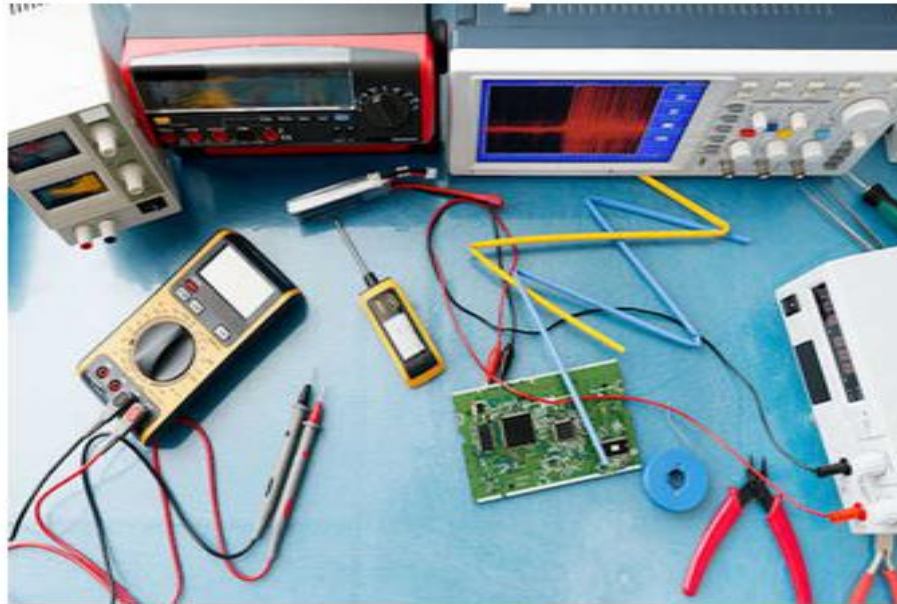


Industrial Electrical/Electronic Control Technology

Level – II

Based on March ,2022Curriculum Version



Module Title: - Perform Electrical Measurement and Calculation

Module code: EIS IEC 01 0322

Nominal duration: 80Hour

Unit one:

1. Plan and prepare tasks.

The unit of content coverage and topics:

- § Personal protective equipment
- § hand tools and measuring instrument
- § work stations safety
- § component measurement .
- § hand tools and measuring instrument
specification

1.1.1. Personal protective equipment

- *A Personal Protective Equipment (PPE) is clothing or equipment designed to reduce employee exposure to chemical, **biological**, and **physical hazards** when on a worksite.*

The different types of PPE include:

- *Head and scalp protection;*
- *Respiratory protection;*
- *Eye protection;*
- *Hearing protection*
- Hand and arm protection
- Foot and leg protection
- Body protection



Face and Eye Protection

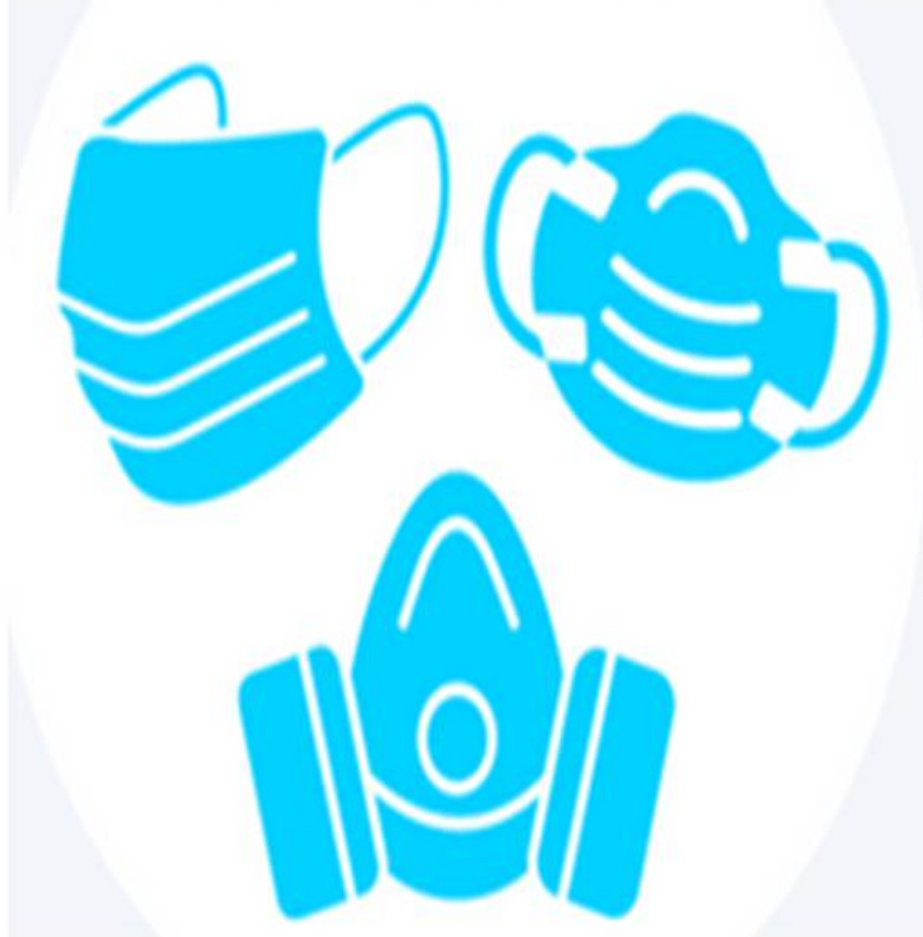
PPE includes safety goggles and face shields and should be used for tasks that can cause eye damage or loss of vision, sprays of toxic liquids, splashes, and burns.



Figure A Face and Eye Protection

Respiratory Protection

PPE includes full-face respirators, self-contained breathing apparatus, gas masks, N95 respirators, and surgical masks are used for a task that can cause inhalation of harmful materials to enter the body. This includes harmful gas, chemicals, large-particle droplets, sprays, splashes, or splatter that may contain viruses and bacteria such as COVID-19, viral infections, and more.



Respiratory Protective Equipment
protects workers against contaminants
present in the workplace such as:

- Harmful gases
- Chemicals
- Particles or droplets containing viruses and bacteria

Hearing Protection

PPE includes ear muffs and plugs and should be used for tasks that can cause hearing problems and loss of hearing.

Gloves: - is the cover of hands made from leather or plastic to protect hands from mechanical, electrical and chemical hazards.

Goggles: - are used to protect the eye from them are during welding or from filing chips during grinding boring holes on brick or concrete surface.

Safety shoes: - is also the hand rubberized a shoe which protects workers feet from electrical, mechanical and chemical hazards.

Helmet:- is the hard rubberized hat (head covering) to protect the workers from over head electrical and mechanical hazards.

Apron (over coat):- is a garment worn over the body clothes to keep the clothes cleanly.

1.2. Hand tools and measuring instrument

I. Hand tools: - are tools which are operating by human hand (mechanical forces).

II. **Hand tools** is a device for doing a particular job that does not use a motor, but is powered solely by the person using it.

- *Types of hand tools and measuring instrument*

§ *Hammer*

§ *Screw driver*

§ *Files*

§ *Insulation remover*

§ *Chisel*

§ *Wrench*

§ *Hacksaw*

§ *Measurement and Level*

§ *Vice*

Tools

§ *Combination plier*

A. Hammer

- There are many types hammer depend up on the ability to performed.
 - Ball-Peen Hammer
 - Dead Blow
 - Rubber Mallet
 - Claw Hammer
 - Cross peen hammer

Cont..

1. Ball-Peen Hammer

- The head is made of heat treated forged **high carbon** steel that is harder than a claw hammer.
- The **round “peening”** end is used less in metalworking than it used to be, but it is meant to work and shape malleable metals.



2. Dead Blow

- Its specialized striking tools used to minimize damage to a part's surface.
- The head of a dead blow is polyurethane and is with sand or lead shot to absorb the impact of the strike.



