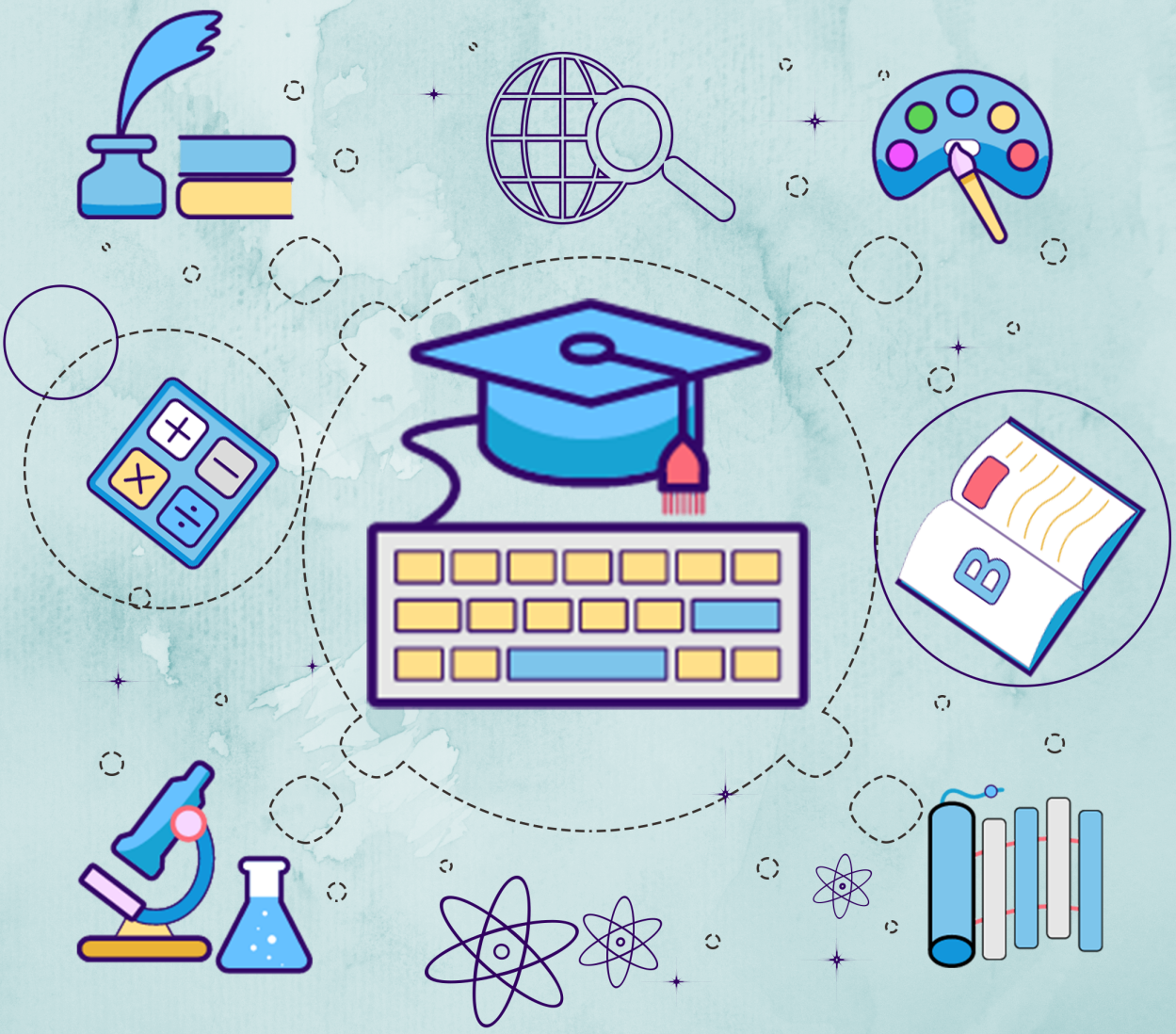
APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

KeralaNotes



SYLLABUS | STUDY MATERIALS | TEXTBOOK

PDF | SOLVED QUESTION PAPERS

www.keralanotes.com

KeralaNotes

KTU STUDY MATERIALS

BASICS OF MECHANICAL ENGINEERING

EST120

Module 3

Related Link :

- KTU S1/S2 STUDY MATERIALS
- KTU S1/S2 NOTES
- KTU S1/S2 SYLLABUS
- KTU S1/S2 TEXTBOOK PDF
- KTU S1/S2 PREVIOUS YEAR SOLVED QUESTION PAPER

MODULE - VI

MANUFACTURING PROCESS.

