RGPVNOTES.IN

Program : **B.Tech**

Subject Name: **Basic Mechanical Engineering**

Subject Code: **BT-203**

Semester: **2nd**

UNIT II

Measurement, Measurement Concept, Measurement Errors, Measurement of Temp., Pressure, Velocity, Flow strain, force and torque, Study of Vernier-caliper, Micrometer, Dial gauge, Slip gauge, Sine-bar and Combination set

Production Engineering, Production related theoretical aspects, Study of processes like casting, carpentry, and welding etc Introduction of Lathe and Drilling machines with their different operations.

Measurement Types

1) **Direct measurement**: In this the value of measured quantity is measured directly without doing any calculations. *Example:* Weight of a substance is measured directly using a physical balance.

2) **Indirect measurement**: The value of the quantity is obtained from measurements carried out by direct method of measurement. *Example:* Weight of a substance can be measured by measuring the length, breadth & height of the substance directly and then by using the relation

Weight = Length x Breadth x Height x Density

3) **Measurement without contact**: The sensor is not placed in contact with the object whose characteristics are being measured like infrared sensors.

4) **Measurement by comparison**: In it measured value of any quantity is compared with a known value of the same quantity.

5) **Method of differential measurement**: Based on the comparison of the quantity to be measured with a quantity of the same kind, with a value known to be slightly difference from that of the quantity to be measured, and the measurement of the difference between the values of these two quantities.

Precision & Accuracy for Measurement

Precision: It is the process in which degree of repetition is counted for the same quantity measurement. It is also known as repeatability of the measuring process. It exists only when a set of observations is gathered for the same quantity under common conditions.

Accuracy: It shows the agreement between the measured and true value. The difference b/w the measured & true value is known as measurement error.

To understand the difference between Precision and Accuracy, the following simple example can be said. A watch will give Precision readings (same time) all the times, but will give Accurate readings (correct time) only 2 times in a day.

Factors affecting the accuracy of measuring system

a) Factors affecting the standard of measurement:

Co-efficient of thermal expansion
Elastic properties
Stability with time
Geometric compatibility

b) Factors affecting the work piece to be measured:

Co-efficient of thermal expansion
Elastic properties
Arrangement of supporting work piece
Hidden geometry
Surface defects such as scratches, waviness, etc.

c) Factors affecting the inherent characteristics of instrument:

Repeatability & readability
Calibration errors

Effect of friction, backlash, etc
Inadequate amplification for accuracy objective
Deformation in handling or use

d) Factors affecting person:
Improper training / skill
Inability to select proper standards / instruments
Fewer attitudes towards personal accuracy measurements

e) Factors affecting environment:
Temperature, humidity, atmospheric pressure, etc
Cleanliness
Adequate illumination
Heat radiation from lights / heating elements

Errors during Measurement
It is the difference between the measured and the true value of the measured Quantity
Error = Measured quantity – True quantity

The error during measurement is expressed as an absolute error.
1) **Absolute error:** It is the algebraic difference between the measured value and the true value of the quantity measured.
2) **Relative error:** It is the result of the absolute error and the value of comparison used for the calculation of that absolute error.

Types of Errors

A) Error of Measurement
1) **Systematic error:** It is the error which happens during several measurements, made under the same conditions, of the same value of a certain quantity, remains constant in absolute value and sign or varies in a predictable way in accordance with a specified law when the conditions change.
The causes of these could be known or unknown.
Random error: This error comes in an unpredictable sequence in absolute value and in sign when a large number of measurements of a quantity are made under practically identical conditions. Random errors are non-consistent.
3) **Parasitic error:** This error comes in measurement because of improper handling of equipment.

B) Instrumental error
1) **Physical measure Error:** It is the difference between the nominal & the conventional value reproduced by the physical measurement
2) M**easuring mechanism Error:** It is the difference b/w the value indicated by the measuring system and the conventional true value of the measurement.
3) **Zero error:** It is the indication of a measuring instrument for the zero value for the measurement.
4) **Calibration error for a physical measure:** It is the difference b/w the conventional value measured by the physical measure and the nominal value of that measurement.
5) **Error due to temperature:** When the temperature of instrument does not maintain its reference value Then this error arises.
6) **Error due to friction:** It is the error due to the friction between the moving parts of the measuring instruments.
7) **Error due to inertia:** It is the error due to mechanical, thermal parts of the measuring instrument.