Cont..

3. Rubber Mallet

- *The rubber Mallet is used in woodworking or when a softer impact is required.*
- *The rubber head ensures that the face of the surface you are striking will not be damaged.*



4. Claw Hammer

- *The claw hammer is the tool most people think of when they think of hammers.*
- *The head of this tool is used for driving nails into wood and the claw on the back is used to pry nails out of wood.*



B. Files

- Depend up on the **shape** and their purposes, file sub divided into:-

- Flat file
- Round file
- Triangle file
- Rectangle file

1. Flat file

- *A flat file is a fine cutting tool with two wide flat faces and two skinny flat faces that can remove small amounts of material from wood, plastic, or metal*



Cont....

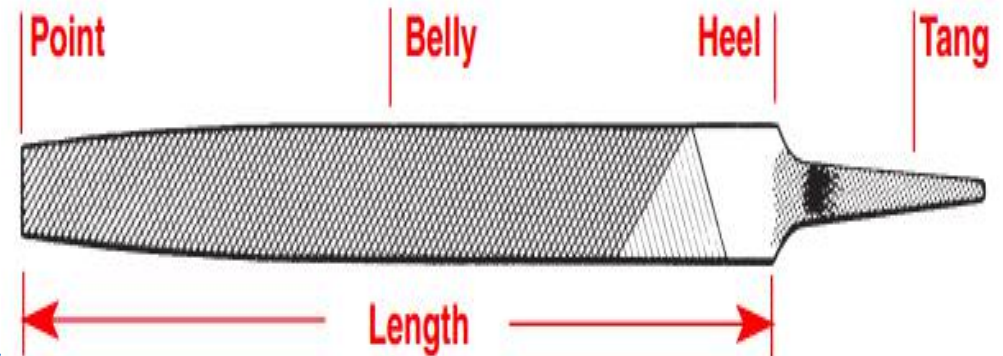
2. round file

- *Its is a fine cutting tool with a cylindrical shape that can remove small amounts of material from wood, plastic, or metal.*
- *It is used to break sharp corners, remove burrs from a work piece, or smooth out the surface of a work piece*



3. Triangle file

- Each part of the file has a name and there are many different shapes and sizes of files. Furthermore, there



Cont....

4. Rectangle file.

- Its is used to sharpen the edge of chisel and to smooth the surface of our work pieces



5. Chisel: - a hardened and sharpened metal which are used to cut wooden work pieces and sheet metals



Wooden chisel



metallic chisel

C. Knives

1. X-Acto Knife / Electrician knife

- Is used to remove insulation from any part of conductor.
- *Cutting tools include hobby and utility knives, saws, carving tools and many small-scale precision knives used for crafts and other*



2. Magazine Knife

- *A magazine knife is a knife used for general or utility purposes with snap-off blades for quick blade replacement.*



Cont..

3. Wire stripper:

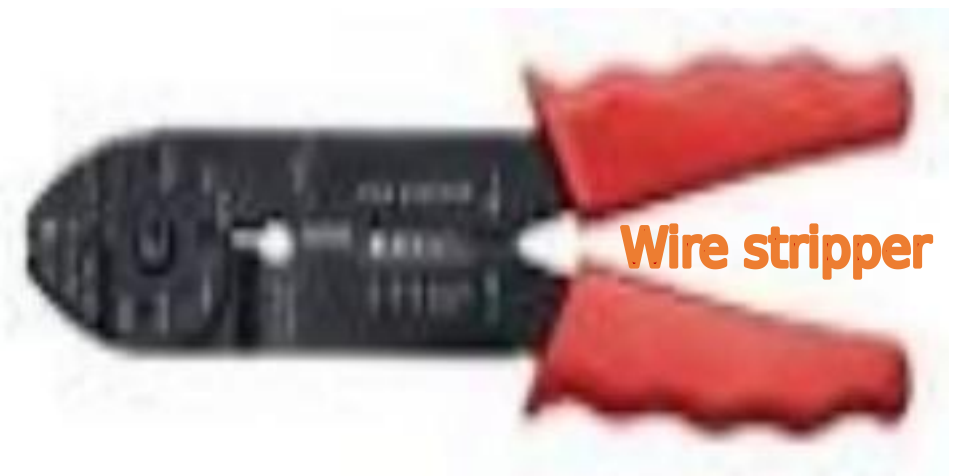
Its is used to remove insulation from the end of conductors.

- **There are tow types of wire stripper**

a) Manual wire striper

b) Automatic wire striper

- **Manual wire striper** is used to remove an insulation from conductor by manual.
- Its also measuring the size of conductor .



Wire stripper

D. Hacksaw

- **Saws** are used for cutting and for other work requiring cutting.
- The commonly used saw for working are the wood saw and hack saw for **metal cutting**.
- **Blades are available** with different numbers of teeth per inch.
- A thinner and/ or harder metal will require a blade with more teeth per inch

- A hacksaw blade should not be stroked faster than 60 strokes per minute.
- Most blades are made of high carbon



E. Wire brush: -

is used to clean the surface of our work pieces which are going to solder (join together).



Wire brush

F. Oil can:

Its is a tool which is used for oiling (lubricating) the movable joint of tools (machines) to decrease mechanical frictions between



G. Vice:

- Sturdy machinist's vises are necessary in the shop. They are particularly convenient for holding parts while drilling, filing, or assembling.
- Always use soft jaws made of sheet copper or aluminum when clamping a part which must not

- These are available in inserts which fit over regular vise jaws.



Machinist Vise



Bench Vise



Swivel Vise



Drill Press Vise

H. Combination plier

there are many types of pliers.

Some of them are:-

1. Universal (side cutter)

pliers

2. Diagonal cutter pliers

3. Long lose pliers

4. Round nose pliers

5. Flat nose pliers

Universal (side cutter)

pliers: - such pliers are used to twist, grip and Cut conductors (wires).



Universal pliers

2. **Diagonal cutter pliers:** - such pliers are used to cut conductors (wires)



• **3. Long nose pliers:** - are used to cut conductors also they are used to grip piece in



4. Round nose pliers:-

also they are used to make



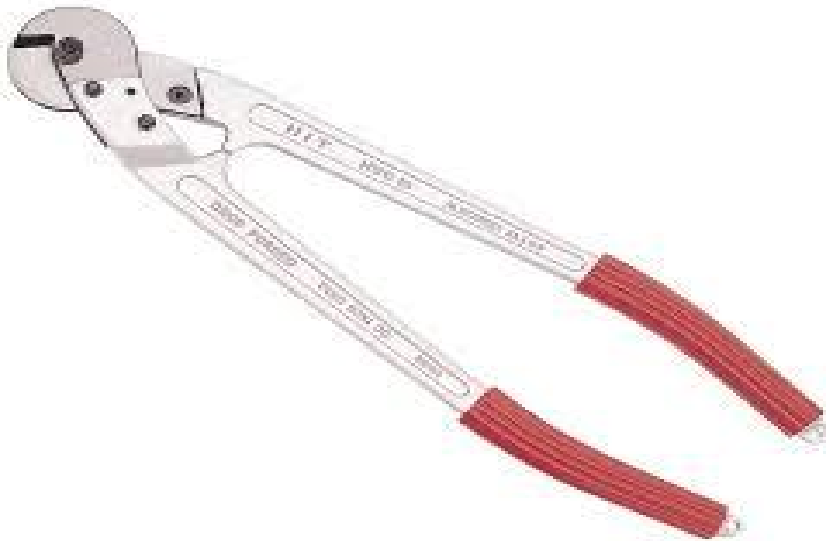
**Round nose
pliers**

- **5. Flat nose pliers**:- are used to bend conductors at an angle of 90° .



I. Bolt and cable cutter

- **Cable cutter:** - is used to cut cable which is beyond the ability of pliers



• Bolt Cutters

- A bolt cutter is a tool used for cutting steel wire, small diameter bolts, and wire mesh.
- This device has compound hinges to maximize leverage and cutting force.



