigh (~). The current that is generated from the generator is called A.C current.



DIRECT CURRENT (DC):

Direct current (DC) is defined as the current which does not change its value and direction. The current that continuously flow in one direction is called direct current or D.C. It is represented by the sigh (—). All cells and batteries produce direct current.



Voltage -time graph for DC

ELECTRICAL MATERIALS:

CONDUCTOR:

Conductor is a material that permits the flow of electrical current in one or more directions. For example, a wire is an electrical conductor that can carry electricity along its length. In metals copper or aluminum are vastly used as conductor. Copper is the international standard to which all other electrical conductors are compared.

Silver is more conductive than copper, but due to cost it is not practical in most cases. However, it is used in specialized equipment, such as satellites.

Aluminum wire, which has 61% of the conductivity of copper, has been used in building wiring for its lower cost. By weight, aluminum has higher conductivity than copper, but it has properties that cause problems when used for building wiring. It can form a resistive oxide within connections that makes wiring terminals heat. Aluminum wires used for low voltage distribution, such as buried cables and service drops, require use of compatible connectors and installation methods to prevent heating at joints. Aluminum is also the most common metal used in high-voltage transmission lines, in combination with steel as structural reinforcement. Pure water is not an electrical conductor, even a small portion of impurities, such as salt, can rapidly transform it into a conductor.

INSULATOR:

An electrical insulator is a material whose internal electric charges do not flow freely, and therefore make it very hard to conduct an electric current under the influence of an electric field. A perfect insulator does not exist, but some materials such as glass, paper, porcelain, mica, rubber-like polymers and most plastics can serve as practical and safe insulators for low to moderate voltages.

Insulators are used in electrical equipment to support and separate electrical conductors without allowing current passing through themselves. An insulating material used in bulk to wrap electrical cables or other equipment is called insulation.

SEMICONDUCTOR:

A semiconductor is a material which has electrical conductivity between that of a conductor such as copper and that

of an insulator such as glass. There are two types of semiconductor materials;

1- INTRINSIC SEMICONDUCTOR:

Semiconductor in pure form having four valance electron & properties of insulator, such as Silicon & Germanium are called intrinsic semiconductor.

2- EXTRINSIC SEMICONDUCTOR:

Semiconductor with addition of impurity is called extrinsic semiconductor. Current conduction in a semiconductor occurs through the movement of free electrons and "holes", collectively known as charge carriers. Adding impurity atoms to a semiconducting material, known as "doping", greatly increases the number of charge carriers within it. When a doped semiconductor contains mostly free holes it is called "p-type", and when it contains mostly free electrons it is known as "n-type".

Semiconductors are the foundation for modern electronics, including transistors, solar cells, light-emitting diodes (LEDs), digital and analog integrated circuits.

OHM'S LAW: The law was named after the German physicist Georg Ohm. Ohm's law states that;

The current in a circuit is directly proportional to the electric potential difference applied across its ends.

$$I \alpha V$$

The current in a circuit is inversely proportional to the total resistance offered by the external circuit.

$$I \alpha \frac{1}{R}$$

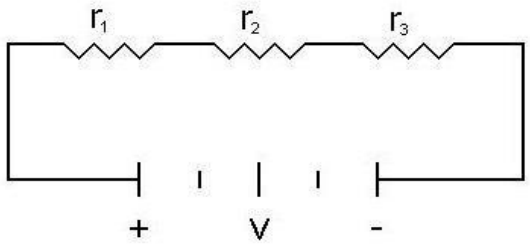
Considering above both factors

$$I \alpha \frac{V}{R}$$

- **Series and Parallel connection of resistances:**

  SERIES CIRCUIT:

  If the resistances are connected in such a way in a circuit that the second end of first resistance is joined with the first end of the second resistance and second end of second resistance is joined with the first end of the third resistance and the last end of third resistance is connected with the negative supply of the battery and the first end of first resistance is connected with the positive supply of the battery, and such a circuit is called series circuit. In other words if dissimilar ends of resistances / loads are joined and a connection, in which only one path is available for the flow of current, is called series connection or series circuit.

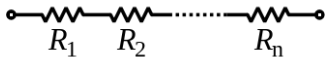


LAWS OF SERIES CIRCUIT: Features of series circuit are as follow;

Current: In a series circuit the current is the same for all elements.

$I = I_1 = I_2 = \ldots = I_n$

Equivalent resistance: The total resistance of resistors in series is equal to the sum of their individual resistances:



$R_{\text{total}} = R_1 + R_2 + \cdots + R_n$

Voltage: The total voltage across of resistors in series is equal to the sum of their individual voltage drops.

Vt = V1 + V2+ -------+ Vn

Conductance: It is a reciprocal quantity to resistance. Total conductance of series circuits of pure resistors, therefore, can be calculated from the following expression:

$$\frac{1}{G_{\text{total}}} = \frac{1}{G_1} + \frac{1}{G_2} + \cdots + \frac{1}{G_n}.$$

For a special case of two resistors in series, the total conductance is equal to:

$$G_{total} = \frac{G_1 G_2}{G_1 + G_2}.$$

FORMULAS

$I = I_1 = I_2 = \ldots = I_n$

$R_{\text{total}} = R_1 + R_2 + \cdots + R_n$

Vt = V1 + V2+ -------+ Vn

$$\frac{1}{G_{\text{total}}} = \frac{1}{G_1} + \frac{1}{G_2} + \cdots + \frac{1}{G_n}$$

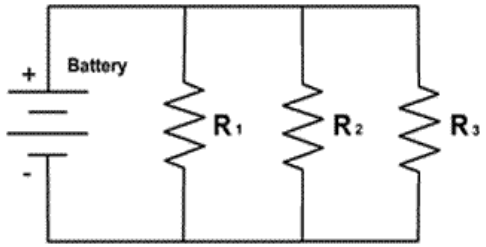
PARALLEL CONNECTION OF RESISTANCES:

PARALLEL CIRCUIT:

If all the resistances are connected in such a way that all the similar ends of the resistances are joined together form the one side, and all the other similar ends of the resistances are also joined together from the other side, and combined one side is connected with positive supply and other combined side is connected with negative supply then such a circuit is called parallel circuit.

In other words a connection in which there is a separate path of current for each resistance or load is called parallel connection of a circuit.

CIRCUIT DRAWING:



LAWS OF PARALLEL CIRCUIT:

Features of parallel circuit are as follow**;**

Voltage: In a parallel circuit the voltage is the same for all elements.

$$V = V_1 = V_2 = \ldots = V_n$$

Current: The current in each individual resistor is found by Ohm's law. Factoring out the voltage gives

$$I_{\text{total}} = V\left(\frac{1}{R_1} + \frac{1}{R_2} + \cdots + \frac{1}{R_n}\right)$$

To find the current in a component with resistance R_i,

$$I_i = \frac{V}{R_i}$$

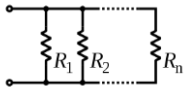
The components divide the current according to their reciprocal resistances, so, in the case of two resistors,

$$\frac{I_1}{I_2} = \frac{R_2}{R_1}$$

$It = I_1 + I_2 + \text{-------} + I_n$

Equivalent Resistance: To find the total resistance of all components, add the reciprocals of the

resistances of each component and take the reciprocal of the sum. Total resistance will always be less than the value of the smallest resistance:



$$\frac{1}{R_{\text{total}}} = \frac{1}{R_1} + \frac{1}{R_2} + \cdots + \frac{1}{R_n}.$$

For only two resistors, the unreciprocated expression is reasonably simple "product over sum".

$$R_{\text{total}} = \frac{R_1 R_2}{R_1 + R_2}.$$

For *N* equal resistors in parallel, the reciprocal sum expression simplifies to:

$$\frac{1}{R_{\text{total}}} = \frac{1}{R} \times N$$

$$R_{\text{total}} = \frac{R}{N}$$

Conductance: Since electrical conductance G is reciprocal to resistance, the expression for total conductance of a parallel circuit of resistors reads:

$$G_{\text{total}} = G_1 + G_2 + \cdots + G_n$$

The relations for total conductance and resistance stand in a complementary relationship: the expression for a series connection of resistances is the same as for parallel connection of conductance's, and vice versa.

FORMULAS:

$V = V_1 = V_2 = \ldots = V_n$

$It = I_1 + I_2 + \text{-------} + I_n$

$$\frac{1}{R_{\text{total}}} = \frac{1}{R_1} + \frac{1}{R_2} + \cdots + \frac{1}{R_n}$$

$$G_{\text{total}} = G_1 + G_2 + \cdots + G_n$$

VOLTAGE DROP:

Voltage drop is the drop of electrical potential or potential difference on the load in an electrical circuit.

DEPENDENCE OF VOLTAGE DROP:

Voltage drop depends upon the resistance of substance in which voltage drop is being calculated and quantity of current flow through it.

FORMULA:

Voltage drop can be calculated using Ohm's law like; E = R I

Where,E = Voltage drop (volts, V), R = Electrical resistance (ohms, Ω), and I = current (amps, A)

POWER AND ENERGY:

ELECTRICAL POWER:

Power is the rate of doing work. Electrical power is denoted with P.

UNITS:

Unit of power is watt which represents 1 Joule per second.

FORMULA:

$P = V \cdot I$ or $P = I^2 \cdot R$ *or* $P = V^2 / R$

P is the electric power in watt (W)

V is the voltage in volts (V)

I is the current in amps (A)

R is the resistance in ohms (Ω)

The electrical power is equal to the energy consumption E divided by the consumption of time t:

$$P = \frac{E}{t}$$

Where, P is the electric power in watt (W)

E is the energy consumption in joule (J)

t is the time in seconds (s)

ELECTRICAL ENERGY:

Capacity of the body to do work is called energy. Energy cannot be created or destroyed; it can be changed from one form to another.

UNIT:

Basic unit of Electrical energy is Joules (Watt Second). Joule is a small unit; electrical energy is measured in Kilowatt hours (KWH) which is called Board of Trade Unit. When 1 KW is used for one hour then it is called 1 KWH. The electricity company charges the cost of electricity from the customer on the basis of kilo watt hour. For this purpose energy meter is installed at the houses and buildings of the customers, which changes its digits according to the load being used with the passage of time, in this why the amount of electricity that is consume can be find out.

FORMULA:

E = Power (Watt) x Time (Hours) in Watt Hour (WH)

= Power (Kilowatt) x Time (Hours) in Kilowatt Hour (KWH)

1 KWH = 1000 x 1 x 3600 S = 36 x 10^5 J

The following formula is used to find cost of energy consumed.

KWH = Day x Hour x Total Watt/1000

Total Cost of Electricity = Kilo Watt hour x Price Per unit

EFFECTS OF ELECTRIC CURRENT:

HEATING EFFECT:

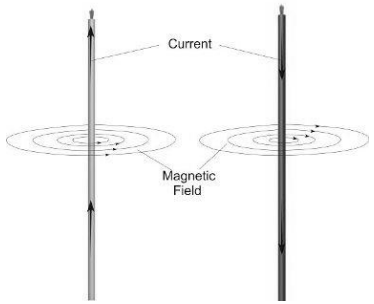
Whenever current passes through a conductor there would be a generation of heat due to resistive loss in the conductor. This is commonly known as heating effect of current. Since, we cannot use electric power directly; we need to convert it into another usable power, like heat, light, or mechanical power etc. When current flows through a conductor some loss occurs and this loss is almost inevitable, and more the resistance of the conductor, more the loss. This loss due to the electrical resistance of conductor is mainly responsible for the **heating effect of current.** As some electric power is converted into heat energy, this phenomenon can be described by Joule's law, which states that,

$$H = i^2 \cdot r \cdot t$$

Where H is the generated heat in calories, i is the current that is flowing through the wire and it is measured in amperes, r is the resistance of the conductor in ohm(Ω) and t is the duration of current flowing in seconds. If we know the time of current flowing, the resistance of wire, and amount of current flow, we can easily find out the generated heat of the circuit. This heat can be utilized in various ways.

MAGNETIC EFFECTS OF ELECTRIC CURRENT:

When a current carrying conductor is placed near a magnetic needle; the needle deflects to a certain direction, when the direction of current in the conductor is reversed, the needle deflects in opposite direction. That means there is a magnetic field **due to** current **carrying conductor**. The magnetic field around the conductor consists of a number of concentric closed lines of force. If we pass a current through a conductor through a card board as shown in the figure and try to plot the field with the help of a magnetic needle on that card board, we shall get the magnetic lines as shown in figure. These are all closed circles and concentric with the conductor. Now if we reverse the current in the conductor and repeat the same experiment as shown in the figure, we shall get the oppositely directed closed circular magnetic lines, concentric with the conductor as shown.



CHEMICAL EFFECT OF CURRENT:

The passage of an electric current through a conducting solution causes chemical reactions. This is known as the chemical effect of electric current. Some of the chemical effects of electric current are the following:

- Formation of bubbles of a gas on the electrodes
- Deposition of metal on electrodes
- Change in colour of solutions

ELECTROLYSIS:

The process of decomposition of a chemical compound in a solution when an electric current passes through it is called electrolysis. The solution that conducts electricity due to the presence of ions is called an electrolyte. Two electrodes are inserted in the solution and are connected to the terminals of a battery with a switch in between. This arrangement is called an electrolytic cell. The electrode that is connected to the positive terminal of the battery is called the anode, and the other connected to the negative terminal is called the cathode. The electrolyte contains ions, which are charged. The positively charged ions are called Cations and the negatively charged ions are called anions. Cations, being positively charged, get attracted to the negatively charged cathode and move towards it. On the other hand, anions, being negatively charged, get attracted towards the positively charged anode and move towards it.

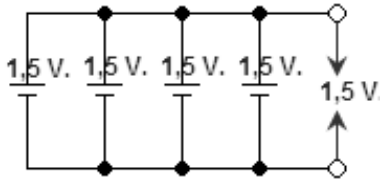
ELECTRIC CELL:

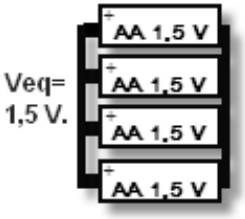
An electrochemical cell is a device capable of either generating electrical energy from chemical reactions or facilitating chemical reactions through the introduction of electrical energy. A common example of an electrochemical cell is a standard 1.5-volt cell meant for consumer use.