C) Error of observation

1) Reading error: It is the error of observation resulting from wrong reading of the indication by the observer for the instrument.

2) Parallax error: It is the reading error which is produced, when the index at a certain distance from the surface of scale, and reading is not in the correct direction.

3) Interpolation error: It is the reading error which is the result of the inexact evaluation of the position of the index

D) Based on nature of errors

1) Illegitimate error: It should not exist. These include mistakes and blunders, or computational errors they create chaos in the final results.

E) Based on control

1) Controllable errors: The source of error is known and it is possible to have a control on these sources.

2) Calibration errors: This is caused due to variation in the calibrated scale from its normal value.

3) Environmental Errors: International agreement has been reached on ambient condition which is at 20^0C temperature, 760 mm of Hg pressure and 10 mm of Hg humidity. Instruments are calibrated at these conditions. If there is any variation in the ambient condition, errors may creep into final results, of the three, temperature effect is most considerable.

4) Stylus pressure errors: Excess pressure during measurement is the cause of this error.

5) Avoidable errors: These errors may occur due to parallax in the reading of measuring instruments.

Causes of Errors

1) Errors due to deflection: When long bars get deformed or deflected. This elastic deformation occurs under their weight. The amount of deflection depends up-on the positions of the supports.

2) Errors due to misalignment: According to Abbes' principle, "the axis or line of measurement of the measured part should coincide with the line of measuring scale or the axis of measurement of the measuring instrument".

3) Error due to contact pressure: The variations in contact pressure, is the main cause of this error. The deformation of the work piece and the anvils of instrument depend upon the contact pressure and the shape of the contact surfaces.

4) Error due to vibrations: This could be because of moving body or part.

5) Error due to dirt: Because of improper maintenance dirty instruments gives wrong values.

6) Error due to poor contact: Because of improper handling the instrument gives the wrong value.

7) Error due to wear in gauges: Wear of measuring surfaces of instrument occurs due to repeated use.

8) Error due to looseness: This happens because of improper contact between the measuring part and the measuring device.

Temperature, Pressure, Velocity, Flow strain, Force and torque measurement:

Temperature Measurement

Temperature measurement, also known as thermometry, describes the process of measuring a temperature for immediate or later evaluation. There are following types of the engineer devices used for temperature measurement: thermocouples, resistive temperature devices (RTDs and thermostats), infrared radiators, bimetallic devices, change-of-state devices.

Thermocouple

Thermocouples made of different metals and joined at one end. Change in the temperature at that junction creates a change in electromotive force (emf) between the other ends. As temperature goes up, this output emf of the thermocouple is measured.

RTDs and thermostats

It works on the concept that the electrical resistance of a material changes as its temperature changes.

Infrared radiators

Infrared sensors are non-contacting devices. They infer temperature by measuring the thermal radiation emitted by a material.

Bimetallic devices

It works on the difference in rate of thermal expansion between different metals. Strips of two metals are joined together. When heated, one side will expand more than the other, and the resulting bending is translated into a temperature reading by mechanical linkage to a pointer. These devices do not require a power supply.