J. types of Screw driver

- Flathead (or Slotted Head) Screwdriver.
- **Phillips Screwdriver.**
- **Pozidriv Screwdriver.**
- **Robertson (or Square) Screwdriver.**
- **Torx (or Star) Screwdriver.**
- **Hexagon (Hex) Screwdriver.**
- **Spanner Driver.**
- **Frearson Driver.**

Cont..

1. Flathead (or Slotted Head) Screwdriver

screwdriver with a flat wedge-shaped tip that fits into a slot in the head of a screw.

type of: screwdriver. a hand tool for driving screws; has a tip that fits into the head



Cont..

2. Phillips Screwdriver.

- A Phillips screwdriver has a head with pointed edges in the shape of a cross, which fits neatly into the cross slots of a



Cont.

3. Pozidriv screw drive

- The Pozidriv drive style has the same **self-centering design** of a Phillips drive style but improves upon the two following factors:
 - **Increased torque** without cam-out.
 - **Greater surface** contact engagement between the drive and the recess in the fastener head making it harder to slip when installed



Cont..

4. Robertson (or Square) Screwdriver.

- It is known as a square screw or **Scrulox**, is a type of screw with a square-shaped socket in the screw head and a corresponding square protrusion on the tool.
- Both the tool and socket have a slight taper



Cont..

5. Torx (or Star) Screwdriver

- **Torx screwdrivers** have a **6-point** star shaped pattern .
- **star bits** as they let you use torque to screw more than usually possible.
- **The head shape** means they are less likely to strip which tends to ruin the end, meaning they are likely



Cont....

6. Hexagon (Hex) Screwdriver.

- **Hex or Allen** keys may not look like the typical screwdriver with a distinct **head**, shaft and handle,
- **but rather** an **L-shaped** piece of metal with hexagonal ends.
- They fit into **hexagon-shaped** holes in



Cont.

7. Spanner Driver

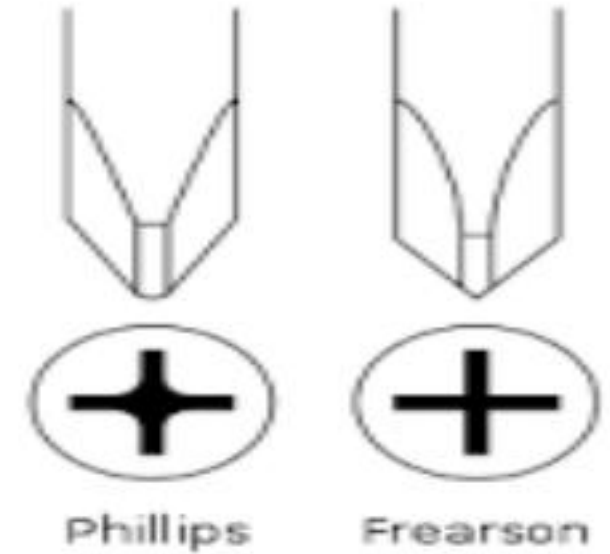
Spanner Hand Drivers
are used to install and remove
spanner head tamperproof
machine screws.



Cont.

8. Frearson Driver.

- The **Frearson screw drive**, also known as the **Reed and Prince screw drive**, and similar to a Phillips but the Frearson has a sharp tip and larger angle in the V shape.
- **One advantage** over the Phillips



K. wrench

- § *Most technical and servicing work/job requires the use of various types of wrenches.*
- § *Many fasteners and parts are copper or brass, aluminum and alloy, and therefore, are rather soft.*
- § *Never use pliers on parts designed to be handled with wrenches.*
- § *A service technician or worker needs several types and sizes of wrenches.*
- § *They should be accurately machined and ground to fit the nut or bolt head accurately and it must fit as much of the hexagon as possible*

Types of wrench listed in the order preferred

a) Socket wrenches

b) Box wrenches

c) Open end wrenches

**d) Adjustable
wrenches**

e) Hex key wrenches

a) Socket wrenches

- If the nut or bolt head has not enough room around it, the socket is the best wrench to use*
- A nut driver is a small direct drive socket wrench.*



Cont..

b). Box wrenches

- *Box wrench* can be used in a tight space where a socket wrench cannot go.
- *Box wrenches* are usually 12-point and provide a powerful non *damaging* grip and the nut or bolt,
- *Box wrenches* maybe straight, offset, or double offset.
- *Most box wrenches are double ended*



Cont..

C) *Open End Wrench's*

- **Open end wrenches** can slide on the nut or bolt head from the side.
- They are used in **close spaces** on union in other places where the socket wrench and box wrench cannot be used.



Cont..

- *Another popular wrench used in work is the **combination** open end and box socket.*
- *Both ends are the same size.*



Combination wrench

D) . Adjustable wrenches

- **Often, odd size** nuts and bolts are found in work.
- Therefore, wrenches with adjustable jaws are necessary in the tool kit.
- **Adjustable** be kept in a...



Cont..

E). Hex Key Wrenches.

- **Hex key wrenches** are constructed of alloy steel with a hexagonal (six-point) tip.
- **A common type of hex key** is the fold up tool with many key sizes in one handle.
- **Individual L-keys and T-handle** hex keys are frequently used for long reach operations,

- such as set screws on pulleys, rotors and PCB



L . Measurement and Level Tools (A layout tool)

- Is a tool used to measure or mark wood, metal, and other materials.
- In measuring instrument each tool has its own duties and operational system for example.

1. STEEL RULE:- is used to measured the length and the diameter of our work pieced such is a hardened steel rule which is graduated in **cm, mm, and half mm, (0.5mm)**

Cont..

2. TAPE RULE:

it is a thin flexible metal graduated in **meter (M), cm and mm**



3. T Square

- T-squares are used to draw horizontal lines in manual drafting.
- They can also be used to layout cut lines on drywall and p



Cont..

4. PROTRACTOR:-

- Its is an instrument which is used to make and check angels from 0° up to 180° mostly such instrument is made from transparent substance

5. CALIPER:- There are two types of caliper

1. Inside caliper

2. Outside caliper

- **Inside caliper:-**The inside calipers are used to measure the internal size of an object



Cont..

b. Outside caliper:-

- Outside **calipers** are used to measure the external size of an object.
- With some understanding of their limitations and usage these instruments can provide a high degree of accuracy and repeatability.



Cont..

6. MICRO METER: -

§ Its is a **precision** (free from error) measuring instrument which is Used when the requirement **measurements** **0.01 mm.**