STORAGE BATTERY:

A Battery consist many cells. Each cell has an anode, cathode and electrolyte. The electrolyte is the main

material inside the battery. It is often a type of acid, and can be dangerous to touch. The anode reacts with the electrolyte to produce electrons (this is the negative or - end). The cathode reacts with the electrolyte and takes electrons (this is the positive or + end). An electric current happens when a wire connects the anode to the cathode, and the electrons move from one end to the other. (But a battery can be damaged by just a wire connecting the two ends, so a load is also needed between the two ends. The load is something that slows the electrons down, and usually does something useful, like a light bulb in a flashlight, or the electronics in a calculator).





The electrolyte can be liquid or solid. A battery is called a wet cell or dry cell battery, depending on the type of electrolyte.

ELECTRIC CIRCUIT:

An electric circuit is a path in which electrons from a source flow. Electric current flows in a closed path called an electric circuit. The point where those electrons enter an electrical circuit is called the "source" of electrons. The point where the electrons leave an electrical circuit is called the "return" or "earth ground".

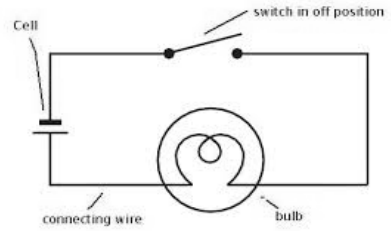
The entire electric instrument e.g. Bulb, Fan, Heater & Radio have two terminals. In any electrical circuit, the current from positive end of the wire, runs to the electric instrument goes back into the battery or generator through the negative end of the wire,, and this is called electric circuit. No electric equipment can work until electric circuit is completed.

CONDITIONS OF CIRCUIT:

There are three states of a circuit.

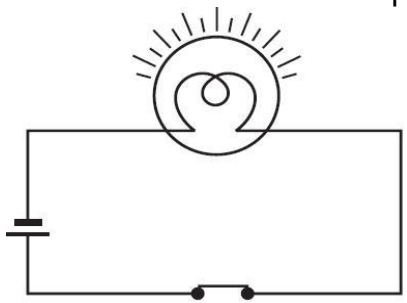
OPEN CIRCUIT:

The open circuit means incomplete circuit, e.g. Broken Path, Such a circuit whose one wire is broken from any two or switch is off. When circuit is open then current cannot flow.



CLOSED CIRCUIT:

Closed circuit means completed circuit, when both the positive and negative wires are joined to the circuit. Switch in the “on” position is called closed circuit. All the electrical equipment works due to closed circuit.



SHORT CIRCUIT:

The short circuit means the smallest path, if positive & negative wires are joined without any load. If current doesn’t flow from its real path, and returned back to the generator or battery due to joining of wires, then such a circuit is called short circuit. Excessive current flows in short circuit. Fuse and circuit breakers are attached to avoid the effects of short circuit as they separate the wire automatically from the supply in case of fault.

LU2. Check Physical status/condition of Machine

- **Purpose of Physical Checking of Machine:**

  Checking for simple things, like signs of wear on machine, can go a long way. The reality is heavy machine is often used with vibration, high temperatures and friction, all of which contribute to the wear and tear of moving

parts. Add age to the mix, and you have a recipe for deterioration. This happens with all machines, and the key to extending machine life is to make sure you do something as simple as adding an operator visual inspection to your machine use requirements. Noticing warped belts, dry or cracked seals and loose bolts, loose fitting, lose / flash / burnt connection may seem small, but these things can be identified through a visual inspection and fixed before they cause a larger problem.

- **Techniques of Physical Checking of Machine:**
  Physical checking technique is a simple method used to detect the nature of fault in which the checker use his senses of;
  Hearing: B**y** hearing the sound of machine you can detect mechanical fault in motor and from humming sound in transformer you can detect the abnormal working due to phase failure.
  Smelling: By using smelling sense you can detectshort circuit and burnt winding of machine.
  Touching: By touching the machine body you can detect the flow of excess current due to short circuit, high load or mechanical fault.
  Seeing: By seeing the body of machine you can detect burnt, loose connection, presence of corrosion or wear & tear.
- **Checking Techniques for loose fitting, loose /Flash/open/Burnt connection:**
  Loose fitting, loose or open connection can be checked by shaking the machine and its connections using hands force.
- **Effects of loose connection:**
  Loose connection causes sparking which ultimately causes of flash, open or burnt terminals / connections.
- **Understanding of Circuit Diagram and check true connection as per circuit diagram:**
  To verify the connection you must know the symbols used in circuit diagram to interpret the circuit diagram and can match the connection of machine with it for identification of wrong connections.

LU3. Check data plate of machine for specifications:

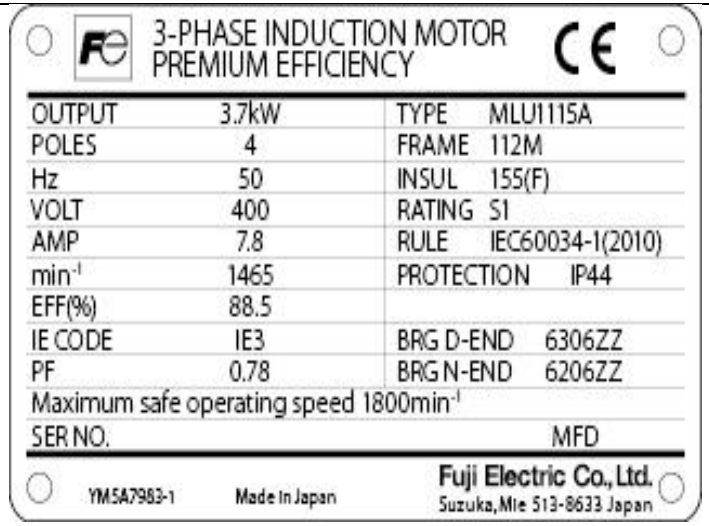
- **Understanding location of Machine Data Plate:**
  Data plates are installed at machines to show brief of their specifications,In motors and transformers these are

located on front side of their body and you must have to locate their position for taking relevant data from it.

- **Understanding of Machine Specification:**

The information given on all nameplates of motors and transformers are called their specifications such as;

- Manufacturer's type and frame designation.
- Output Power
- Maximum ambient temperature for which machine is designed.
- Insulation class
- RPM at rated load (In case of motor)
- Frequency, Voltage, Current & Power factor
- Number of phases.
- Nominal efficiency
- Voltage Vector Group (In case of transformer) etc.



LU4. Conduct Megger test of the Machine:

- **Identification of required Tools and Equipment for conduct of Megger Test:**

Following tools / equipment will be required to perform Megger test of faulty machine.

Safety Kit, Screw Driver set, Spanner set, Megger with leads

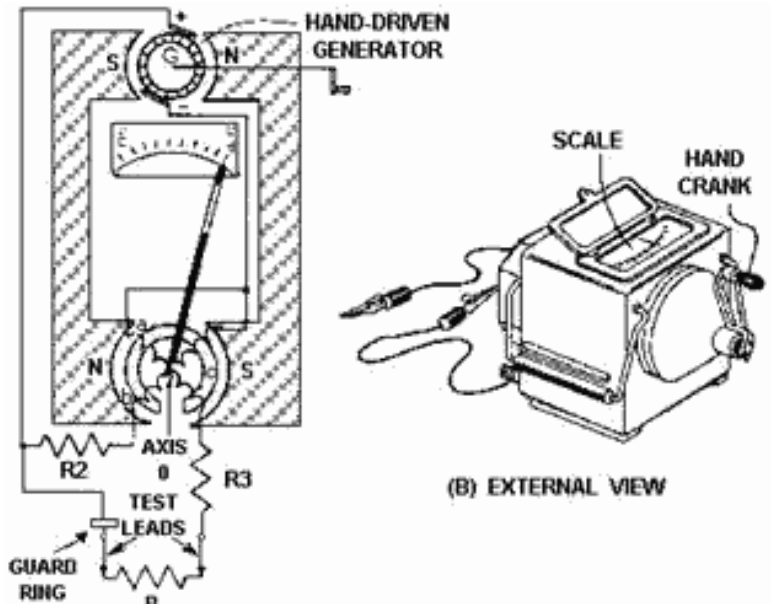
- **Disconnection Sequence of supply Cables:**

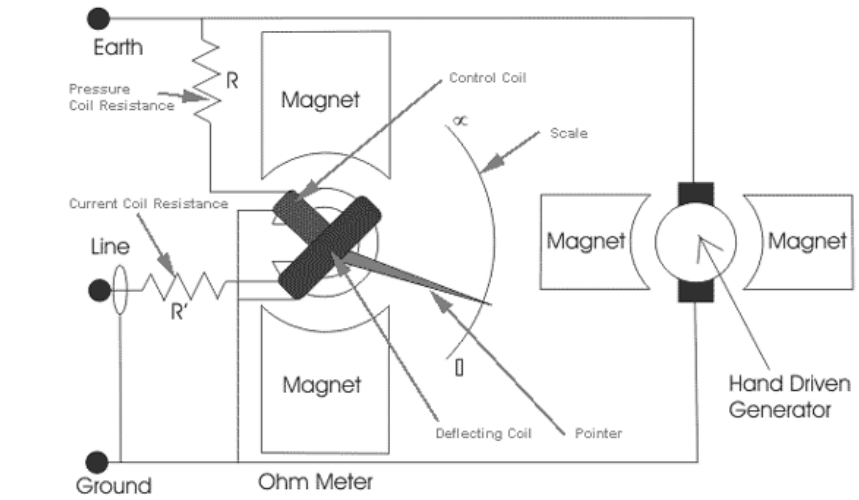
  To perform Megger test of machine, it must be isolated from electric supply in following manner.

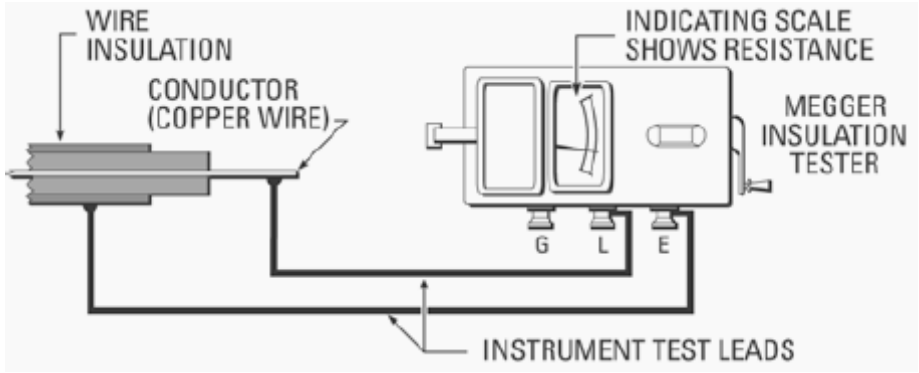
  1- Switch off itsbreaker of input supply source and properly tag it.
  2- Switch off its breaker of output (In case of transformer) and properly tag it.
  3- Disconnect its supply cables from terminals one by one and mark the position / sequence on each cable accordingly for assistance of properly refixing after test.

- **Use of Megger for conduct of Open, Short, Ground, Earth leakage tests:**

  Megger is used to find fault in winding, especially insulation, short circuit & open circuit test can be performed with this instrument. Constructional details are shown in below diagrams.







After disconnecting all supply cable of machine, connect the terminal E & L of Megger with the two ends of one phase winding of machine with connection leads. Rotate the Megger hand crank at 120 RPM to develop 500 volt DC voltage which causes a flow of current through winding as per winding condition.

In case of open circuit no current will flow hence the pointer of meter of Megger will not move and stay at infinity resistance value.

In case of short circuit maximum current will flow hence the pointer of meter of Megger will quickly move to Zero resistance value.

In case of healthy circuit minimum current will flow hence the pointer of meter of Megger will slightly move

and show value of insulation resistance in Mega Ohms.

In case of checking ground fault connect Megger L terminal with phase winding and E terminal with machine body. Rotate the Megger hand crank at 120 RPM to develop 500 volt DC voltage which causes a flow of current through winding and body of machine as per winding condition. Minimum current will flow in case of healthy winding;hence the pointer of meter of Megger will show almost infinity resistance value. Maximum current will flow in case of ground fault; hence the pointer of meter of Megger will show zero resistance value. If you have digital Megger, then there will be no handle to rotate, you have to just switch on its battery supply to provide 500 volt DC voltage required to perform test.

Take readings of insulation resistance with Megger of different phases of machine and record them in table shown.

Phase #	Reading of Megger in MΩ	Write Condition as Open, Short or Ground
1		
2		

3

LU5. Carry out Transformer's oil test:

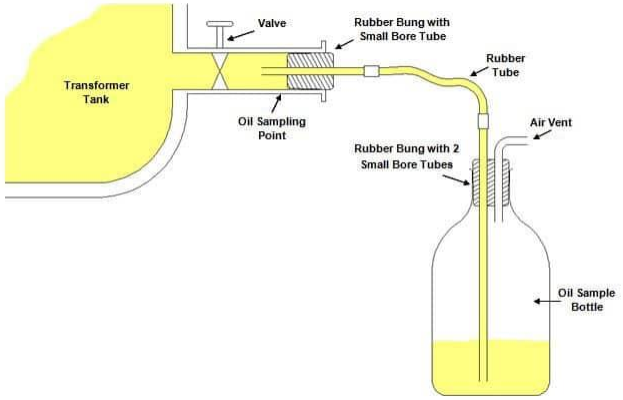
Recognition of the required tools equipment, PPEs and their use to carry out Transformer Oil Test

Following tools / equipment will be required to perform oil test of faulty transformer.

Safety Kit / PPE, Screw Driver set, Spanner set, Oil sampling kit

Method to Take Oil Sample from Transformer:

Takeoil sampling kit**.** It's important to keep any sampling kit clean after use so it is kept in a good condition and can then be re-used for future sampling requirements.