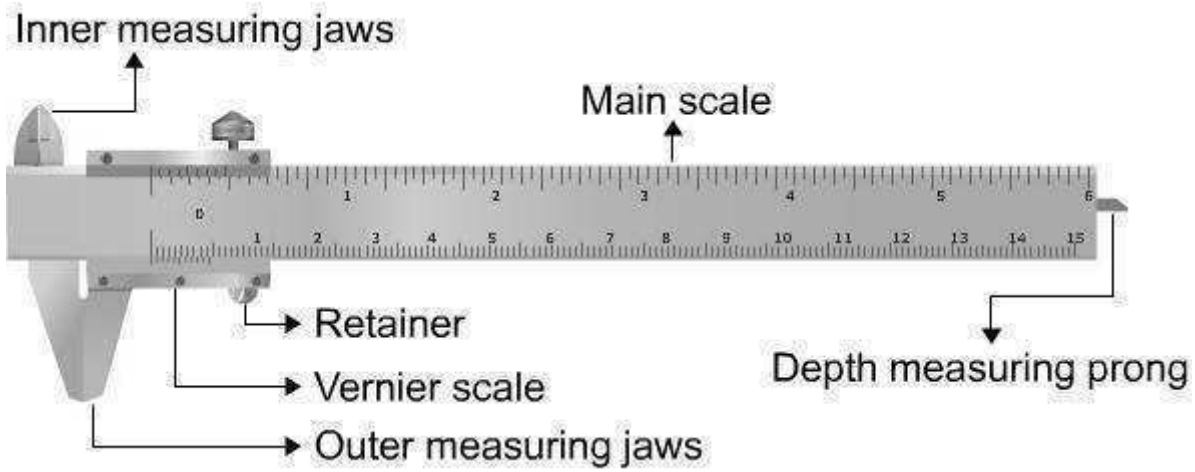
Change-of-state devices

Change-of-state temperature sensors consist of labels, pellets whose appearance changes once a certain temperature is reached. They are used, for instance.

Vernier caliper, Micrometer, Dial gauge:

Vernier caliper

It is an instrument that measures internal or external dimensions and distances. Parts of a Vernier Caliper



It consists of a main scale fitted with a jaw at one end, another jaw, having the Vernier scale, moves over the main scale. When jaws are in contact, the zero of the main scale and the zero of the Vernier scale should coincide. If both the zeros do not coincide, there will be a + or - zero error.

Least Count

It is the smallest reading which the instrument can calculated,

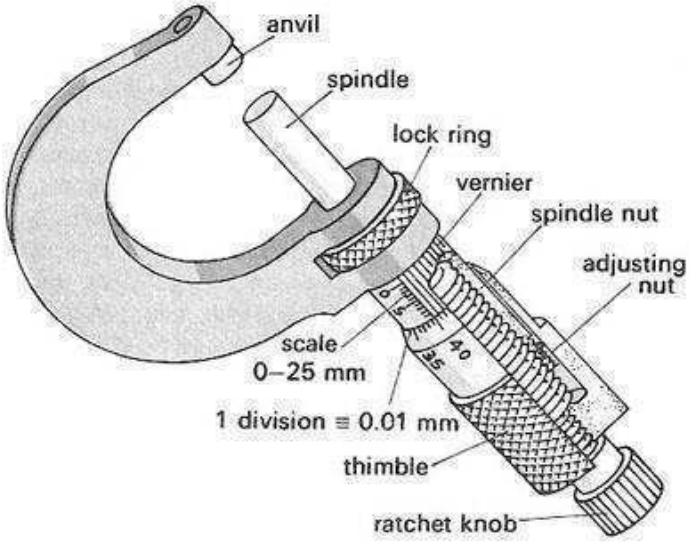
Least count = One Main scale division / Number of divisions in Vernier scale

Micrometer

A micrometer sometimes known as a **micrometer screw gauge** is a device widely used for precise measurement of components in mechanical engineering and machining as well as most mechanical trades, along with other metrological instruments. It is used for measuring dia. of objects like wires, with an accuracy of 0.001cm.

The least count of micrometer can be calculated using the formula:

Least count = Pitch / Number of divisions on the circular scale = 0.5 mm / 50 = 0.01 mm