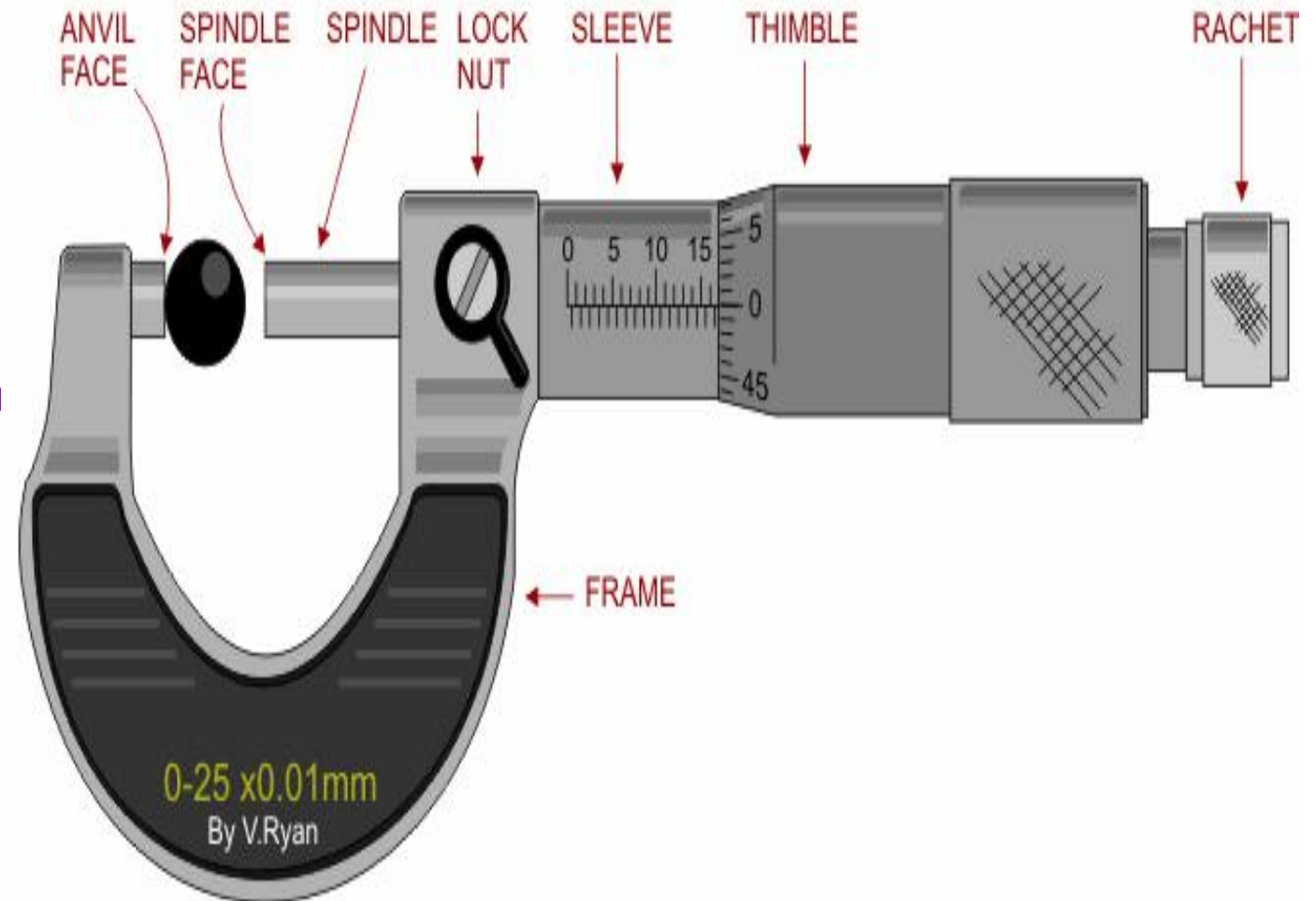
§ it is used to measure the **outside dimensions** of flat round and square work Piece if it is the, **outside micrometer** .

§ **Each Micro Meter** has the Same measuring range which is **25mm.**

Cont..

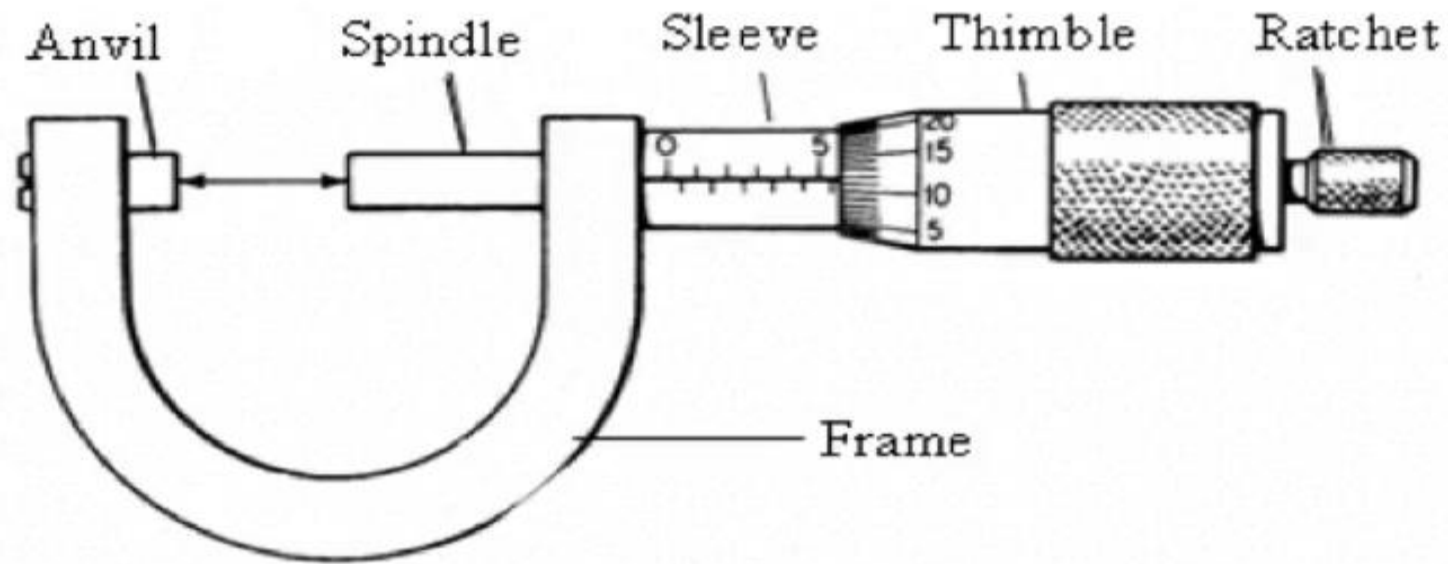
The main part of micro meter are:-

- v **Frame**
- v **Anvile**
- v **Spindle**
- v **Barrel (sleeve)**
- v **Thimble**
- v **Ratchet**
- v **Lock nut**



How to use the Micrometer screw gauge

- Place the object whose thickness is to be measured in between the jaws (the anvil and the spindle) of the micrometer.
- Rotate the ratchet clockwise until the jaws touch the object. As soon as the object is gripped tight enough, it starts to slip, making a characteristic sound.
- Take the reading in three steps as shown below.



Cont..

- **1. Frame:** - The C-shaped body that holds the anvil and barrel in constant relation to each other.
- **2. Anvil:** - The shiny part that the spindle moves toward, and that the sample rests against.
- **3. Spindle:** - The shiny cylindrical part that the thimble causes to move toward the anvil.
- **4. Lock nut / lock-ring / thimble lock:** - the knurled part (or lever) that one can tighten to hold the spindle stationary, such as when momentarily holding a measurement.
- **5. Sleeve / barrel / stock:** - The stationary round part with the linear scale on it. Sometimes vernier markings.
- **6. Thimble:** - is movable part of micro meter it rotates around the barrel manually. Each graduated line on the thimble represents the displacement of spindle which is equal to 0.01mm when the thimble rotates one cycle. The spindle moves 0.5mm towards the anvil.

Cont..

7. Ratchet:- indicates the correct measuring pressure by giving sound

8. Datum line:- is the line which is found along the barrel

9. The long graduated lines across the datum line at the side of the number **0 is called Major division (MD)**. They are measured in **“1.00”mm**.

10. The small graduated line across the other side of the datum line is called **minor division on (MID)**. They are measured in **1/2mm (0.5mm)**.

Cont..