There is a step by step process that should be followed and if done correctly will ensure a good quality and representative sample is taken:

- Check the weather…if it's raining try to avoid taking a sample, aim for a nice dry, warm day. Not always possible to plan the weather so erect a canopy / tent over the unit and sampling point and ensure to keep all kit clean and dry. A small amount of rain can affect your results dramatically.
- Clean the sample tap before any sampling is started; use a wire brush and/or lint free cloth to remove and debris form the external surface.
- Connect the correct size oil resistance rubber bung to the sample tap by pushing or tapping it on and don't forget to attach the stainless-steel tube to the pre-drilled hole.
- Always drain at least 500ml of oil out of the unit and to a waste container before taking your sample, this ensures any debris is flushed out before you take your sample… VERY important.
- The temperature of the flowing oil should be recorded and noted on the sample label, this is required for any accurate moisture determination.
- Rinse out the bottle with the oil to ensure it is clean and warmed so any debris or condensation is removed.
- Attach the bottle bung with inlet tube and air vent tube to the sample bottle. The stainless-steel tube should extend to the bottom of the bottle and ensure a slow flow rate to cause minimum air displacement and oil disturbance.

  The bottles should be allowed to overflow and tubing should be withdrawn slowly and the bottle should be tipped to allow some oil to flow out leaving approximately 2cm head space. The reason for this is to allow space for any thermal expansion or volatile gas's within the sample but not leaving too much which will allow gas to escape from the oil into the headspace.

  The cap should be securely screwed onto the sample vessel.

The sample should be cleaned, clearly labeled and securely and safely packed in a carry case or box to ensure safe transport to the lab.

Understanding of Oil Testing Techniques for High Voltage, Break Down, Moisture and Flash Point Tests:

Transformer oil testing is important to:

Determine essential electrical properties of transformer oil

Identify if a certain oil is suitable for future use

Detect whether regeneration or filtration is needed

Reduce oil costs and enhance component life

Prevent untimely failures and maximize safety

Keep in mind, and transformer oils can last for up to 30 years. So taking the proper testing procedures now will save you thousands of dollars in the long run.

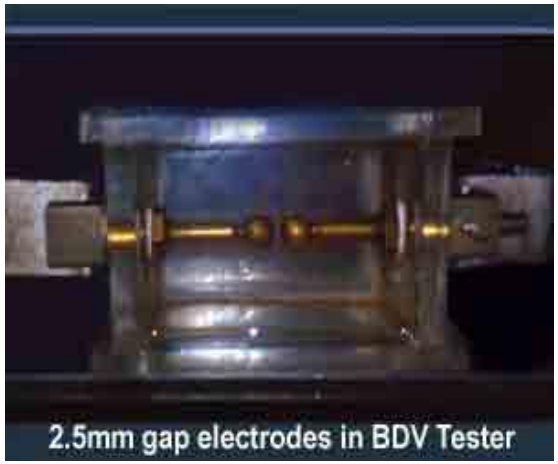
Dielectric Strength of Transformer Oil

For mineral oil, a generally accepted minimum dielectric strength is 30 kV for transformers with a high-voltage rating of 230 kV and above and 27 kV for transformers with a high-voltage rating below 230 kV. New oil should have a minimum dielectric strength of 35 kV by ASTM methods of testing.

https://www.electrical4u.com/images/BDV-Tester.jpg

The **dielectric strength of transformer oil** is also known as the breakdown voltage (BDV) of transformer oil. Breakdown voltage is measured by observing at what voltage, sparking strands between two electrodes immersed in the oil, separated by a specific gap. A low value of BDV indicates presence of moisture content

and conducting substances in the oil.



https://www.electrical4u.com/images/electrodes-in-bdv-tester.jpg

For measuring BDV of transformer oil**,** portable BDV measuring kit is generally available at site. In this kit, oil is kept in a pot in which one pair of electrodes are fixed with a gap of 2.5 mm (in some kit it 4mm) between them. Now slowly rising voltage is applied between the electrodes. The rate of rising voltage is controlled at 2 KV/s and observes the voltage at which sparking starts between the electrodes. That means at which voltage dielectric strength of transformer oil between the electrodes has been broken down.

This measurement is taken 3 to 6 times in the same sample of oil, and we take the average value of these readings. BDV is an important and popular test of transformer oil, as it is the primary indicator of the health of oil and it can be easily carried out at the site.

Dry and clean oil gives BDV results, better than the oil with moisture content and other conducting impurities. Minimum breakdown voltage of transformer oil **or** dielectric strength of transformer oil at which this oil can safely be used in transformer, is considered as 30 KV.

Flash Point of Transformer Oil

Flash point of transformer oil is the temperature at which oil gives enough vapors to produce a flammable mixture with air. This mixture gives momentary flash on the application of flame under standard condition. Flashpoint is important because it specifies the chances of fire hazard in the transformer. So it is desirable to have a very high flash point of transformer oil**.** In general it is more than 140^{o}($>10^{o}$).

LU6.Perform Transformer Turn Ratio Test:

Recognition of the required tools, equipment and PPEs for Turn Ratio Test of Transformer

Arrange the required tools, equipment & PPE to perform TTR test of transformer

Method of conducting TTR Test

Turns Ratio Test Procedure, Step by Step:

Step 1.

Isolate the equipment, apply working grounds to all incoming and outgoing cables and disconnect all incoming and outgoing cables from the transformer bushing terminals connections.

Disconnected cables should have sufficient clearance from the switchgear terminals greater that the phase spacing distance. Use nylon rope to hold cable away from incoming and outgoing terminals as required.

Step 2.

Connect the H designated three-phase test lead with the military style connector at one end to the mating connection on the test set marked with an H. Ensure that the connector's index notch lines up properly.

Step 3.

Connect the X designated three-phase test of lead military style connector at one end to the mating connection on the test set marked with an X. Ensure that the connector's index notch lines up properly.

Step 4.

Connect the H1, H2, H3; designed test leads to the corresponding H1, H2, H3; transformer terminal / bushing. Connect H0 test lead to H0 terminal / bushing.

Step 5.

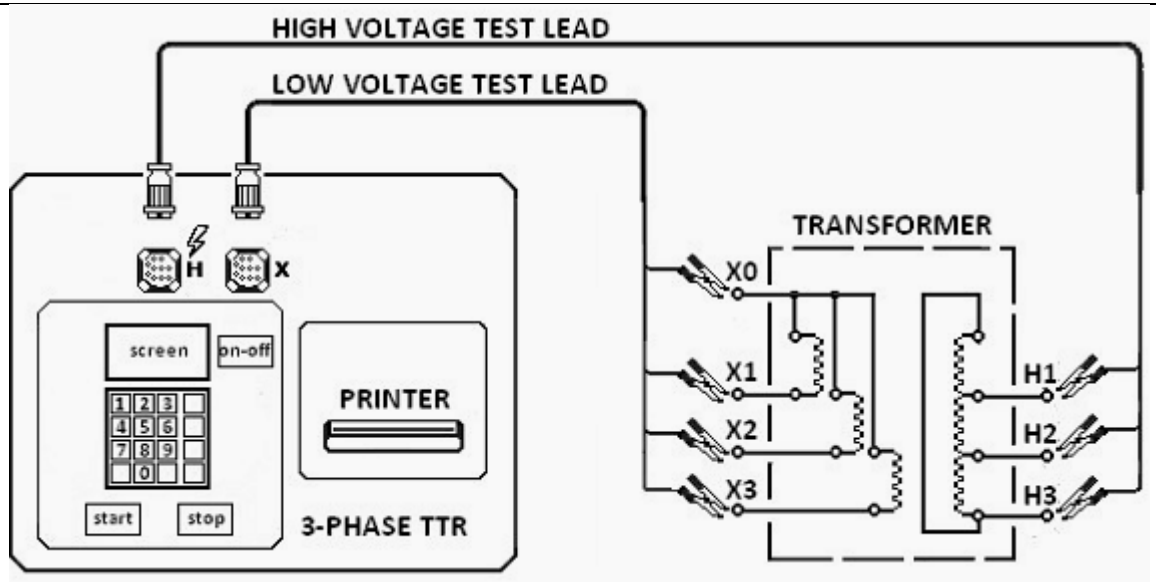
Connect the X1, X2, X3; designed test leads to the corresponding X1, X2, X3; transformer terminal / bushing. Connect X0 test lead to X0 terminal / bushing.

Step 6.

Perform turn ratio measurements for all tap positions.

Step 7.

Confirm that the measured ratios are within 0.5% of the calculated ratios.



Three-phase Transformer Turns Ratio (TTR) Connection diagram.

Importance of Comparing TTR Test results with the nominal/Specified voltage and Turn Ratio:

Power transformer turns ratio test is an AC low voltage test which determines the ratio of the high voltage winding to all other windings at no-load. The turn's ratio test is performed on all taps of every winding.

The Transformer Turns Ratio tester (TTR) is device used to measure the turn's ratio between the windings.

Voltage is applied on the H marked leads and measured of the X marked lead by the test set.
Ratio measurements are conducted on all tap positions and calculated by dividing the induced voltage reading into the applied voltage value. When ratio tests are being made on three-phase transformers, the ratio is taken on one phase at a time with a three-phase TTR until the ratio measurements of all three phases are completed.

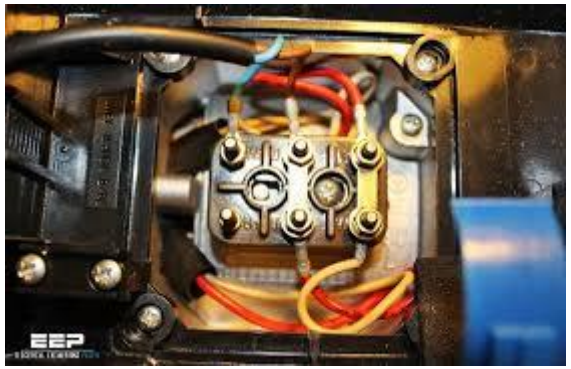
LU7. Check Terminals/Terminal plate of Machine

Understand effects of rusting /Carbonizing, Inter Terminal space, condition of linking strips and nut bolts:

Rust / carbon and corrosion don't conduct well, But it won't make much difference if it is just on the surface of the wire and the connections are sound. The electricity mostly flows in the center for most common wiring except at very high frequencies.Most electricity conducting wires are made of metals(copper or aluminum) and terminals are also made of these materials to facilitate electric connection. Rusting / carbonizing badly affects the connection resistance and mechanical strength, of inter terminal space, condition of linking strips and nut bolts. Smooth flow of current is not possible in terminals having rusting / carbonizing. So it is necessary for sound connection that all terminals of motor and transformer should be free from rust and carbon.

Checking Techniques of rusting /Carbonizing, Inter Terminal space, condition of linking strips and nut bolts:

Physical checking is the ideal technique of checking presence of rust and carbon on terminals of motor and transformer.



ELECTRICAL MACHINE WINDING TECHNICIAN

Module-B
LEARNER GUIDE
National Vocational Certificate Level 2

Version 1 - September, 2018

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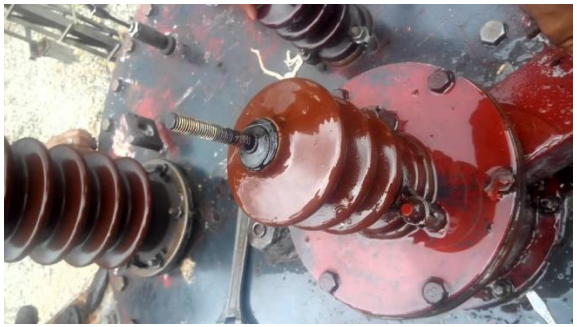


Module B: 0713001128 Ensure Electrical Isolation of Machine

Objective: This Module covers the knowledge & skills required to Ensure Electrical isolation of Machine through 'Prepare for work' , Ensure Use of PPE's , Isolate Machine from Electrical Supply , Perform Tagging of Machine ,Document the Electrical Isolation of Machine, Communicate with machine operator and other personnel, De-energise machine .

Duration: 110 Hours **Theory: 22 Hours** **Practice: 88 Hours**

Learning Unit	Learning Outcomes	Learning Elements	Materials Required
U1. Prepare for Work to ensure Electrical Isolation of Machine	**The trainee will be able to:** • Identify the required PPE's • Collect the required PPE's • Identify the required tools and equipment • Collect the required tools and equipment • Ensure functional condition of PPE's/Tools and equipment • Prepare the required tags for isolation	• Recognition of required Tools, Equipment and PPEs • Importance of functional conditions of required Tools, Equipment and PPEs and their use • Importance of Tagged display for isolation	**Tools** • Spanner Set Screw Driver Set • Allen key Set • Clamp Meter • Safety Belt • Ladder **Consumables Items** • Hand Gloves • Safety Shoes • Safety Goggles
LU2. Wear PPE's	**The trainee will be able to:** • Wear PPE's as per job requirement • Clean the PPE's after use • Perform proper storing of the PPE's after use.	• Selection of required PPE's for electrical isolation of machine • Demonstration of wearing proper PPEs	**Tools** • Spanner Set Screw Driver Set • Allen key Set • Clamp Meter • Safety Belt • Ladder **Consumables Items** • Hand Gloves • Safety Shoes • Safety Goggles
LU3. Isolate Machine from Electrical Supply	**The trainee will be able to:** • Identify the machine for isolation • Collect the required tools for isolation	• Importance of Electrical isolation of Machine • Recognition of supply sources/Points • Types and importance of	**Tools** **Consumables Items** Different types of • Main Switches

	• Identify the supply Sources/points to be isolated • Identify the supply disconnecting devices • Take on board the concerned department for electrical isolation • Switch off the supply sources • Perform electrical isolation of machine.	supply disconnecting devices and their working Principle	• Circuit Breakers • Isolators • Starters
LU4. Perform Tagging of Machine	**The trainee will be able to:** • Collect required tagging • Perform tagging of faulty Machine	• Importance of Tagging • Tagging Types and Techniques	**Tools** **Consumables Items** Different types of • Tags
LU5. Document the Electrical Isolation of Machine	**The trainee will be able to:** • Enlist the tagged Machines • Document nature of the faults • Record the electrical isolation of machine	• Importance of Documentation regarding Electrical isolation of Machine	**Tools** **Consumables Items** • Led Pencils • Rubber • Sharpener • Writing sheets/Cards • Permanent Marker
LU6. Communicate with machine operator and other personnel	**The trainee will be able to:** • Identify nature of fault of machine • Diagnose the causes of	• Types of Faults and their causes of Electrical Machines • Importance of communicating nature of Faults and medium	**Tools** **Consumables Items** • Pen

	fault • Communicate nature of fault of machine to operation department • Prepare memo/(MWR) Maintenance Work Request for maintenance of machines	of Communication • Method of preparation (MWR) Maintenance Work Request	• MWR Book/Sheet/Performa
LU7. De-Energize Machine	**The trainee will be able to:** • Identify the required tools and equipment for De-energize the machine • Collect the required tools and equipment for De-energize the machine • Identify the part of the machine to be De-energize • Perform de-energizing of machine	• Importance of de-energizing of machine • Method of de-energizing of machine	**Tools** • AVO meter • Clamp on meter • Screw driver set • Combination plier • Spanner set • Ellen key set • Portable search light **Consumables Items**

LU1. Prepare for Work to ensure Electrical Isolation of Machine

Recognition of required Tools, Equipment and PPEs

Importance of functional conditions of required Tools, Equipment and PPEs and their use

Importance of Tagged display for isolation

LU2. Wear PPE's

Demonstrate to wear PPEs

LU3. Isolate Machine from Electrical Supply

Importance of Electrical isolation of Machine

Safe isolation has long been a procedure carried out by a competent person in order to safely isolate electrical circuits or equipment before electrical work is undertaken. Many accidents are consequent due to a lack of safe isolation procedures in place, or by safe isolation procedures being carried out incorrectly on low voltage electrical installations. For this reason, it is imperative to have a safe isolation procedure documented and set in place. When electrical isolators are switched to the off position, holes line up through which a caliper can be inserted and locked with a personal padlock. This ensures that unless the padlock is removed the equipment cannot be switched back on and re-energized. Other forms of energy can be locked off by applying valve and tap isolators.