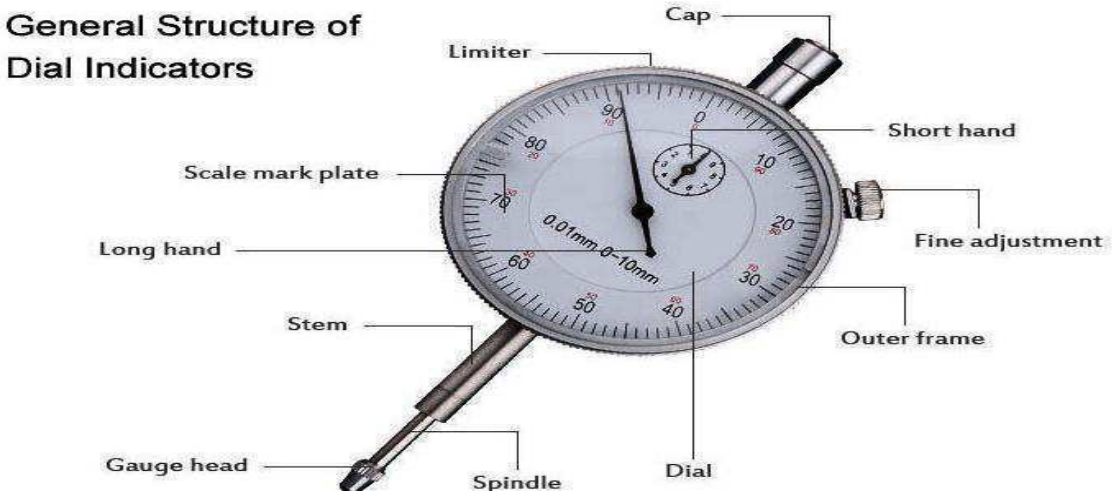
Dial gauge

Dial indicators are important devices used in manufacturing and metal engineering. These devices measure small linear distances that are important in the establishment of precision and accuracy. Dial gauge having following parts.

Graduated dial and needle- These are responsible for recording the minor increments that result out of the measurement procedure.

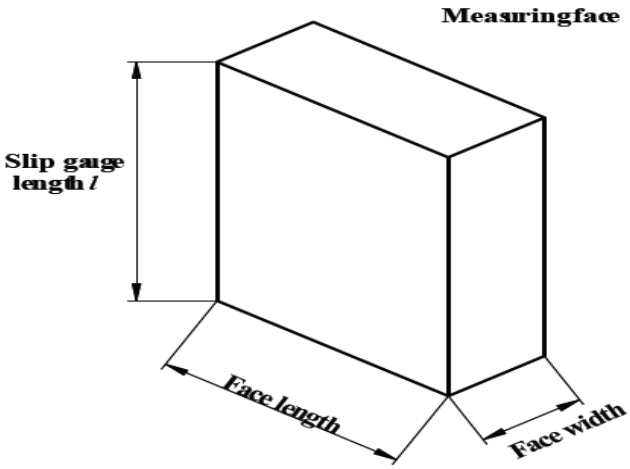
Embedded clock face and needle- These are smaller than the graduated dial and needle and are used for recording the number of needle rotations in the main dial.

Plunger- It is the moving part of a dial indicator that moves perpendicular to the testing object.



Slip gauges

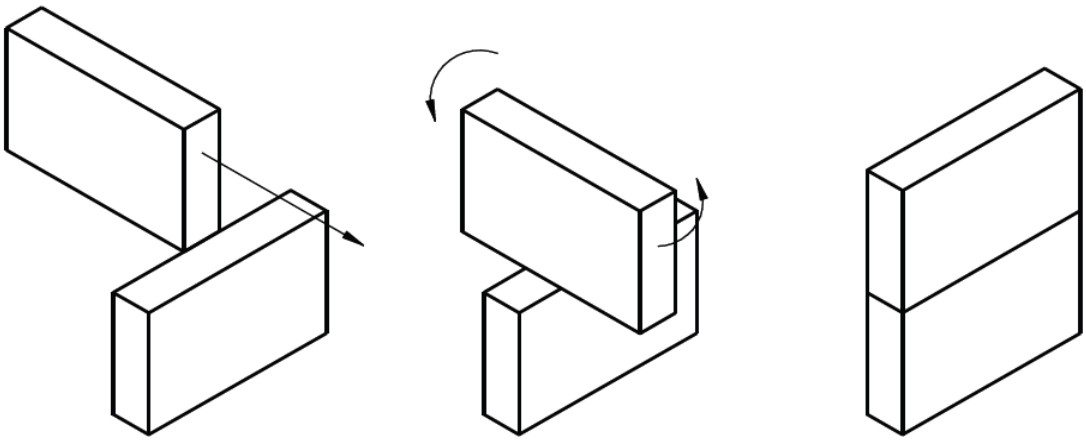
These are the rectangular blocks of steel having cross section of 30 mm face length & 10 mm face width



These blocks of steel have been hardened and stabilized by heat treatment. They are of size to very high standards of accuracy and surface finish. Correctly cleaned and wrung together, the slip gauges adhere to each Other by molecular attraction. They should then be cleaned, Smeared with Vaseline and returned to their case after use.