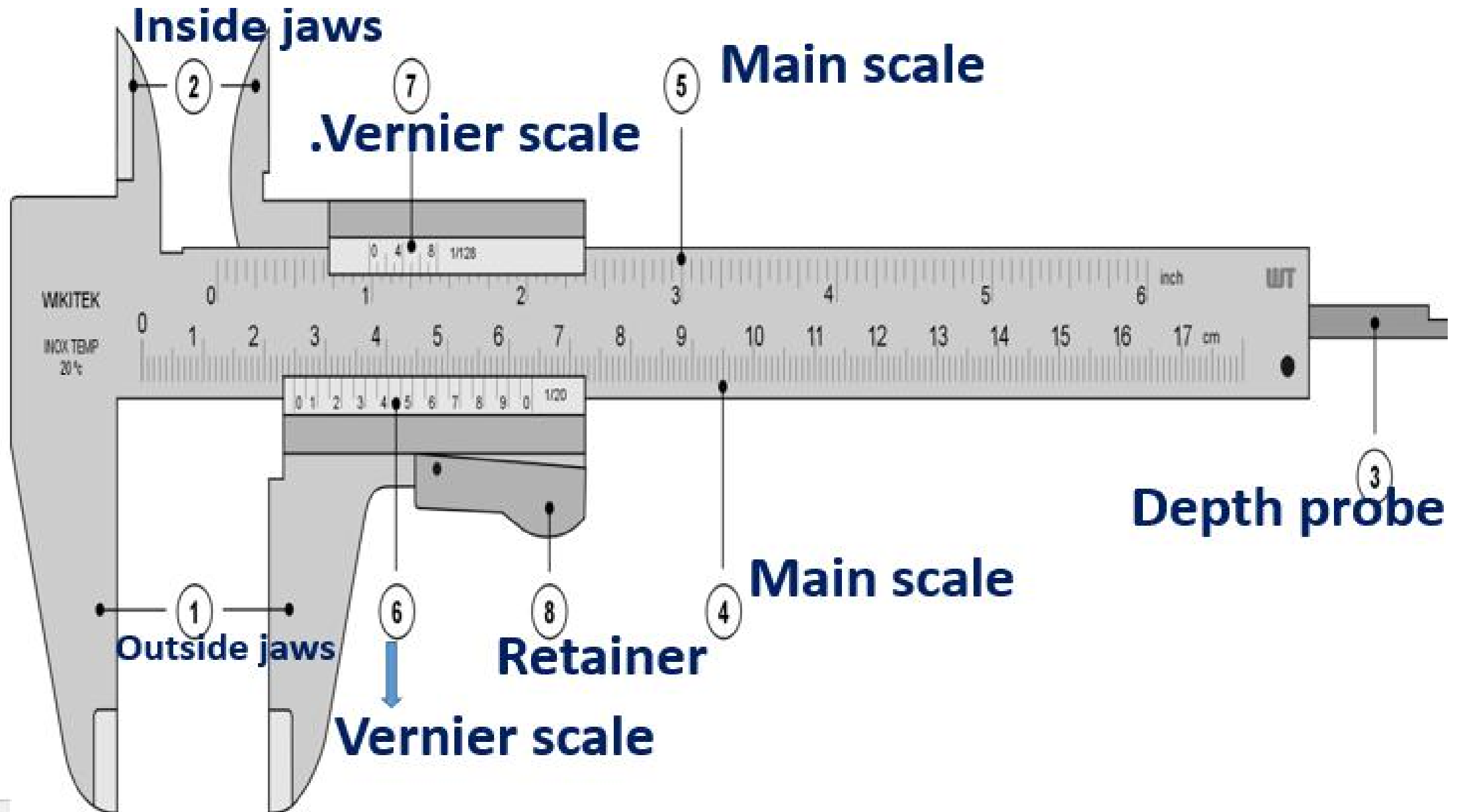
7VERNIER CALIPER: -

- Vernier caliper is a precise measuring instrument which designed to make accurate measurement of **0.1mm or 0.05mm**.this instrument is used to measure the width, the diameter, and the depth of our work pieces.

The main parts of vernier caliper are

- 1. Outside jaws**
- 2. Inside jaws**
- 3. Depth probe**
- 4. Main scale**
- 5. Main scale**
- 6. Vernier scale**
- 7. Vernier scale**
- 8. Retainer**

Cont..



0

4

8

1/128in

0

1

2

3

4

5

0

1

2

3

4

5

6

7

8

9

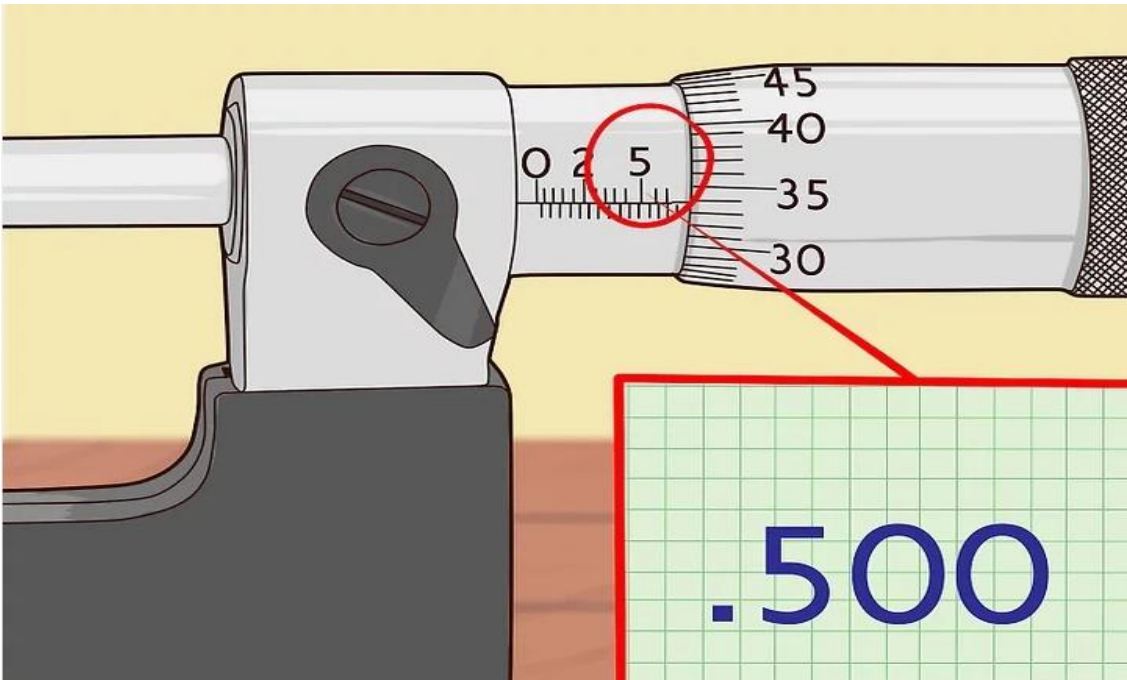
0

0.05mm

Cont..

- 1. Outside jaws:-** used to measure external diameter or width of an object
- 2. Inside jaws:-** used to measure internal diameter of an object
- 3. Depth probe:-** used to measure depths of an object or a hole
- 4. Main scale:-** scale marked every mm
- 5. Main scale:-** scale marked in inches and fractions
- 6. Vernier scale:-** gives interpolated measurements to **0.1 mm** or better
- 7. Vernier scale:-** gives interpolated measurements in