Recognition of supply sources/Points

To isolate the electric supply it is necessary to locate & recognize the all points of supply sources which are required to be switched off for complete isolation.

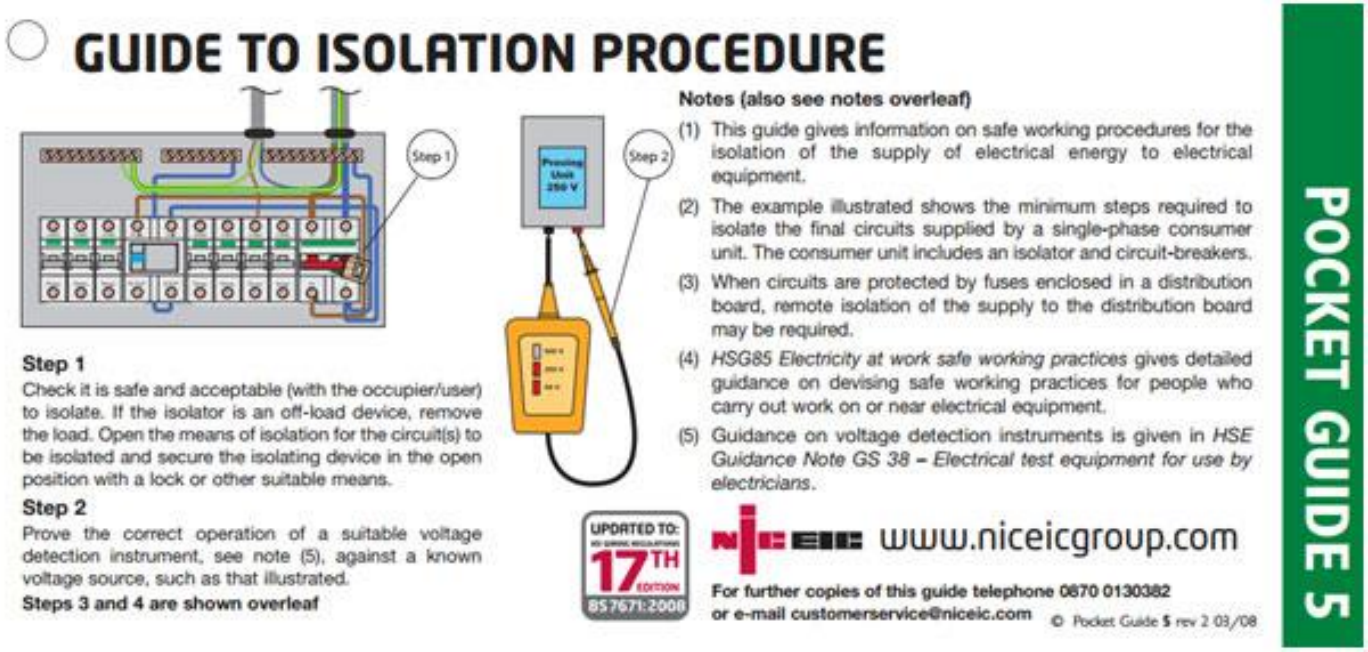
Types and importance of supply disconnecting devices and their working Principle

The main purpose of supply disconnecting devices is safety because if a fault occurs in one section of a circuit or power supply then electrical isolation is must which can be achieved by isolator, switch or circuit breaker to keep apart that section from other sections of system to perform repair work. In asimilar scenario, isolators also ensure safety of workers in regular maintenance and service of the power system. Isolators separate a certain circuit from the electricity mains and discharge any residual current, left in the circuit, to the ground.Working of an isolator is very simple and it can be operated in various ways such as fully-automatic, semi-automatic or manually operated. Isolators are sometimes used as switches that can be opened or closed based on the requirement.

Types of Isolators

There are various kinds of isolators available in the market. Choice of electrical isolators depends upon the requirement and application and based on the placement in the system. Isolators based on Application can be classified into four types

1. **Single Break Isolator**
2. **Double Break Isolator**
3. **Pantograph Isolator**
4. **MCB Isolator**



GUIDE TO ISOLATION PROCEDURE

Step 1

Step 2

Step 1

Check it is safe and acceptable (with the occupier/user) to isolate. If the isolator is an off-load device, remove the load. Open the means of isolation for the circuit(s) to be isolated and secure the isolating device in the open position with a lock or other suitable means.

Step 2

Prove the correct operation of a suitable voltage detection instrument, see note (5), against a known voltage source, such as that illustrated.

Steps 3 and 4 are shown overleaf

Notes (also see notes overleaf)

(1) This guide gives information on safe working procedures for the isolation of the supply of electrical energy to electrical equipment.

(2) The example illustrated shows the minimum steps required to isolate the final circuits supplied by a single-phase consumer unit. The consumer unit includes an isolator and circuit-breakers.

(3) When circuits are protected by fuses enclosed in a distribution board, remote isolation of the supply to the distribution board may be required.

(4) *HSG85 Electricity at work safe working practices* gives detailed guidance on devising safe working practices for people who carry out work on or near electrical equipment.

(5) Guidance on voltage detection instruments is given in *HSE Guidance Note GS 38 – Electrical test equipment for use by electricians*.

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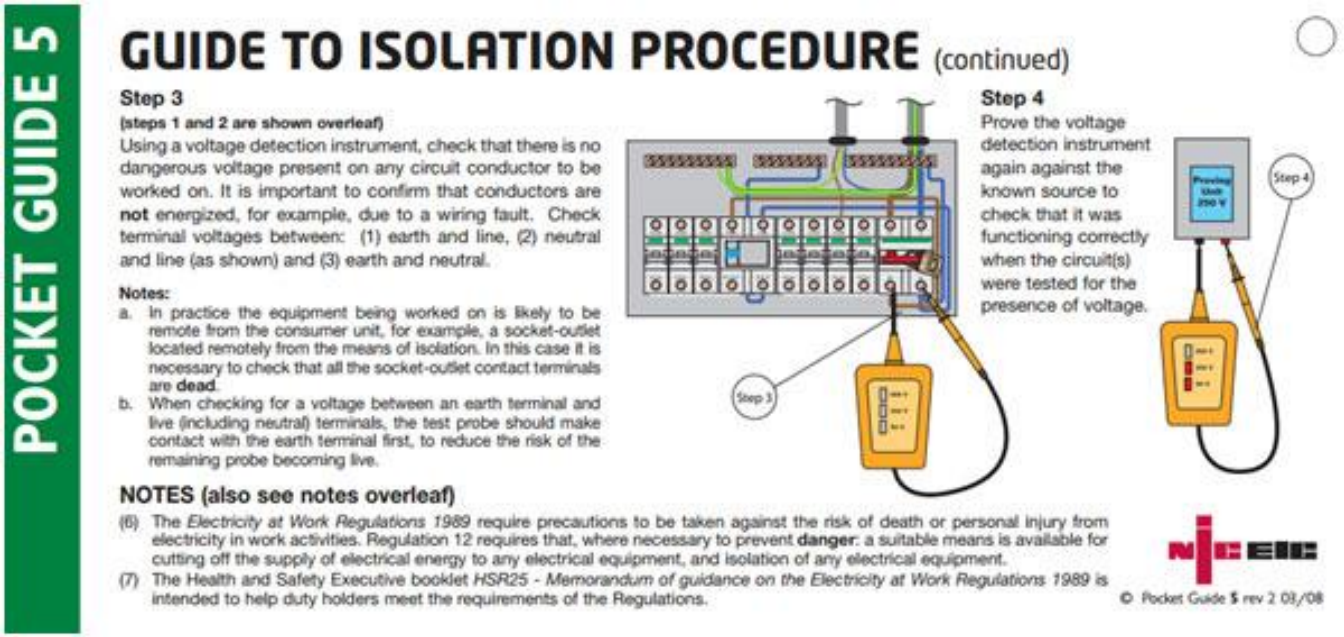
POCKET GUIDE 5



POCKET GUIDE 5

GUIDE TO ISOLATION PROCEDURE (continued)

Step 3

(steps 1 and 2 are shown overleaf)

Using a voltage detection instrument, check that there is no dangerous voltage present on any circuit conductor to be worked on. It is important to confirm that conductors are **not** energized, for example, due to a wiring fault. Check terminal voltages between: (1) earth and line, (2) neutral and line (as shown) and (3) earth and neutral.

Notes:

a. In practice the equipment being worked on is likely to be remote from the consumer unit, for example, a socket-outlet located remotely from the means of isolation. In this case it is necessary to check that all the socket-outlet contact terminals are **dead**.

b. When checking for a voltage between an earth terminal and live (including neutral) terminals, the test probe should make contact with the earth terminal first, to reduce the risk of the remaining probe becoming live.

Step 4

Prove the voltage detection instrument again against the known source to check that it was functioning correctly when the circuit(s) were tested for the presence of voltage.

NOTES (also see notes overleaf)

(6) The *Electricity at Work Regulations 1989* require precautions to be taken against the risk of death or personal injury from electricity in work activities. Regulation 12 requires that, where necessary to prevent **danger**: a suitable means is available for cutting off the supply of electrical energy to any electrical equipment, and isolation of any electrical equipment.

(7) The Health and Safety Executive booklet *HSR25 - Memorandum of guidance on the Electricity at Work Regulations 1989* is intended to help duty holders meet the requirements of the Regulations.

LU4. Perform Tagging of Machine

Importance of Tagging

Tagging isa labeling process that is always used when lockout is required. The process of tagging out a system involves attaching or using an information tag or indicator (usually a standardized label) that includes the following information:

- Why the lockout/tag out is required (repair, maintenance, etc.).
- Time of application of the lock/tag.
- The name of the authorized person who attached the tag and lock to the system.

Tagging Types and Techniques

Steps of a lockout/tag out program include:

Prepare for shutdown

The authorized person will identify which sources of energy are present and must be controlled; and more importantly, identify what method of control will be used.

Notify all affected employees

The authorized person will communicate the following information to notify affected persons:

- What is going to be locked/tagged out

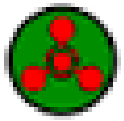
- Why it is going to be locked/tagged out.
- For approximately how long will the system be unavailable
- Who is responsible for the lockout/tag out
- Who to contact for more information.

Equipment Shutdown:

If the system is operating it should be shutdown in its normal manner. Use manufacturer instructions or in-house work instructions. Equipment shutdown involves ensuring controls are in the off position, and verifying that all moving parts such as flywheels, gears, and spindles have come to a complete stop.

Isolation of system from hazardous energy:

The exact written instructions will be specific to that system in the workplace. Tick the types of isolation you have performed on site at the tag and it should be tagged at site.

ENERGY SOURCE		ENERGY SOURCE	
	ELECTRICAL 480 VAC		PNEUMATIC
	WATER		NATURAL GAS
	CHEMICAL Or COOLANT		HYDRAULIC
	STEAM		MECHANICAL

LU5. Document the Electrical Isolation of Machine

Importance of Documentation regarding Electrical isolation of Machine:

When electrical isolation of machine is carried out for repair, it should be documented and a tag of isolation must be attached with machine / at site.

LU6. Communicate with machine operator and other personnel

Types of Faults and their causes of Electrical Machines

Electrical fault is an abnormal condition, caused by equipment failures such as transformers and rotating machines, human errors and environmental conditions. Theses faults cause interruption to electric flows, equipment damages and even cause death of humans, birds and animals.

Types of Faults

Electrical fault is the deviation of voltages and currents from nominal values or states. Under normal operating conditions, power system equipment or lines carry normal voltages and currents which results in a safer operation of the system. But when fault occurs, it causes excessively high currents to flow which causes the damage to equipment's and devices. Various electrical equipment's like; generators, motors, transformers, reactors, switching devices; etc. causes short circuit faults due to malfunctioning, ageing, insulation failure of cables and winding. These failures result in high current to flow through the devices or equipment which further damages it.

Electrical faults are also caused due to human errors such as selecting improper rating of equipment or devices, forgetting metallic or electrical conducting parts after servicing or maintenance, switching the circuit while it is under servicing, etc.