Wringing of Gauges:

Slip gauges are wrung together to give a height of the required dimension.

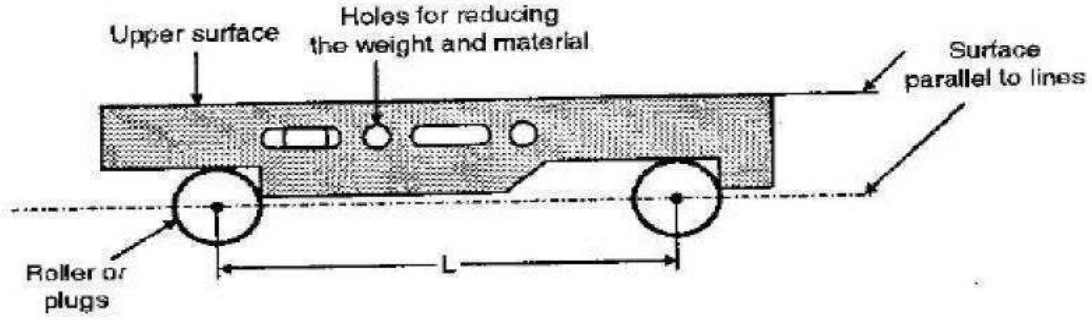


Wringing of Slip Gauges

Sine Bar:

It is a precision measuring instrument and is an excellent example of combination of linear and angular measurement. Consists of a bar carrying a suitable pair of rollers set at a known centre distance. It is made of high carbon, high chromium corrosion resistant steel.

If l is the linear distance between the axes of the rollers and *h* is the height of the slip gauge, then sin θ = *h*/l



Sine bar working principle:

First kept it on the surface plate, the work piece is then placed on the sine bar such that the surface whose angle is to be measured is facing upwards. Place the set of slip gauges below one end of the roller of sine bar such that the upper surface of the work piece is approximately parallel with the table surface. Place the plunger of the dial gauge on the upper surface of the work piece, Take readings with the dial gauge and note their difference.

Advantages of sine bar:

1. It is used for accurate and precise angular measurement.
2. It is available easily.
3. It is cheap.

Disadvantages:

1. The application is limited for a fixed centre distance between two plugs or rollers.
2. It is difficult to handle and position the slip gauges.
3. If the angle exceeds 45°, sine bars are impracticable and inaccurate.
4. Large angular error may results due to slight error in sine bar.

Combination Set :

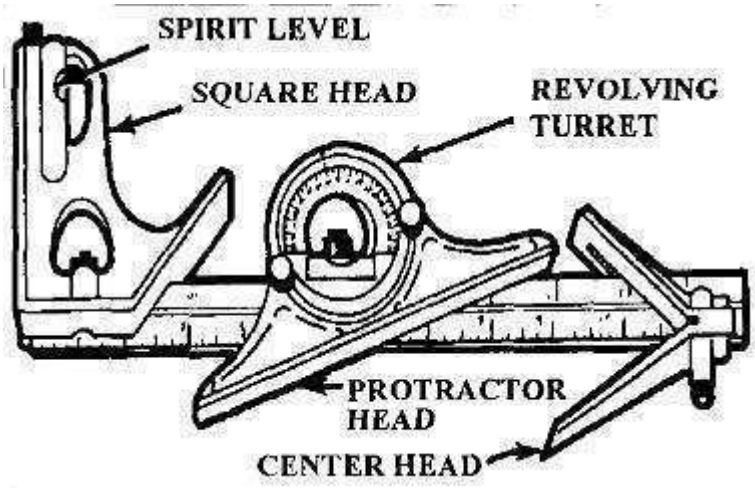
This is the most commonly used non-precision instrument in layout and inspection work.

It consists of scale, squaring-head, protractor and centre-head. One surface of the squaring head is always perpendicular to the scale and it can be adjusted at any place by a locking bolt and nut.