Method 2: Reading an Inch Micrometer

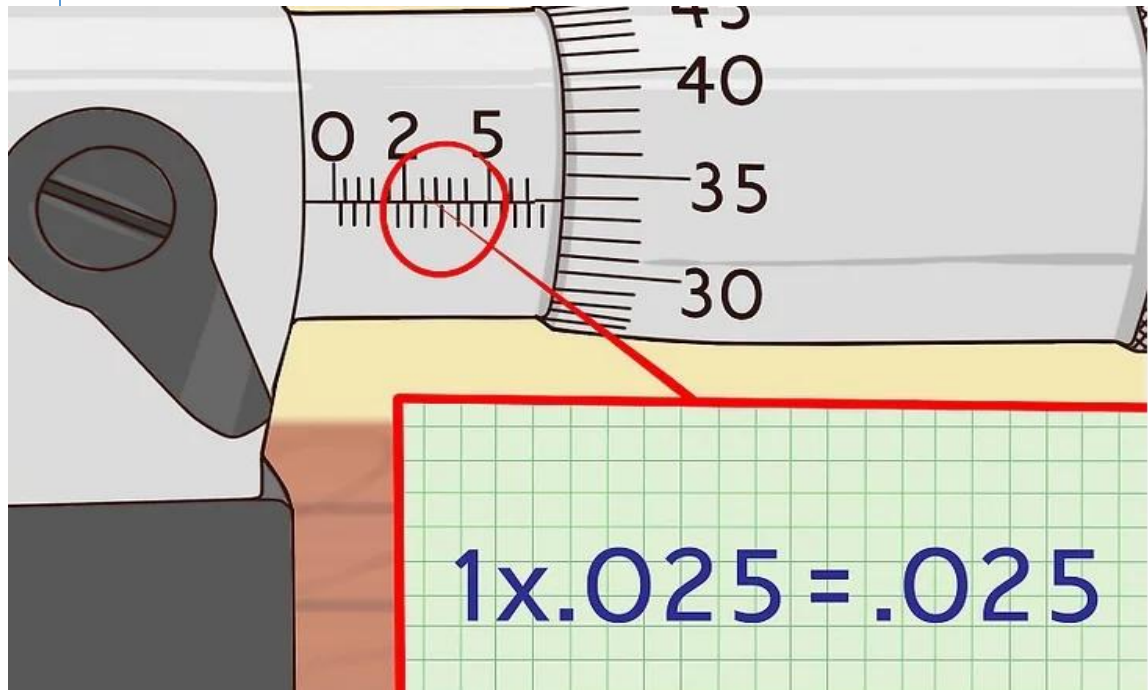


1. Learn the different number scales on the thimbles.

- On the sleeve is a scale that measures by the one-hundred thousands or $1/10$ of an inch; in decimal form it would be .100.*
- In between those whole numbers are three lines that represent twenty-five thousandths of an inch; in decimal form, it would look like .025.*
- The thimble has evenly spaced lines that represent one-thousandth of an inch; in decimal form it would be .001.*

Cont..

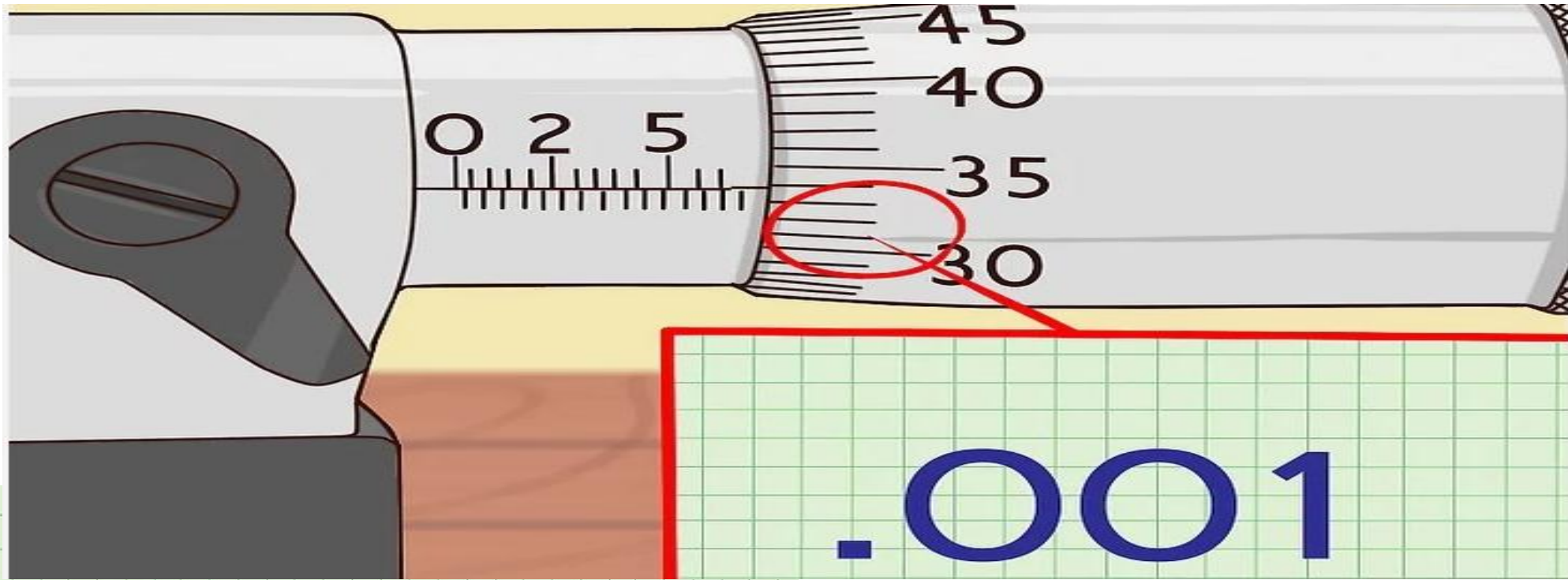
- Above the whole number scale on the sleeve are lines that measure to ten-thousandths of a inch; in decimal form it looks like .0001.



2. Read the whole number on the sleeve first.

- The last visible number will read as the thousandths. For example, if the last number you can see on the sleeve is 5, then it would read 500 thousandths, or .00005.

Cont..



$$.500 + .025 + .001 = .526$$



Electrical Test instrument and measurement

Test instrument:-are used to indicate the magnitude of electrical quantities such as voltage, current and resistance etc.

They are:-

1. **Volti meter**
2. **Voltage tester**
3. **Watt meter**
4. **Kilo watt hour meter**
5. **Frequency met**

electrical measurement

- **Volti meter:-is** used to indicate the magnitude of electrical quantities.



**Digital multi meters
multi meter**



Analogue

Cont....

- Voltage tester:-

Its is used to indicate whether an electrical line is negative or not.



Voltage tester

§ Watt meter:- is used to measure an electrical power.



Watt meter

Cont....

- **Kilo watt hour meter**:- is used to indicate the consumed electrical energy.



Kilo watt hour meter

- **Frequency meter**:- is used to indicate the revolution of generators in cycle per second



Frequency meter

Cont....

Safety Requirements:-

- Testing instruments are more sensitive devices. Therefore, we have to take a great care for them based on the given instructions by your instructor/trainer

M. Power Hand Tools

Power tools: - are tools which perform their duties by an electrical power.

- They are:-

a. Electrical soldering iron (soldering Gun):-

are used to change electrical energy in to heat energy for the purpose of soldering processes.



Electrical soldering iron

Cont....

b. Electrical plate Iron:- is used to make clothes smooth by the means of heat.



Electrical plate
iron

Cont....

- § *Electric drill* should be grounded for safety.
- § *The metal frame* of the drill should be electrically connected to a good ground.
- § *Most electric drills* are equipped with a three prong grounded plug.
- § *If the circuit to which the drill is connected is not provided with a three prong grounded socket, a grounded adaptor should be used.*
- § *Some hand drills have the electric motor insulated from the case, and do not need grounding.*

TYPES OF DRILL MACHINES

- 1. Improvised Mini Drill Press*
- 2. Drill -Grinder*
- 3. Pedestal Drill Press*
- 4. Double Pinion /''Eggbeater'' Hand Drill*
- 5. Hand Drill*
- 6. Electric Hand Drill*
- 7. Battery Operated /Cordless Hand Drill*
- 8. Pedestal drill press*

Cont....

Mini drill press – used for drilling small item and PCB for electronic products



MINI DRILL PRSS F

Improvised mini drill press – fabricated by copying the original drill press using only the double pinion drill, used for small items that needs a controlled rpm movement



IMPROVISED MINI
DRILL PRESS

Cont....

- ***Drill - Grinder*** – the double purpose machine that can be used for both drilling and grinding



- ***Pedestal drill press*** - A drill press is a fixed style of drill that may be mounted on a stand or bolted to the floor



PEDESTAL DRILL
PRESS

Cont....

- **Electric hand drill** – the boring or holing equipment using electricity for easiness of work and having a faster rpm for faster work

ELECTRIC HAND DRILL



- **Cordless/battery operated hand drill** – used for holing or drilling where electricity is not available, but usually used for screw application.