The main faults in the aforementioned electric machines can be classified as:
(i)- Winding faults resulting in the open or short circuits on one or more windings;
(ii)- Broken rotor bar or end-ring faults on induction motors;
(iii)-Static or/and dynamic air-gap irregularities (rotor eccentricity in motors);
(iv)-Bearing and gearbox failures in motors;
(v)-Short circuit in the rotor field windings in motors;
(vi)-Defects of the permanent magnets of PM motors.
(vii)-Insulation failure

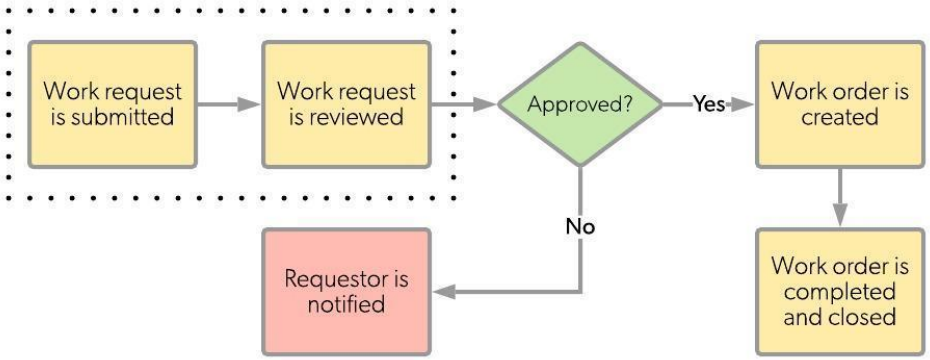
Each fault disturbs the motor's normal operation producing several symptoms, like unbalanced line currents and air-gap voltages, torque and speed pulsations, decreased efficiency and average torque, excessive heating, and increased losses.

Importance of communicating nature of Faults and medium of Communication

When nature of fault is discussed with workers, colleagues and supervisor, it is easier to understand / pinpoint the cause of fault, which enable us to minimize the occurrence of same nature faults. Different mediums of communication can be utilized, such as conversation (oral or written), discussion, fault written reporting, through email, browsing using net facility. Use simple language for better understanding.

Method of preparation (MWR) Maintenance Work Request:

A work request is a formal document (digital or paper) that describes maintenance work that needs completed. A work request is the identification of work needed, issued by the customer to the maintenance department.



The maintenance department is home to workers that are skilled in the upkeep of facilities, grounds, equipment, vehicles, and other assets. They are the caretakers of property and, as a result, support a variety of customer needs. These needs can quickly add onto regular, scheduled work such as routine cleaning and preventive maintenance. In order to manage and validate all tasks, maintenance must operate with a clear workflow.

5 key elements to a work request:

1. Requesting party: an individual person or department
2. Issue: these can include leaky faucets, carpentry work, snow removal, landscaping, interior lighting renewal, tooling changeover, and vehicle repair
3. Priority: low, medium, or high; due dates should be stated if known
4. Location: specific area in facility and specific plant if there are multiple
5. Budget: important for work planning and negotiations, accounting and finance records, and management approval

The more detailed a work request, the better. Detailed work requests help maintenance supervisors and managers turn a work request into a work order faster.

Types of work requests

Work requests can be classified in several ways depending on the type of industry, size of business, and size of maintenance team. Some different types of maintenance requests are listed below.

By type of requestor

- Tenant request: HVAC stops working, running toilet, drywall repair
- Operator request: machine stops working, high scrap rates, fluid leaks
- Employee request: furniture relocation, change of office lights, carpet repair

By type of establishment

- School request: restrooms, classrooms, laboratories maintenance

- Park request: turf, landscaping, sign repair
- Industrial request: blast furnaces, boilers, food conveyor maintenance

By type of priority

- Discretionary (important but not mandatory): office painting, moving of furniture, cubicle upgrading
- Non-discretionary (mandatory)
- Emergency (associated with protecting lives or preventing loss of expensive assets): chemical spills, power failures, ice removal from walkways
- Urgent (associated with timeliness of work needed): restoration of hot water in a lavatory, air-conditioning repair, running urinals
- Routine: preventive maintenance activities, routine cleaning, lawn mowing
- Non-routine: in addition to emergency and urgent work, this also includes planned special projects

LU7. De-Energize Machine

Importance of de-energizing of machine

De-energizing is a process that is used to disconnect and isolate a system from a source of energy in order to prevent the release of that energy. By de-energizing the system, you are eliminating the chance that the system could inadvertently, accidentally or unintentionally cause harm to a person through movement, or the release of heat, light, or sound.

Method of de-energizing of machine

Equipment should be de-energized for inspections, tests, repairs, and other servicing. Such maintenance tasks can be performed when the equipment is energized provided provisions are made to allow maintenance to be performed safely. As a general rule, no electrical apparatus should be worked on while it is energized. Work on or near energized conductors or equipment rated over 50 volts should be performed only when it is not feasible to de-energize, or when it would create a greater hazard to perform the work in a de-energized condition. When it is necessary to work in the vicinity of energized equipment, all safety precautions should be followed, such as roping off the dangerous area, using rubber blankets for isolation, and using rubber gloves and properly insulated tools and equipment. All insulating tools such as rubber gloves and blankets should be tested periodically.

Prior to performing maintenance on or near live electrical equipment, Standard for Electrical Safety Requirements for Employee Workplaces, should be used to identify the degree of personal protective equipment (PPE) required.

These concepts are applicable to conducting measurements for power-quality concerns, as well as for installing monitors for longer-term monitoring. Again, working on de-energized circuits is the preferred method,

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but that is not always feasible in the work place. But this doesn't mean that safety should be compromised. There have been occasions when electricians connect the power-quality monitor without reading the user's guide to determine the proper connection method, do not wear proper personal protective equipment, and leave the panel off with the energized wires hanging out. Not only are they jeopardizing their safety and the safety of anyone else in the area, they are jeopardizing the operation of the facility as well. An accident is not something that just happens to someone else. They often happen to those who didn't take the necessary precautions to make them preventable incidents.

Module C: 0713001127 Carry out Mechanical De- Installation of Machine

Objective: This Module covers the knowledge& skills required to Carry out Mechanical De- Installation of Machine through Prepare for work, Isolate Machine from Pneumatic Supply, Isolate Machine from Fuel Supply, Isolate Machine from Gear Box, Isolate Machine from Pulley ,Perform De-Coupling of Machine , De- Install Machine from Foundation

Duration: 110 Hours **Theory: 22Hours** **Practice: 88 Hours**

Learning Unit	Learning Outcomes	Learning Elements	Materials Required
LU1. Prepare for work to Carry out Mechanical De-Installation of Machine	**The trainee will be able to:** • Identify the required PPE's • Collect the required PPE's • Identify the required tools and equipment • Collect the required tools and equipment • Ensure functional condition of PPE's/Tools and equipment	• Prepare list & Recognition of required Tools, Equipment and PPEs for mechanical De-Installation of Machine • Importance of functional conditions of required Tools, Equipment and	**Tools** • Spanner Set • Screw Driver Set • Allen key Set • Clamp Meter • Safety Belt • Ladder • Screw

	• Ensure safe working conditions ➢ Clear Passage ➢ Cleanliness ➢ Adequate light ➢ Ventilation	PPEs and their use • Importance of safe working condition regarding ➢ Clear passage ➢ Cleanliness ➢ Adequate light ➢ Ventilation	wrench **Consumables Items** • Hand Gloves • Safety Shoes • Safety Goggles
LU2. Isolate Machine from Pneumatic /hydraulic Supply	**The trainee will be able to:** • Wear the required PPE's • Identify the required tools and equipment • Locate the main valve of Pneumatic/hydraulic supply to the machine • Shut off main valve of Pneumatic/hydraulic supply to the machine • Identify parts to be isolated from pneumatic/hydraulic supply • Perform isolation of all the pneumatic/hydraulic supplies to the machine • Perform dead plugging of all the pneumatic/hydraulic supplies • Maintain Record of pneumatic/hydraulic supplies isolation	• Demonstrate to wear PPEs • Importance of isolation from Pneumatic/Hydraulic supplies • Techniques/sequence of isolation of Pneumatic/Hydraulic supplies	**Tools** • Screw driver set • Combination plier • Spanner set • Ellen key set • Portable search light • Adjustable Screw Wrench • Pipe Wrench • Hammer • Hack Saw • Cable Knife **Consumable Material** • Dead Plugs • Teflon tape

	• Perform Tagging of the isolated pneumatic/hydraulic supplies		• Safety Gloves
LU3. Isolate Machine from Fuel Supply	**The trainee will be able to:** • Wear the required PPE's • Identify the required tools and equipment • Locate the main valve of fuel supply to the machine • Close the main valve of fuel supply to the machine • Identify parts to be isolated from fuel supplies • Perform isolation of all the fuel supplies to the machine • Perform dead plugging of all the fuel supplies • Maintain Record of fuel supplies isolation • Perform Tagging of the isolated fuel supplies	• Demonstrate to wear PPEs • Importance of isolation from fuel supply • Techniques/sequence of isolation of fuel supply	**Tools** • Screw driver set • Combination plier • Spanner set • Ellen key set • Portable search light • Adjustable Screw Wrench • Pipe Wrench • Hammer • Hack Saw • Cable Knife • Fire Extinguisher **Consumable Material** • Dead Plugs • Teflon tape • Safety Gloves • Tags

LU4. Isolate Machine from Gear Box	**The trainee will be able to:** • Wear the required PPE's • Identify the required tools and equipment • Locate the gear box of the machine • Perform marking on driver, driven and foundation for proper alignment and placement of parts • Perform isolation of Gear Box • Record isolation of Gear Box • Perform Tagging on Gear Box and driven end	• Demonstrate to wear PPEs • Importance of isolation from gear box • Techniques/sequence of isolation of Machine from gear box • Importance of Marking on Driver, Driven and Foundation for proper alignment and placement of parts	**Tools** • Screw driver set • Combination plier • Spanner set • Ellen key set • Portable search light • Adjustable Screw Wrench • Pipe Wrench • Hammer • Hack Saw **Consumable Material** • Safety Gloves • Tags
LU5. Isolate Machine from Pulley	**The trainee will be able to:** • Wear the required PPE's • Identify the required tools and equipment • Locate the pulley of the machine • Perform isolation of pulley • Record isolation of pulley • Perform Tagging on pulley and its allied parts	• Demonstrate to wear PPEs • Importance of isolation from Pulley • Techniques/sequence of isolation of Machine from Pulley	**Tools** • Screw driver set • Combination plier • Spanner set • Elenkey set • Portable search light

			• Adjustable Screw Wrench • Pipe Wrench • Hammer • Hack Saw **Consumable Material** • Safety Gloves • Tags
LU6. Perform De-Coupling of Machine	**The trainee will be able to:** • Wear the required PPE's • Identify the required tools and equipment • Locate the parts of the machine to be De-coupled • Perform marking on parts to be De-coupled for realignment/readjustment • Perform De-coupling of the machine • Record De-coupling of the machine • Perform Tagging on De-coupled parts of the machine	• Demonstrate to wear PPEs • Understanding the parts of Machine to be De-Coupled • Importance of De-Coupling of Machine • Advantages of Position Marking of Coupling Parts for Re-Alignment • Techniques/sequence of De-Coupling of Machine • Importance of Tagging	**Tools** • Screw driver set • Combination plier • Spanner set • Allen key set • Portable search light • Adjustable Screw Wrench • Pipe Wrench • Hammer • Hack Saw **Consumable Material**

			• Safety Gloves • Tags
LU7. De- Install Machine from Foundation	**The trainee will be able to:** • Wear the required PPE's • Identify the required tools and equipment • Identify machine to be de-installed from foundation • Perform de-installation of machine from foundation • Record de-installation of machine • Perform tagging on the de-installed machine	• Demonstrate to wear PPEs • Identification of Machine to be De-Installed from foundation • Techniques/sequence of De-Installation of Machine from foundation • Importance of Tagging	**Tools** • Screw driver set • Combination plier • Spanner set • Allen key set • Portable search light • Adjustable Screw Wrench • Pipe Wrench • Hammer • Hack Saw • Cold Chisel **Consumable Material** • Safety Gloves • Tags

LU1. **Prepare for work to Carry out Mechanical De-Installation of Machine:**

- Prepare list & Recognition of required Tools, Equipment and PPEs for mechanical De-Installation of Machine
- Importance of functional conditions of required Tools, Equipment and PPEs and their use
- Importance of safe working condition regarding; Clear passage, Cleanliness, Adequate light, Ventilation

LU2. **Isolate Machine from Pneumatic /hydraulic Supply:**

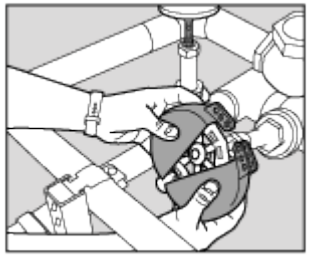
Demonstrate to wear PPEs

Importance of isolation from Pneumatic/Hydraulic supplies:

Stored energy whether it may be electrical, pneumatic, hydraulic or gravitational can cause equipment to move or pipes to burst. A system for controlling that energy is an essential measure to reduce risk when maintenance is being undertaken. Ensuring that you are aware of where to isolate and having a process for them to prove that the isolation is effective will remove the risk of contact with moving machinery, pressurized air and oil injuries.

Techniques/sequence of isolation of Pneumatic/Hydraulic supplies:

- Hydraulic and Pneumatic potential energy - Set the valves in the closed position and lock them into place. Bleed off the energy by opening the pressure relief valves, then closing the airlines.



Hydraulic and Pneumatic lockout

The person responsible for implementing this procedure must ensure that:

- There are accessible written procedures for isolation and lock off, and the procedures must identify the lock off points for all items/sections of plant;
- Isolators are clearly labeled, indicating the sections of plant that they isolate;
- Identification signs on all items of plant and equipment correspond to the isolation signage;
- There are authorized personnel working on plant who are trained to understand the relevant isolation and lock off safe working practices, and know where lock off points are located;
- Sufficient hasps and padlocks are provided to enable compliance with the written procedure;
- Trained, competent and authorized personnel are available if isolation involves the removal of fuses. Isolation and lock off are two distinct control measures.

LU3. Isolate Machine from Fuel Supply:

- Demonstrate to wear PPEs
- **Importance of isolation from fuel supply:**

  The isolation process is also known in industry as 'lockout / Tagout' and is used to isolate machinery and equipment from its energy source. It is important to ensure the isolation of any unsafe machinery/equipment from potential uncontrolled energy sources during repair, service or maintenance work.