The squaring head also contains a spirit level which is used to test the surfaces for parallelism. It can also slide to any position and be locked there. A scribing point is also inserted into the rear of the base for scribing purposes.

The squaring head and scale can be used for height and depth measurements, inside and outside squaring operations.

The protractor is also capable of sliding along the scale. It contains a semi-circular disc graduated from 0 to 90° on either side of centre. With the help of protractor, the correct angle of the work can be checked.



Production Engineering

Theoretical aspects of production processes like casting, carpentry, welding:

Casting

Casting is one of the oldest manufacturing processes. It is the first step in making most of the products. Followed by the following steps for casting

Steps: -

Making mould cavity
Material is first liquefied by properly heating it in a suitable furnace
Liquid is poured into a prepared mould cavity
Allowed to solidify
Product is taken out of the mould cavity,
Trimmed and made to shape

Advantages

Molten material can flow into very small sections so that intricate shapes can be made by this process. As a result, many other operations, such as machining, forging, and welding, can be minimized. Possible to cast practically any material like ferrous or non-ferrous, the necessary tools required for casting moulds are very simple and inexpensive. As a result, for production of a small lot, it is the ideal process. There are certain parts (like turbine blades) made from metals and alloys that can only be processed this way. Size and weight of the product is not a limitation for the casting process.

Carpentry

Carpentry is the skill or work of making or fixing wooden objects or wooden parts of buildings it's a trade in which the primary work is the cutting, shaping and installation of building materials during the construction of buildings, concrete formwork, ships, timber bridges, etc.
For the carpentry work following tools are used

Carpentry Hand Tools:

- Hammer
- Tape Measure
- Chalk Line
- Carpenter's Pencil
- Utility Knife
- Tin Snips
- Nail Puller
- Speed Square
- Framing Square
- Levels
- Wood Chisel (1 inch)

Essential Power Tools:

- Circular Saw
- Drill (3⁄8" to 1⁄2" chuck)
- Reciprocating Saw

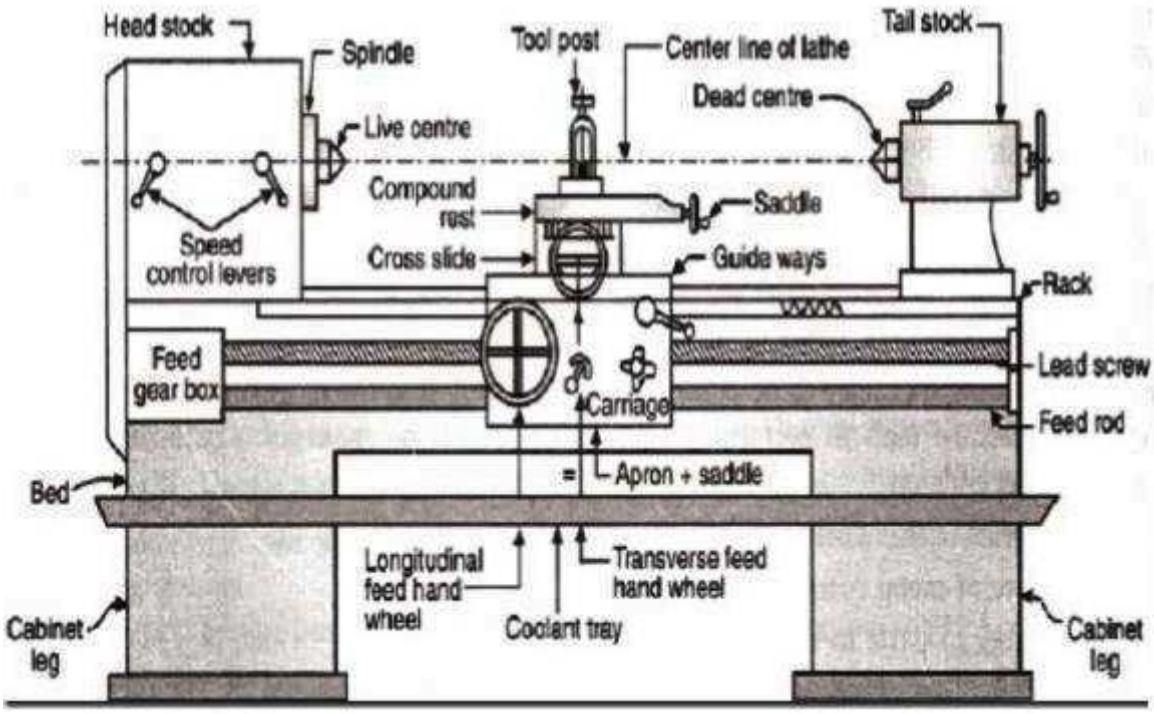
Welding

It's the process of joining two or more, similar or dissimilar metals by heating them to a suitable temperature, with or without application of pressure, filler material and flux. The heat may be supplied by electric are, combustion of gas, or electrical resistance etc.

Some of the welding methods are:
Gas welding – Also known as oxyacetylene welding
Electric Arc welding – Types are MIG and TIG, Submerged arc welding.
Resistance Welding – Spot welding, Seam welding are the types.
Solid State Welding – Cold welding, Friction welding are the types.
Radiant Energy Welding – Laser and electronic beam welding.
Low Temperature Welding – Soldering and Brazing are of the types.

Lathe and Drilling machines and their operations
Lathe
Principle of operation
In the lathe machine the work piece to be machined is held firmly and rotated above its axis, while the cutting tool is moved relative to work piece. Because of this reason the lathe machine is also known as Turning Machine.
The cutting tool which is made of harder material then that of work piece is feed against the work piece. It removes undesirable material from work piece.

Basic elements or Parts
Bed
Head Stock
Tail stock
Carriage
Lead Screw
Feed drive



Specification of Lathe
1. Overall Length of Bed- It is the total length of the lathe bed.
2. Swing length- It is the maximum diameter of work piece that can revolve between the centers without touching the bag. It is also the maximum diameter work piece that can be machined.
3. Distance between Centers- It is the distance between head centre and tail centre. It is also the maximum length of work piece that can be mounted between the centers.
4. Max. And Min. Spindle Speed- It gives the maximum and minimum speed at which the spindle rotates.

Types of Operations

Turning
Eccentric Turning
Taper Turning
Facing
Chamfering
Grooving
Parting
Knurling
Drilling
Boring

Drilling

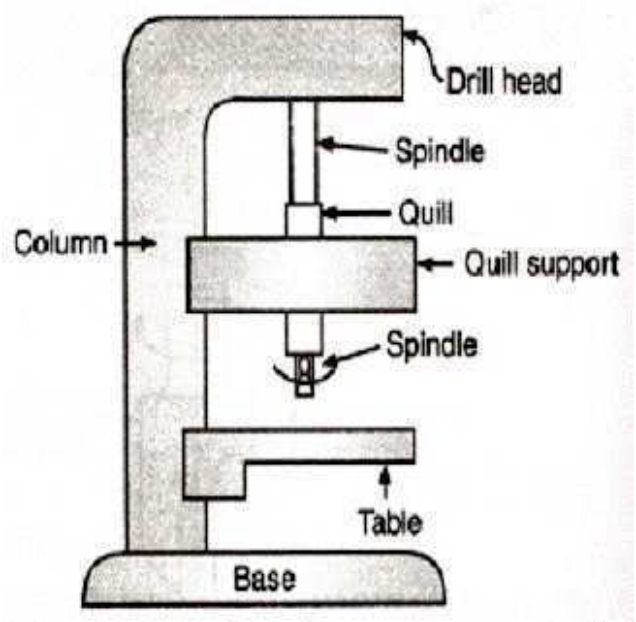
The process of making cylindrical hole in work piece is called drilling .The machine tool used for making the hole in work piece by forcing the rotating tool into stationary work piece is called as Drilling Machine.

Principle of operation

In a drilling machine the work piece is firmly kept on worktable. The work piece is stationary .The cutting tool called drill is press fitted into the spindle of drilling machine.

Basic elements or Parts

Base
Column
Work Table
Drilling Head
Spindle



Types of Operations

Drilling
Reaming
Boring
Counter boring
Spot facing
Counter Sinking
Tapping
Trepanning

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