Unit Two:

2. Selection of measuring instruments

The following content and topics are coverage as:

Ø methods of checking **hand tools** and **measuring** instruments

Ø **Isolation** of faulty tools

Ø Selection of **measuring instruments**

Ø **accurate** measurements

2.1. Methods of checking hand tools and measuring instruments

- *Measurement* the process of associating numbers with physical **quantities** and **phenomena**.
- *Measurement is fundamental to the sciences; to engineering, construction, and other technical fields; and everyday activities.*
- **Concepts and measurement principles**
 - Ø **Standard** : is a material measure or physical property that defines or reproduces the unit of measurement of a base or derived quantity.
 - Ø **Accuracy** : The closeness of the **agreement** between the result of a **measurement** and a true value of the measure

Cont..

Ø **Precision** *The closeness of the agreement between the results of successive measurements of the same measure and carried out under the same conditions of measurement. Precision is also called **repeatability**.*

Ø **Reproducibility** : *The closeness of the agreement between the results of measurements of the same measure and carried out under **changed conditions** of measurement*

Cont.

Fundamental and derived units and their definition

§ At the time of measuring a physical quantity, we **must express** the **magnitude** of that quantity in terms of a unit and a **numerical** multiplier,

§ **i.e., Magnitude of a physical quantity = (Numerical ratio) × (Unit)**

§ **The mathematical ratio** is the number of times the unit occurs in any given amount of the same quantity and, therefore, is called the number of measures.

§ In the International System of **Units**, the fundamental

Table 2.1 table of fundamental units

Physical quantity	SI unit	Symbol	Definition
Length	Meter	M	The length of path travelled by light in an interval of $1/299\,792\,458$ seconds
Mass	Kilogram	Kg	The mass of a platinum– iridium cylinder kept in the International Bureau of Weights and Measures.
Time	Second	Sec	9.192631770×10^9 cycles of radiation from vaporized caesium-133 (an accuracy of 1 in 10^{12} or 1 second in 36 000 years)
Temperature	Kelvin	K	The temperature difference between absolute zero and the triple point of water is defined as 273.16 kelvin
Current	Ampere	A	One ampere is the current following through two infinitely long parallel conductors of negligible cross-section placed 1 meter apart in a vacuum and producing a force of 2×10^{-7} newtons per meter length of conductor

Cont..

Luminous intensity	Candela	Cd	One candela is the luminous intensity in a given direction from a source emitting mono chromatic radiation at a frequency of 540 tera-hertz ($\text{Hz} \times 10^{12}$) and with a radiant density in that direction of $1.4641 \text{ mW/steradian}$. (1 steradian is the solid angle which, having its vertex at the centre of a sphere, cuts off an area of the sphere surface equal to that of a square with sides of length equal to the sphere radius)
Matter	Mole	Mol	The number of atoms in a 0.012 kg mass of carbon-12

Cont.

- **Derived Units** and **Other quantities**, called derived quantities, are defined in terms of the **seven base quantities** via a system of quantity equations.
- The **SI derived units** for these derived quantities are obtained from these equations and the seven SI base units.

Cont.

Table 2.2 Examples of SI derived units

Derived quantity	Name	Symbol
Area	square meter	m^2
Volume	cubic meter	m^3
speed, velocity	meter per second	m/s
Acceleration	meter per second squared	m/s^2
wave number	reciprocal meter	m^{-1}
mass density	kilogram per cubic meter	kg/m^3

Cont.

specific volume	cubic meter per kilogram	m^3/kg
current density	ampere per square meter	A/m^2
magnetic field strength	ampere per meter	A/m
amount-of-substance concentration	mole per cubic meter	mol/m^3
Luminance	candela per square meter	cd/m^2
mass fraction	kilogram per kilogram, which may be represented by the number $1 \text{ kg}/\text{kg} = 1$	

2.2. *Electrical quantities /electronic units*

- *Units that can be measured in Electrical /electronic include,*
 - *current,*
 - *voltage,*
 - *power,*
 - *resistance,*
 - *conductance,*
 - *charge, and*
 - *frequency.*

Cont.

*i. **Voltage**: defining when some **distance separates** two bodies with **unequal charges** they risk the potential for doing work.*

- Its unit is **volt** .A device measure voltage is known as **voltmeter** .*

ii. Resistance is current flowing through a circuit encounters opposition. This **opposition** is referred to as resistance. Its unit is ohm. A device measure voltage is known as **ohmmeter**.

iii. Current:- is the movement of charges in a conductor. It is the measure of the number of electrons that flow past a given point notice per second. One AMP is the amount of current that flows when one coulomb flows past the point in one second .A device measure

Cont.

- **There are two types of A Current**

- a) Alternating current**

- b) Direct Current (DC):**

a) Alternating current describes the flow of charge that changes direction periodically. As a result, the voltage level also reverses along with the current. AC is used to deliver power to houses, office buildings, etc.

b) Direct Current (DC): Direct current is a bit easier to understand than alternating current. Rather than oscillating back and forth, DC provides a constant voltage or current.

Cont.

iv. Siemens:- Conductivity of a material is the ease with which it passes electrons.

- Conductivity and resistivity of a material are inversely related by the formula **$G=1/R$** .
- The unit of conductance is the Siemens.
- The symbol used for the Siemens is (S).

***V. watt** is the unit of power or the rate of doing work in an electrical circuit. The power converted in an electrical circuit is 1 watt when energy is converted at the rate of 1 **joule-per-second**.*

Cont.

***VI. Coulomb (Q)** is the unit of electrical charge. One coulomb is a charge of 6.25×10^{18} electrons.*

- A flow of one coulomb past a point in one second is one ampere.*

***VII. Frequency** is the number of times an event occurs in a given period. In electrical circuits, frequency is usually given in cycle-per-second.*

- By international agreement, the term Hertz (Hz) has been adopted to mean cycle-per-second.*

Cont.

VIII. Ranges of Electrical Units:- As we noted earlier, electronics is a science which uses **very large** and **very small units**, such as

- **A thousand-ohm resistor,**
- **A millionth-farad capacitor,**
- **A thousand million-cycles-per- second and soon.**
- To save time in writing and speaking these terms,

Cont.

2.3 Table of the most Common prefixes used in Electronics

Prefix	Symbol	Value
Pico	P	10^{-12}
Nano	N	10^{-9}
Micro	μ	10^{-6}
Milli	M	10^{-3}
Kilo	K	10^3
Mega	M	10^6
Giga	G	10^9
Tera	T	10^{12}

Unit Three:-

3. Use hand tools and measurement instrument

- *This unit will also assist you to attain the learning outcomes stated in the cover page.*
 - ✓ *Cleaning measuring instruments*
 - ✓ *Undertake instruments store in proper manner*
 - ✓ *Use standard operating procedures*
 - ✓ *Report malfunctions, unplanned or unusual events*
 - ✓ *Identify secondary instrument and absolute instrument*

3.1. Standard operating procedures Methods of cleaning measuring instrument

- **Standards and code of practice**
- **Cleaning** is the complete removal of food soil using appropriate detergent chemicals under recommended conditions.

Cleaning Methods

- ▼ *Mechanical Cleaning:- Often referred to as **clean-in-place (CIP)**. Requires no disassembly or partial disassembly.*
- ▼ *Clean-out-of-Place (COP):- Can be partially disassembled and cleaned in specialized COP pressure tanks.*
- ▼ *Manual Cleaning:- Requires total disassembly for cleaning and inspection.*

Cont..

Scheduled Cleaning

- ▼ *The environment in which you use it: Some situations may cause measuring tools to require cleaning more often.*
- ▼ *The task for which you use it: The job you use the tool for can also impact how often it requires cleaning.*

•3.2. Standard operating procedures

- Instruments store in proper manner*
- This **standard operating procedure (SOP)** describes procedures that will be used to obtain field Parameter measurements for surface water and groundwater parameter samples.*
- These temperature, and **specific conductivity (S.C.)**.*
- It describes field measurement procedures, personnel responsibilities and qualifications, and **quality assurance / quality control (QA/QC)** procedure.*

Cont..