- **Techniques/sequence of isolation of fuel supply:**

  Isolation can be used as a standalone method of ensuring the safety of maintenance staff carrying out maintenance operations at a quarry where permits to work are not necessary or as part of a Work Permits requirements. The basic rules are that there should be isolation from the entire power source, the isolator should be locked in position (for example by a padlock), and a sign should be used to indicate that maintenance work is in progress. Before entering or working on the equipment, it is essential that the

effectiveness of the isolation is verified by a suitably competent person.

LU4. Isolate Machine from Gear Box:

- Demonstrate to wear PPEs
- **Importance of isolation from gear box:**

  Most modern gearboxes are used to increase torque while reducing the speed of a prime mover output shaft (e.g. a motor crankshaft). This means that the output shaft of a gearbox rotates at a slower rate than the input shaft, and this reduction in speed produces a mechanical advantage, increasing torque. Before removing the motor from site for repair it is necessary to isolate the motor from gearbox.
- **Techniques/sequence of isolation of Machine from gear box:**

  Gearboxes are isolated from motor before shifting them from site for repair work. Proper marking is carried out before detaching its nut bolts etc. from the motor body, below some types of gearboxes used in industry are shown.

Figure 1
Worm Gear

Figure 2
High-Performance/ High-Efficiency Worm Gear

Figure 3
Double-Enveloping, Multi-Start Design of High-Performance Worm Gears

Figure 4
Bevel Gear

Figure 5
Bevel Gear Wheels

Figure 6

Miter Gear

Figure 7

- **Importance of Marking on Driver, Driven and Foundation for proper alignment and placement of parts:**
  It is very important to mark the position on driver & driven for their proper refitting after the repair work. You have to just match the marking symbols which will help you to get proper fitting quickly.

LU5. Isolate Machine from Pulley:

- Demonstrate to wear PPEs
- **Importance of isolation from Pulley:**
  It is necessary to remove pulleys or couplings from a motor or drive shaft without causing damage to the components before taking the motor away from site for repair.
- **Techniques/sequence of isolation of Machine from Pulley:**
  To remove the pulley you should observe the following sequence;
  1- Remove the belts from pulley
  2- Remove the bolt if connected at the edge of shaft
  3- Remove the pulley using puller or press
  4- Store the cutter safely

See the video of pulley removing from link shown below
https://www.youtube.com/watch?v=U7WXl4uJgkc

LU7. De- Install Machine from Foundation:

- Demonstrate to wear PPEs
- **Identification of Machine to be De-Installed from foundation:**
  Take a roundhand identify the points of machine to be de-attached / de-installed from foundation. Observe the size of bolts for proper selection of tools required.
- **Techniques/sequence of De-Installation of Machine from foundation:**
  You should follow the following sequence of de-installation of machine from foundation.
  i. Check the condition of foundation bolts.
  ii. If rust is deposited on bolts then put some kerosene oil of them, wait for some time.
  iii. Put some Mobil oil on studs.
  iv. Using proper size spanner, unbolt them one by one.
  v. Make sure that all bolts are unbolted.
  vi. Apply mechanical pressure at motor body and tilt it for some angle.

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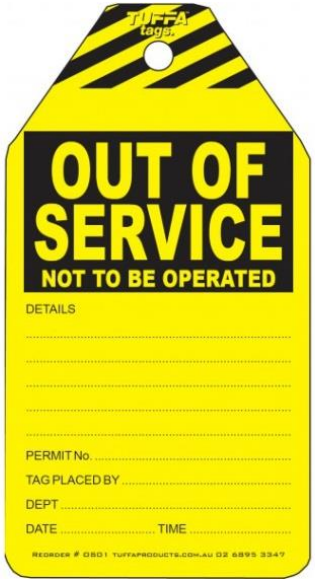
Importance of Tagging:

When a machine is removed from foundation it should be properly tagged with written detail of causes of out of service etc.



Module D: 0713001125 Maintain Tools/ Equipment and Machinery

Objective: This Modulecovers the knowledge & skills required to Maintain Tools/ Equipment and Machinery through Prepare for work , Maintain Tools and equipment , Ensure Insulation of Tools and Equipment , Calibrate measuring instruments , Perform Lubrication of tools and equipment , Maintain Machines , Manage Inventory of tools/equipment and Machinery

Duration: 50 Hours **Theory: 10 Hours** **Practice: 40 Hours**

Learning Unit	Learning Outcomes	Learning Elements	Materials Required
LU1. Prepare for work to maintain tools / equipment and machinery	**The trainee will be able to:** • Prepare list of the PPE'S required for Winding Technician. • Identify the required PPE'S • Collect the required PPE'S • Ensure working / functional condition of PPE'S • Prepare list of the tools / equipment required for Winding Technician • Identify the tools/equipment required for Winding Technician • Collect the tools/equipment required for Winding Technician	• Identification of PPE's, tools/equipment and materials required for maintenance. • Enlisting of tools, PPEs and materials required for Maintenance. • Importance of functional conditions of required Tools, Equipment and PPEs and their use • Importance of safe working condition regarding ○ Clear passage ○ Cleanliness ○ Adequate light ○ Ventilation	**Tools** • Spanner Set • Screw Driver Set • Allen key Set • Clamp Meter **Consumables Items** • Hand Gloves • Safety Shoes • Safety Goggles
LU2. Maintain Tools and equipment	**The trainee will be able to:** • Display list of the tools / equipment required for winding technician • Match the available tools / equipment with the displayed list • Prepare list of missing tools and equipment	• Importance of maintaining / displaying list of tools / equipment's required for winding technician • Matching techniques for the available tools / equipment's with the displayed list. • Importance of pin	

	• Arrange the missing tools and equipment	pointing of missing tools and equipment's • Arrangement procedure for the missing tools and equipment.	
LU3. Perform Preventive maintenance of tools and equipment	**The trainee will be able to:** • Check physical condition of tools and equipment • Perform cleaning of tools and equipment • Perform lubrication of tools and equipment • Ensure proper storage of tools and equipment	• Importance of checking physical condition of the tools / equipment's. • Define preventive maintenance. • Describe Techniques of preventive maintenance: ○ Cleaning ○ Lubrication ○ Sharpening • Storing techniques of tools in the tools	
LU4. Perform Corrective maintenance of tools and equipment	**The trainee will be able to:** • Check working/functional condition of tools and equipment • Perform Corrective maintenance of tools and equipment regarding: ➢ Sharpening ➢ Adjustment ➢ Balancing ➢ Tightness	• Importance of checking working condition of the tools/equipment. • Define corrective maintenance. • Describe Techniques of corrective maintenance: ○ Sharpening ○ Adjustment ○ Balancing ○ Tightness	

	➢ Jamming ➢ Breakage ➢ Calibration	○ Jamming ○ Breakage ○ Calibration ○ Sharpening • Storing techniques of tools / equipment's & machinery.	
LU5. Ensure Electrical/Thermal Insulation of tools and equipment	**The trainee will be able to:** • Check Electrical Insulation of tools and equipment • Maintain electrical insulation of tools and equipment • Check Thermal Insulation of tools and equipment • Maintain Thermal insulation of tools and equipment • Ensure proper storage of tools and equipment	• Define Electrical / thermal insulation of tools/ equipment. Importance of checking Electrical / Thermal of tools / equipment's. • Techniques of maintaining Electrical / thermal insulation of tools/equipment.	
LU6. Calibrate measuring instruments	**The trainee will be able to:** • Check calibration of measuring instruments • Set calibration of measuring instruments **P3:**Compare calibration with the standard/Pre-calibrated instrument	• Define calibration of measuring instruments. • Calibration techniques of measuring instruments. • Techniques for comparing calibration with the standard / Pre-calibrated instrument	
LU7. Maintain Winding Machines	**The trainee will be able to:** • Check physical condition of	• Define winding machine. • Importance of	

	winding machines • Perform cleaning of winding machines • Perform lubrication of winding machines • Check calibration of turns counter of winding machines • Set calibration of turns counter of winding machines • Replace turns counter of winding machines • Ensure safe covering/storing of winding machines	checking physical condition of winding machine. • Techniques for cleaning, lubrication of winding machine. • Importance of setting calibration of turns counter of winding machine. • Replacement techniques of turn counter winding machine and its safe covering / storing.	
LU8. Manage Inventory of tools/equipment and Machinery	**The trainee will be able to:** • Collect relevant inventory forms/stock register • Record receiving of tools, equipment and machinery in inventory forms/stock register • Maintain record of tools and equipment in stock register	• Arrangement of relevant inventory forms/stock register. • Enlisting procedure of faulty tools / equipment's & machinery. • Demand generation for provision/replacement of faulty tools • Inventory management techniques.	

LU1: Prepare for work to maintain tools / equipment and machinery

LU2: Maintain Tools and equipment

LU3. Perform Preventive maintenance of tools and equipment

Importance of checking physical condition of the tools / equipment's:

Checking for simple things, like signs of wear on equipment, can go a long way. The reality is heavy equipment is often used with vibration, high temperatures and friction, all of which contribute to the wear and tear of moving parts. Add age to the mix, and you have a recipe for deterioration. This happens with all equipment, and the key to extending equipment life is to make sure you do something as simple as adding an operator visual inspection to your equipment use requirements. Noticing warped belts, dry or cracked seals and loose bolts may seem small, but these things can be identified through a visual inspection and fixed before they cause a larger problem.

Define preventive maintenance:

It is maintenance that is regularly performed on equipment tools & machinery to lessen the likelihood of it failing. It is performed while the equipment, tool & machinery are still working so that it does not break down unexpectedly. It is the key to extending equipment, tool & machinery life and ultimately saving your time and money. While your perception may be that paying for preventative maintenance is unnecessary spending, the reality is that without it, you're often left with more expensive repairs.

Describe Techniques of preventive maintenance:

The primary goal of preventive maintenance is to prevent the failure of equipment before it actually occurs. It is designed to preserve and enhance equipment reliability by replacing worn components before they actually fail. Reduced cost of repairs by reducing secondary failures.

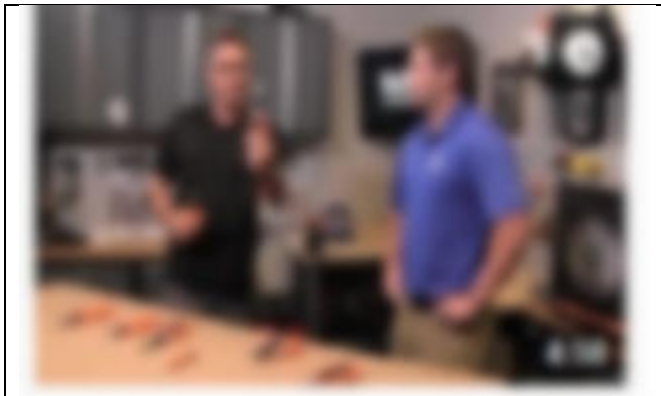
- Cleaning
- Lubrication
- Sharpening

Storing techniques of tools:

Examples and illustrations

https://www.youtube.com/watch?v=41DlPm1858w

https://www.youtube.com/watch?v=ElX6ig8jExM



https://www.youtube.com/watch?v=bjXbZKeLxW8

https://www.youtube.com/watch?v=asLbNVa0oHI

Complete set of electrical tools and equipment's

By taking proper care of your tools, you'll ensure that they'll remain in good working order and will be ready for use when you need them. No matter what kind of tools currently in your possession, it's important to take some time organizing your collection so you're protecting your investment. You'll want them in good condition when it's time to start that next project. Putting tools, there are a few basic tool storage ideas and tips to keep in mind before you put them away.

- **Follow the instructions.** Some manufacturers will have specific instructions for how to store tools, so consult your manual first and foremost. It's important to follow these instructions, especially for larger power tools like saws or drills, so they remain in good working condition.
- **Clean them off.** Tools should be cleaned each time you use them. Wipe them down with a damp rag or towel to get rid of any dirt, dust, grease or debris. Make sure tools are free of mud and grime. Everything should be completely dry before placing it in storage to avoid rust developing.
- **Use original cases.** Power tools usually come in hard, plastic cases, and it's recommended to keep these cases for storage whenever possible. These cases will keep your power tools in storage safe from extreme conditions, plus all the parts can be stored right alongside them in the case. No more lost power cords or chargers.
- **Invest in sturdy storage containers.** If you don't have the original container, or you're storing smaller hand tools, invest in some sturdy containers. This will not only keep your tools organized, but also allows them to be easily transportable to your next project area.
- **Store in a safe, dry place.** Along with having the right containers, another way to protect your tools is to ensure that area you're storing them in is safe and dry. Water or humidity can cause damage to tools, especially power tools.
- **Go vertical.** Tools should never be stored on the ground. Invest in some shelving for smaller tools, or hang

pegboard along your workbench or on a wall in your workplace. You'll be able to hang things like wrenches, hammers, box cutters and many other tools so they'll be easy to access at any time.

LU4: Perform Corrective maintenance of tools and equipment

Define corrective maintenance:

Corrective maintenance is defined as maintenance which is carried out after failure detection and is aimed at restoring an asset to a condition in which it can perform its intended function.

Corrective maintenance can be subdivided into "immediate corrective maintenance" (in which work starts immediately after a failure) and "deferred corrective maintenance" (in which work is delayed in conformance to a given set of maintenance rules).

The decision to choose corrective maintenance as a method of maintenance is a decision depending on several factors as the cost of downtime, reliability characteristics and redundancy of assets.

Describe Techniques of corrective maintenance:

The steps of corrective maintenance are, following failure, diagnosis – elimination of the part, causing the failure – ordering the replacement – replacement of the part – test of function and finally the continuation of use.

The basic form of corrective maintenance is a step-by-step procedure. The object's failure triggers the steps. Modern technologies as the use of Industry 4.0 features reduce the inherent drawbacks of corrective maintenance, e.g. providing device history, fault patterns, repair advice or availability of spare parts, Sharpening, Adjustment, Balancing, Tightness, Jamming, Breakage, Calibration.

https://massets.limblecmms.com/blog/wp-content/uploads/2019/04/16212005/corrective- maintenance.jpg

LU5: Ensure Electrical/Thermal Insulation of tools and equipment

Define Electrical / thermal insulation of tools/ equipment:

Insulators are used in electrical equipment to support and separate electrical conductors without allowing current through themselves. An insulating material used in bulk to wrap electrical cables or other equipment is called insulation. All tools, equipment's used in electrical works must have proper insulation to avoid possibility of electric shock during work.

Thermal insulation is the reduction of heat transfer (i.e., the transfer of thermal energy between objects of differing temperature) between objects in thermal contact or in range of radiated influence.

- **Importance of checking Electrical / Thermal insulation of tools / equipment's:**

  Insulation due to dryness varies, so it is very important to keep the insulation up to mark especially of those tools, equipment & machinery which is working in environment factors such as humidity, corrosive gases in their workplaces, are destructive to electrical insulation. This is the main reason why an insulation-testing program should be carried out. A regular program of insulation resistance testing is recommended to cut down and reduce the risk of electrical shocks, to maintain the safety of personnel, and to reduce repair times due to failure.

  A combination of electrical stress and the degradation of insulation are constantly happening, as one of the major causes of insulation failure is general wear and tear. As pinholes or cracks develop, moisture and foreign materials penetrate the insulation, providing a lower resistance path for leakage current. Once started, different degradation processes aid each other; this will then permit excessive current through the insulation. The leaking current cannot be detected by smell or by sight; this is what makes the issue dangerous as only the consequences can be noticed - often too late.

- **Techniques of maintaining Electrical / thermal insulation of tools/equipment:**

  If there is a planned maintenance program in place, this will pick up the gradual reduction in insulation resistance; this will also allow for a service program of replacement or renewal prior to the part having a full field failure. If there is no maintenance program then the item with poor and degraded insulation may become dangerous to the touch when voltage is applied. The item may not only be a danger to the user, but it may also be dangerous to any person in the area its being used.

  The normal steps for a class one test are visual checks, earth bond, insulation resistance, (occasionally flash) and leakage test. Any of the tests which cause a fail should stop the test, and prevent the item being used in general service F or a class 2 test, the sequence is visual, insulation resistance, (flash), leakage. The insulation test is always carried out as either the first or the second powered test, and is carried out in order of electrical safety. All of the mainstream testing equipment

carries out an insulation resistance test, commonly known as DCIR. It is carried out with DC test voltage; this voltage ranges from 250, 500, up to 1000V.

The voltage is applied through the live-neutral connections and is measured against the earth. The higher the reading the better, although for a class 1 appliance the reading must be above 1M Ohm, and for a Class 2 appliance it must be above 2M Ohm.

LU6. Calibrate measuring instruments

Define calibration of measuring instruments:

Calibration is a comparison between a known measurement (the standard) and the measurement using your instrument. Typically, the accuracy of the standard should be ten times the accuracy of the measuring device being tested. However, accuracy ratio of 3:1 is acceptable by most standards organizations.

Calibration of your measuring instruments has two objectives. It checks the accuracy of the instrument and it determines the traceability of the measurement. In practice, calibration also includes repair of the device if it is out of calibration. A report is provided by the calibration expert, which shows the error in measurements with the measuring device before and after the calibration.

Calibration techniques of measuring instruments:

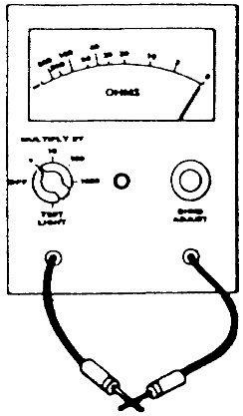
Techniques for comparing calibration with the standard / Pre-calibrated instrument;to explain how calibration is performed we can use an external micrometer as an example. Here, accuracy of the scale is the main parameter for calibration. In addition, these instruments are also calibrated for zero error in the fully closed position and flatness and parallelism of the measuring surfaces. For the calibration of the scale, a calibrated slip gauge is used. A calibrated optical flat is used to check the flatness and parallelism.

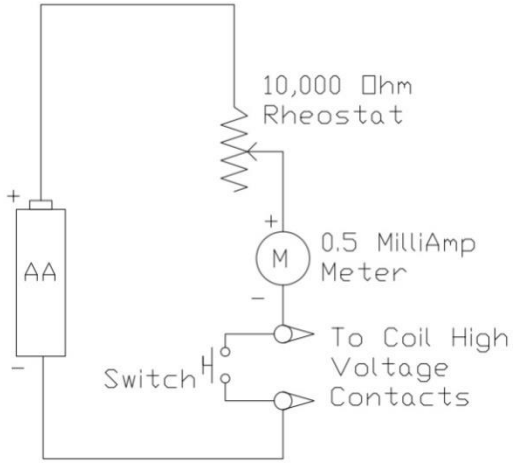
The accuracy of all measuring devices degrades over time. This is typically caused by normal wear and tear. However, changes in accuracy can also be caused by electric or mechanical shock or a hazardous manufacturing environment (e.g., oils, metal chips etc.). Depending on the type of the instrument and the environment in which it is being used, it may degrade very quickly or over a long period of time. The bottom line is that, calibration improves the accuracy of the measuring device. Accurate measuring devices improve product quality. A measuring device should be calibrated:

- According to recommendation of the manufacturer.
- After any mechanical or electrical shock.
- Periodically (annually, quarterly, monthly)

Zero Adjustment of Analog multi meter: Zero adjustment of analog multimeter can be done by observing the following procedure.

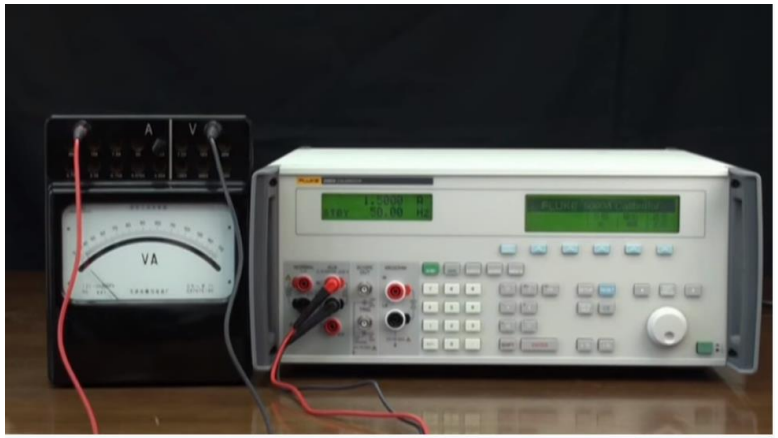
1- Turn & set the selector switch at resistance “X 1”position.
2- Connect the meter leads.
3- Short the both leads with each other.
4- Switch on supply.
5- Adjust the Zero, by rotating zero adjustment knob.





Analogue Multimeter ZERO ADJUSTMENT.wmv

https://www.youtube.com/watch?v=FU61wvF-FLU



The 5080A Multi-Product Calibrator: Calibrating an Analog Multimeter

https://www.youtube.com/watch?v=j6mdLSLFN8c

LU7: Maintain Winding Machines

Define winding machine:

Electrical coil winding machines are used to wind coils for motors, transformers, inductors, and chokes. Some electrical coil winding machines are used in automated coil winding and assembly, magnet wire winding, transformer winding, or motor winding applications.

Types

Electrical coil winding machines include motor coil, transformer coil, inductor coil, and choke coil winding machines. Motor coil winding machines are used to wind both single-phase and three-phase motor coil. They are designed for use with concentric or equal-size motor winding arbors. Medium-duty motor winders and heavy-duty motor winders are also available. Transformer coil winding machines are used to produce coils for power transformers that convert power-level voltages from one level or phase configuration to another. They are also used to wind coils for toroid transformers, devices that consist of copper wire wrapped around a cylindrical core. In addition, electrical coil winding machines are used with inductors and chokes, passive components that resist changes in current and store energy in the form of a magnetic field.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https://5.imimg.com/data5/IR/AP/MY-8160070/ceiling-fan-stator-winding-machine-500x500.jpg	https://encrypted-tbn0.gstatic.com/images?q=tbn:ANd9GcRRL8aCPDqdGBK3qjJA0BOYI4ohhURkMO4PhOOEhJYr6O3FoMtyoA

Importance of checking physical condition of winding machine:

It is very important to check & physically inspect the winding machine to keep it fit for use, and to enhance its healthy life.

Techniques for cleaning, lubrication of winding machine: Clean the winding machine motor external dust and sludge in a timely manner. Use more environmental dust, cleaned once a day. Check the wiring box wiring screw is loose, burned. Check the fixing part screw, including foot screw, end cap screws, bearing cap bolts. Tighten the loose nut. Inspection and maintenance of bearings in use for some time to be cleaned, replace the grease or lubricating oil. Time for cleaning and oil change, with winding machine working conditions, working environment, cleanliness, and lubricant types may be. Every 3-6 months, should be cleaned, replace and grease. When the oil temperature is high or environmental conditions is poor, dusty winding machine regular cleaning, oil change. Cleaning of rolling bearings, replace grease.

- **Importance of setting calibration of turns counter of winding machine:**
  Setting of calibration of turns counter is very important, because error in counting of number of turns of coils will badly affect the working of machine after winding. Low number of turns will reduces the resistance of winding hence on applying voltage the motor will take excess current which will burnt the winding, similarly excess number of turns will increase the resistance of winding which will affect the working of machine.
- **Replacement techniques of turn counter winding machine and its safe covering / storing:**
  To replace turn counter of winding machine, it must be unscrewed from the winding machine and then after placing the new one at its place it must be screwed properly. The winding machine must be covered for its safe storing and to keep it dust free, which will enhance its healthy life.

LU8: Manage Inventory of tools/equipment and Machinery:

- **Arrangement of relevant inventory forms/stock register.**
  Each company / workshop use inventory from / stock register designed according their own need to keep the update record of their available tools / equipment & machinery. A sample form is shown below.
- **Enlisting procedure of faulty tools / equipment's & machinery.**
  Faulty tools equipment & machinery are entered in the consumed Column of the inventory form / stock register and their numbers are subtracted from available in stock column to update the record.
- **Demand generation for provision/replacement of faulty tools.**
  To maintain the tools equipment up to date, faulty tools equipment must be replaced with new one, for this purpose in industry you have to generate demand on requisition form available in printed form in which you write the name of item with its full specification. On your demand the main store issue this from their available stock or provided after purchase process.
- **Inventory management techniques:**
  Inventory Management is a practice of tracking and controlling the inventory orders, its usage and storage along with the management of finished goods that are ready for sale. Improper inventory management can lead to an increase in storage

cost, working capital crunch, wastage of labor resources, increase in idle time, disruption of the supply chain, etc. All this leads to a reduction in sales and unsatisfied customers. Therefore, inventory management is an important aspect of the business which the management cannot afford to ignore. Effective and efficient management of the same is a must.

7 MOST EFFECTIVE INVENTORY MANAGEMENT TECHNIQUES ARE AS FOLLOWS:

There are various types of inventory management techniques which can help in efficient inventory management. They are as follows:

ABC ANALYSIS

ABC analysis stands for Always Better Control Analysis. It is an inventory management technique where inventory items are classified into three categories namely: A, B, and C. the items in A category of inventory are closely controlled as it consists of high-priced inventory which may be less in number but are very expensive. The items in B category are relatively lesser expensive inventory as compared to “A” category and the number of items in “B” category is moderate so control level is also moderate. The “C” category consists of a high number of inventory items which require lesser investments so the control level should be minimum.

JUST IN TIME (JIT) METHOD

In Just in Time method of inventory control, the company keeps only as much inventory as it needs during the production process. With no excess inventory in hand, the company saves the cost of storage and insurance. The company orders further inventory when the old stock of inventory is close to replenishment. This is a little risky method of inventory management because a little delay in ordering new inventory can lead to stock out situation. Thus this method requires proper planning so that new orders can be timely placed.

MATERIAL REQUIREMENTS PLANNING (MRP) METHOD

Material Requirements Planning is an inventory control method in which the manufacturers order the inventory after considering the sales forecast. MRP system integrates data from various areas of the business where inventory exists. Based on the data and demand in the market, the manager would carefully place the order for new inventory with the material suppliers.

ECONOMIC ORDER QUANTITY (EOQ) MODEL

Economic Order Quantity technique focuses on taking a decision regarding how much quantity of inventory should the company order at any point of time and when should they place the order. In this model, the store manager will reorder the inventory when it reaches the minimum level. EOQ model helps to save the ordering cost and carrying costs incurred while placing the order. With the EOQ model, the organization is able to place the right quantity of inventory.

MINIMUM SAFETY STOCKS

The minimum safety stock is the level of inventory which an organization maintains to avoid the stock-out situation. It is the level when we place the new order before the existing inventory is over. Like for example, if the total inventory in an organization is 18,000 units, they place a new order when the inventory reaches 15,000 units. Therefore, the 3,000 units of inventory shall form part of the minimum safety stock level.

VED ANALYSIS

VED stands for Vital Essential and Desirable. Organizations mainly use this technique for controlling spare parts of inventory. Like, a higher level of inventory is required for vital parts that are very costly and essential for production. Others are essential spare parts, whose absence may slow down the production process; hence it is necessary to maintain such inventory. Similarly, an organization can maintain a low level of inventory for desirable parts, which are not often required for production.

FAST, SLOW & NON-MOVING (FSN) METHOD

This method of inventory control is very useful for controlling obsolescence. All the items of inventory are not used in the same order; some are required frequently, while some are not required at all. So this method classifies inventory into three categories, fast-moving inventory, slow-moving inventory, and non-moving inventory. The order for new inventory is placed based on the utilization of inventory.

Conclusion

Inventory management is an essential part of every business. With an effective inventory management system in place, the business can significantly reduce its various costs like warehousing cost, inventory carrying cost, ordering cost, cost of obsolescence, etc. It improves the supply chain of the business. Managers are able to forecast the level of production at which they need to place new orders for inventory. Hence, organizations should take all the necessary steps to maintain an effective inventory management and control system.