Five common causes of equipment failure

Ø Improper operation

Ø Failure to perform preventive maintenance

Ø Too much preventive maintenance

Ø Failure to continuously monitor equipment

Ø Bad (or no) reliability culture

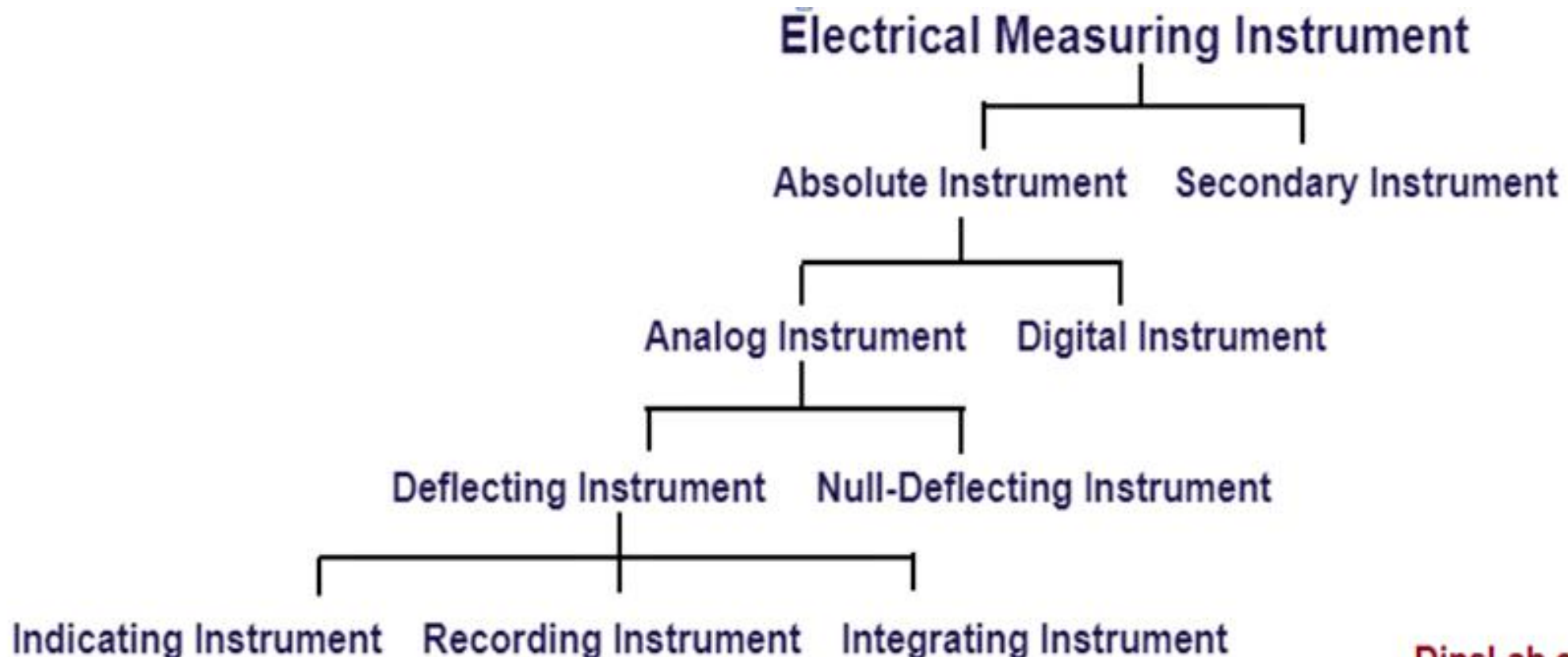
3.3. Secondary instrument, absolute instrument and store in proper manner

As per the Electrical Quantities, instruments are broadly classified into two parts.

Classification of electrical measuring instruments.

Classification according to the Nature of the Operation

- **1. Absolute Instrument:-** this instrument



Cont..

- Gives the value of the electrical quantity to measure in terms of the **constant** and its **deflection**.
- This instrument is known as '**Absolute Instrument**'.
- It is also called a **Primary Instrument** or **Indirect Instrument**.
- **Example:- Tangent Galvanometer** is the best example of an absolute instrument. It is used for detecting and displaying an electric current unit.

Cont..

- **Secondary Instrument:-** The instrument gives the value of the quantity to be measured directly into the deflection. This instrument is known as **‘Secondary Instrument’**.
- These instrument values are required to **compare** with absolute **instruments** or the standard values of the instruments.
- **Example:** Ammeter, Volt meter, Watt meter, etc are examples of secondary instruments.

Cont..

Classification according to the Nature of the Operation

§ The instrument can also be classified based on the nature of the operation. They majorly fall into the secondary instrument.

This instrument is divided into four major parts.

- A. Indicating Instrument
- B. Recording Instrument
- C. Integrating Instrument
- D. Null Deflection instrument
- E. Shortly describe as,

Cont..

- **A. Indicating Instrument:-** the Indicating Instrument displays only the value of the electrical quantities per time of measurement.
 - This instrument gives the reading only when connected to the electrical supply. Otherwise, it goes to zero position.
 - **Example:** Ammeters, Voltmeters, Watt meters, etc are example of the indicating instrument.
- **B. Recording Instrument:-** the Recording Instrument displays and records the reading of the electrical quantities at per time of measurement.
 - This instrument is generally used in the Generating Station and Substation.
 - **Example:** ECG, and X-Rays are examples of recording instruments

Cont..

C. Integrating instrument:- the Integrating Instrument displays, record, and add the numerical value of the reading of the electrical quantities per time of measurement

Example :- Energy meter, and Ampere-hour meter are examples of the integrating instrument

- **D. Null Deflection Instrument:-** the Null Deflection Instrument shows the reading of the electrical quantities without the deflection angle at per time of measurement . **AC**

Instrument:- the AC Instrument is connected with the AC supply. Further, they are classified into two parts .

v **AC Instrument**

v **DC Instrument**

Ø **Example:-**The potentiometer is an example of a null deflection instrumen

Cont..

2. DC Instrument:- the instrument is connected with the DC supply.

Example: 'Permanent Magnet Moving Coil Instruments' is the best example of the DC instrument.

Classification according to the Effect

Due to the various **magnetic effects, electromagnetic induction effects, electrostatic effects, thermal effects, chemical effects**, etc., there are more chances to get the application or system damage. So, multiple types of instruments are used to measure and compare the unknown quantities with the standard value. These instruments protect the device.

Cont..

The classification is as follows.

- Moving Coil Instruments
- Moving Iron Instruments
- Induction Instruments
- Electrostatic Instruments
- Electrolytic Instruments
- Hot Wire Instruments

Cont..

Classification according to Moving Coil [M.C.] Instrument

The Moving Coil Instrument is classified into two parts.

- Permanent Magnet Moving Coil [PMMC] instrument
- Electro dynamic or Dynamo meter types instrument

Classification according to Moving Iron [M.I.] Instrument

The Moving Iron Instrument is classified into two parts.

- Attraction type M.I. instrument
- Repulsion type M.I. instrument

Cont..

Classification according to an Electrical Application

In daily routine, multiple instruments are used for multiple purposes.

Instruments work on AC or DC electrical sources as per the appliances use.

Here is the list of the most popular and widely used instruments.

Ammeter:- is an instrument used to measure the amount of electrical current intensity in a circuit. The unit of measure is ampere (a). It is connected along or series to the circuit.

Voltmeter:- is an instrument used to measure electrical pressure or voltage of a circuit. The unit of measure is volt (v). This is connected across or parallel to the circuit.

Cont..

Clamp Ammeter:- is also called tong-tester. It is used to measure current flowing in a conductor. It is clamped or hanged in a conductor.

Multi meter:- A multi meter is a popular type of electrical measuring instrument. Like its name, it works like an ammeter, voltmeter, and ohmmeter to measure current, voltage, and resistance respectively.

The multi meter is available into two different forms, like-Analog and digital