ELECTRICAL MACHINE WINDING TECHNICIAN

Module-E
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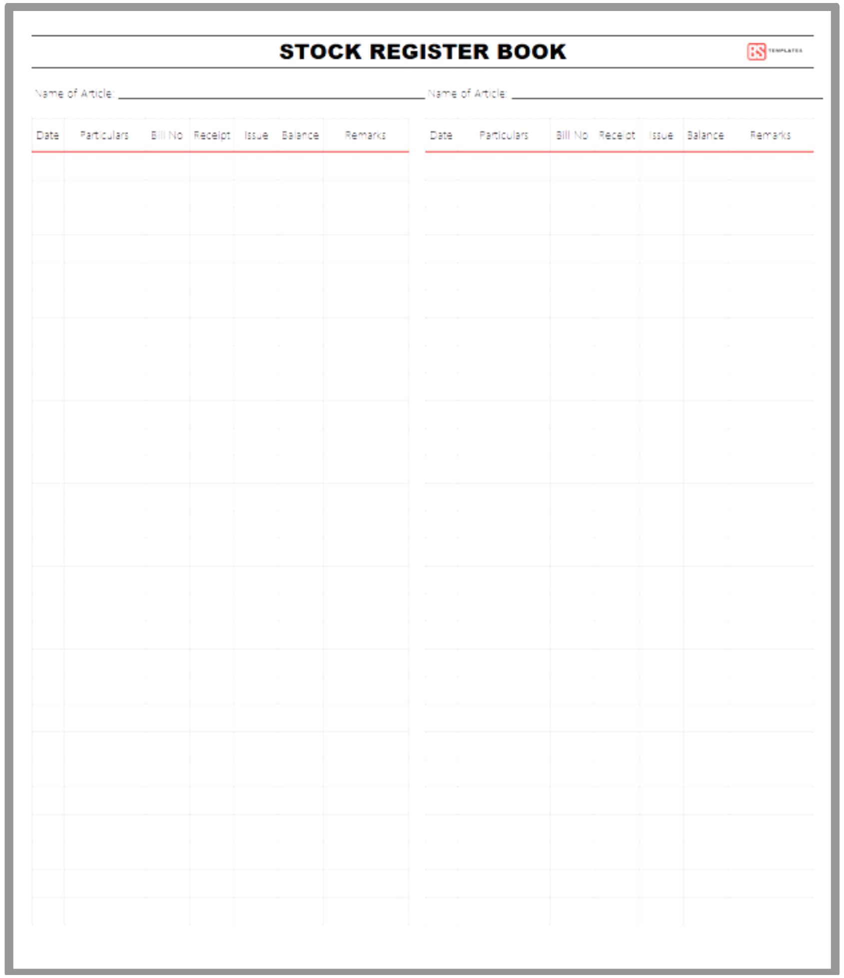
National Vocational Certificate Level 2

Version 1 - September, 2018



STOCK REGISTER BOOK

Name of Article: ____________________ Name of Article: ____________________

Date	Particulars	Bill No	Receipt	Issue	Balance	Remarks	Date	Particulars	Bill No	Receipt	Issue	Balance	Remarks

Module E: Comply with Personal Health and Safety Guidelines

Objective:

Duration: 30 Hours **Theory: 6 Hours** **Practice: 24 Hours**

Learning Unit	Learning Outcomes	Learning Elements	Materials Required
LU1. Identify Personal Hazards at Workplace	The trainee will be able to: • Interpret work processes and procedures correctly to identify risk to Health, hygiene and safety at workplace • Recognize processes, tools, equipment and consumable materials that have the potential to cause harm • Prepare Report of the identified risk to Health, hygiene and safety		
LU2. Apply Personal Protective and Safety Equipment (PPE)	The trainee will be able to: • Select personal protective equipment in terms of type and quantity according to work orders. • Wear, adjust, and maintain personal protective equipment to ensure correct fit and optimum protection in compliance with company procedures. • Ensure personal protective equipment is cleaned and stored in		

	proper place.		
LU3. Comply Occupational Safety and Health (OSH)	The trainee will be able to: • Maintain cleanliness and hygiene as per organizational policy • Comply with Health, hygiene and safety precautions before starting work • Follow organizational Health, hygiene and safety guidelines during work • Deal with resolvable problems according to prescribed procedures • Report un resolvable problems to immediate supervisor • Place the tools equipment etc. at their prescribed place after completion of work		
LU4. Dispose -off hazardous Waste/materials	The trainee will be able to: • Identify hazardous waste/ drug materials which needs to be disposed off • Collect hazardous or non-hazardous waste carefully from the designated area as per approved procedure		

ELECTRICAL MACHINE WINDING TECHNICIAN

Module-F
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	• Use proper disposal hazardous containers for dispose-off hazardous waste as per procedure • Take necessary precautions like putting masks and gloves while disposing hazardous waste/ materials as per standard operating procedure		

ELECTRICAL MACHINE WINDING TECHNICIAN

Module-G
LEARNER GUIDE
National Vocational Certificate Level 2

Version 1 - September, 2018

Module F: Communicate the Workplace Policy and Procedure

Objective:

Duration: 20 Hours **Theory:4 Hours** **Practice: 16 Hours**

Learning Unit	Learning Outcomes	Learning Elements	Materials Required
LU1. Identify workplace communication procedures	The trainee will be able to:		
LU2. Communicate at workplace	The trainee will be able to:		
LU3. Draft Written Information	The trainee will be able to:		
LU4. Review the Documents	The trainee will be able to:		

Module G: Perform Basic Communication(Specific)

Objective:

Duration: 30 Hours **Theory:6 Hours** **Practice: 24 Hours**

Learning Unit	Learning Outcomes	Learning Elements	Materials Required
LU1.Communicate in a team to achieve intended outcomes	**The trainee will be able to**: • Treat team members with respect • Maintain positive relationships to achieve common organizational goals • Get work related information from team • Identify interrelated work activities to avoid confusion • Adopt communication skills, which are designed in a team. • Identify problems in communication with a team Resolve Communication barrier through discussion		

	and mutual agreement		
LU2.Follow Supervisor's instructions as per organizational SOPs	The trainee will be able to: • Receive the instructions from Supervisor • Carry out the instructions of the supervisor Report to the supervisor as per organizational SOPs		
LU3.Develop Generic communication skills at workplace	The trainee will be able to: • Develop basic reading skills • Develop Basic writing Skills Develop basic listening skills		

ELECTRICAL MACHINE WINDING TECHNICIAN

Module-H
LEARNER GUIDE
National Vocational Certificate Level 2

Version 1 - September, 2018

Module H: Perform Basic Computer Application(Specific)

Objective:

Duration: 40 Hours **Theory:8 Hours** **Practice:32 Hours**

Learning Unit	Learning Outcomes	Learning Elements	Materials Required
LU1. Create Word Documents	The trainee will be able to: • Open word processing application • Create a word document • Customize page layout with relevant name setting • Set up page in a word document • Edit word document as required • Use simple formatting tools when creating the document • Save word document to directory • Insert table in a word document • Insert appropriate images into document as necessary • Insert header/footer in a word document • Insert section break in a word document		

	• Set style in word document • Select basic Print settings Print the document		
LU2. Use internet for Browsing	The trainee will be able to: • Use search engines to open website • Search data on different topics • Refine search to increase relevance of information or content Navigate a website to access the information or content required		

Summary of Module

Module	Learning Unit	Duration
○ **Module A:** Perform on-site Inspection/testing of machine **Aim:** The aim of this module is to develop basic knowledge, skills and understanding required to Perform on-site Inspection/testing of machine like checking data plate, terminal/terminals plate of machine and conduct of Megger test and transformer oil test.	**LU1.** Take feedback from the operator **LU2.** Check Physical status/condition of Machine **LU3.** Check data plate of machine for specifications **LU4.** Conduct Megger test of the Machine **LU5.** Carry out Transformer's oil test **LU6.** Perform Transformer Turn Ratio Test **LU7.** Check Terminals/Terminal plate of Machine	110

Module	Learning Unit	Duration
Module B: Ensure Electrical isolation of Machine **Aim:** The aim of this module is to develop basic knowledge, skills and understanding required to Isolate Machine from Electrical Supply, perform tagging of machine, communicate with machine operator and de energizing of machine.	**LU1.** Prepare for Work to ensure Electrical Isolation of Machine **LU2.** Wear PPE's **LU3.** Isolate Machine from Electrical Supply **LU4.** Perform Tagging of Machine **LU5.** Document the Electrical Isolation of Machine **LU6.** Communicate with machine operator and other personnel **LU7.** De-Energize Machine	110
○ **Module C:** Carry out Mechanical De-Installation of Machine **Aim:** The aim of this module is to develop basic knowledge, skills and understanding required for isolation of machine from Pneumatic/hydraulic supply, Fuel Supply, Gear Box, Pulley, perform de-coupling and de installation of Machine from the foundation.	**LU1. Prepare for work to Carry out Mechanical De-Installation of Machine** **LU2.** Isolate Machine from Pneumatic/hydraulic **LU3.** Supply **LU4.** Isolate Machine from Fuel Supply **LU5.** Isolate Machine from Gear Box **LU6.** Isolate Machine from Pulley **LU7.** Perform **LU8.** De-Coupling of Machine **LU9.** De- Install Machine from Foundation	110

Module	Learning Unit	Duration
○ **Module D:** Maintain Tools/ Equipment and Machinery **Aim:** The aim of this module is to develop basic knowledge, skills and understanding required to perform preventive and corrective maintenance of Tools/equipment used for the trade of Electrical Machine Winding Technician.	**LU1. Prepare for work to maintain tools / equipment and machinery** **LU2.** Maintain Tools and equipment **LU3.** Perform Preventive maintenance of tools and equipment **LU4.** Perform Corrective maintenance of tools and equipment **LU5.** Ensure Electrical/Thermal Insulation of tools and equipment **LU6.** Calibrate measuring instruments **LU7.** Maintain Winding Machines **LU8.** Manage Inventory of tools/equipment and Machinery	50
Module E: Comply Personal Health and Safety Guidelines **Aim:** The aim of this module is to develop basic knowledge, skills and understanding required to identify personal hazards at work place , application of PPE's and compliance of health and safety guidelines.	**LU1. Identify Personal Hazards at Workplace** **LU2. Apply Personal Protective and Safety Equipment (PPE)** **LU3. Comply Occupational Safety and Health (OSH)** **LU4. Dispose of hazardous Waste/materials from the designated area.**	30 hours

Module	Learning Unit	Duration
Module F: Communicate the Workplace Policy and Procedure **Aims:** The aim of this module is to develop basic knowledge, skills and understanding to communicate the work place policies and procedures.	**LU1. Identify workplace communication procedures** **LU2. Communicate at workplace** **LU3. Draft Written Information** **LU4. Review Documents**	20 hours
Module G: Perform Basic Communication (Specific) **Aim:** The aim of this module is to develop basic knowledge, skills and understanding that how to communicate in a team, follow organizational SOP and develop generic communication skills at the work place.	**LU1. Communicate in a team to achieve intended outcomes** **LU2. Follow Supervisor's instructions as per organizational SOPs** **LU3. Develop Generic communication skills at workplace**	30 hours
Module H: Perform Basic Computer Application (Specific) **Aim:** The aim of this module is to develop basic knowledge, skills and understanding required how to perform basic computer application like creation of word document and use of internet for browsing.	**LU1. Create Word Documents** **LU2. Use internet for Browsing**	40

Test Yourself (Multiple Choice Questions)

Level- 2

Please mark the correct one from the given options.

QNO 1: What is important to know for Arrangement of Tools & Equipment?

A. Identify of tool and Equipment's
B. Prepare list of tools
C. Specifications of tool & Equipment
D. Condition of tools & Equipment

QNO 2: Safe use of tools is ensured if the tools are :

A. Insulated
B. Accurate
C. Complete
D. Broken

QNO3: What is the unit of current?

A. Volts
B. Watt
C. Ampere
D. Ohms

QNO4: What will flow in circuit when voltage is applied?

A. Power
B. Current
C. Voltage
D. Resistance

QNO 5: What is opposing capacity of materials against the current flow?

A. Conductance
B. Inductance
C. Capacitance
D. Resistance

Q No 6: What you can measure with Megger?

A. Conductor resistance
B. Conductor capacitance
C. Insulation resistance
D. Insulation capacitance

Q N0 7: What is the measuring unit of Megger?

A. Kilo
B. Mega
C. Giga
D. Micro

Q No 8: What will be the value of current in short Circuit?

A. Zero
B. Minimum
C. Normal
D. Abnormal

Q No 9: What type of maintenance you will do after detection of fault?

A. Preventive
B. Corrective
C. Progressive
D. Protective

Q No 10: What type of maintenance you will do before arising of fault?

A. Preventive
B. Corrective
C. Progressive
D. Protective

Q No. 11: Zero adjustment of equipment is a part of?

A. Identification
B. Callibration
C. Representation
D. Preventation

Q No 12: Insulation failure cause fault of?

A. Open circuit
B. Working circuit
C. Short circuit
D. Healthy circuit

Q No 13: Tag must be displayed when machine is?

A. Off
B. Working
C. Connected
D. Isolated

Q No 14: When faulty machine received in workshop, it is mandatory to up date?

A. Cleanenance
B. Repair
C. Inventory
D. Connection

Q No 15: Moisture in transformer oil will effects its?

A. Dielectric properties
B. Thermal properties
C. Chemical properties
D. Phisical properties

Q No 16: Transformer oil can last up to?

A. 20 Years
B. 25 Years
C. 30 Years
D. 35 Years

Q No 17: It is a formal document that describes maintenance work to be completed?

A. MWD
B. MWR
C. MWA
D. MWM

QNo.18:The process of disconnection and isolation of a system from a source of energy is called :

A. De-energizing
B. Isolation
C. Dis-connection
D. Connection

Q No 19: TTR stands for?

A. Total Trace Ratio
B. Transformer Trace Ratio
C. Trace Turn Ratio
D. Transformer Turn Ratio

Q No 20:In factories/work shops load is shifted with the help of :

A. Fork Lifter
B. Loader
C. Chain Block
D. Tripod

Answer Key	
Question Number	**Correct Answer**
1	A
2	A
3	C
4	B
5	D
6	C
7	B
8	D
9	B
10	A
11	B
12	C
13	D
14	C
15	A
16	C
17	B
18	A
19	D
20	A

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