Manufacturing:

Production of finished products having definite geometric shape and properties in order to satisfy the needs.

Manufacturing Process

1. Primary manufacturing process

* Metal in a molten form or solid powder is made into the nearly required shape of the final product by creating cohesion among the particles.

e.g., casting, powder metallurgy, plastic moulding etc.

2. Deforming Process

*Original shape of a solid is converted to another shape maintaining the cohesion among particles.

e.g., forging, rolling, extrusion, sheet metal working, explosive forming, swaging etc.

3. Machining Process

Shape and size of the metal is changed by removing material from the unwanted region.

e.g., turning, drilling, grinding, milling, etc.

4. Joining Process

Two or more metal parts are united together to make intermediate product or final product.

e.g., resistance webbing, pressure welding, brazing, soldering, etc.

5. Surface finishing process

Provide required cleaning, surface finish and protective coating to the final product, without changing the dimensions of the part.

e.g., buffing, honing, electroplating, etc.

6. Property Modification Process

The material property of the product is changed to achieve the desired characteristics without changing its dimensions.

e.g., heat treatment and surface treatment process like, stress releiving, annealing, tempering, etc.

CASTING

Casting is a process in which molten metal is poured into a mould or cavity and allowed to solidify.

Molten metal

* The liquid form of the metal with which the component is to be made.

* Obtained by melting the metal by heating it to very high temperature.

* Cupola, Open hearth furnace, electric furnace, --- are the furnaces commonly used for melting metal.

Mould:

A negative print of the product to be cast.

Moulding:

The process of making mould of desired shape using sand, pattern and core so that the molten metal can be poured into it to produce casting.

Pattern:

Model or replica of the component to be made by casting. Has the shape and size of the final component.

Core:

Solid mass prepared using drysand, inorder to introduce into the mould cavity, to form a hole or recess.

Gate:

Channel or passage through which the molten metal flows to the mould cavity. The gating system include:

(i) Pouring basin
(ii) Sprue
(iii) Gates
(iv) Riser

Advantages of Casting

1. Cheapest method of fabrication.
2. Large size components can be produced easily.
3. Components of complicated shape can be cast easily and in lesser time.

4. Higher strength and rigidity.
5. Overall production time of the finalised component is reduced.
6. Required dimensional accuracy can be easily achieved.
7. Almost all metals and alloys and plastics can be cast.

Steps in Casting

1. Making the pattern
2. Preparation of moulding sand and making mould and core.
3. Melting of metal and pouring into the mould.
4. Cooling and solidification
5. Removing from mould
6. carrying out fettling(removing unwanted projection)
7. Final finishing and heat treatment.

Casting Process

1. Sand casting
2. Shell mould casting
3. Permanent mould casting
4. Die casting

5. Centrifugal casting
6. Investment casting

Sand Casting:

- Most widely used casting process.
- Most sandcasting operation use silica sand (SiO) mixed with other minerals.
- Used sand can be reused.

Gating system of sand casting

Major elements of sandcasting gate system are

1. Cope and Drag
   - The moulding flask is made up of two parts of gating system.
   - The top half is known as cope and bottom half is known as drag.
2. Mould Cavity
   - The molten metal flowing into the gap present inbetween cope and drag is known as mould cavity.
3. Pattern:
   - Geometry of mould cavity is created by

use of pattern.

4. Sprue:

- It is the funnel shaped cavity to flow the molten metal.
- The top of the sprue is known as pouring cup.

5. Runner:

- The molten metal is passed from sprue to the gate through runner.

6. Gate:

- It is a region where runner joins with mould cavity.

7. Riser:

- Riser is used to findout the mould cavity is filled or not.
- It also act as vent hole to flow out the gases which is generated in solidification process.

8. Core:

- It is used to obtain a desired hole in the cavity.

Defects in Casting

Imperfections in the castings.

1. Formation of blow holes.
2. Inclusion of foreign matter.
3. Incomplete cavity filling (misrun)
4. Rough surface
5. Localised enlargement.
6. Thin projections on casting
7. Small cavities formed on surface.
8. Internal air pockets are formed by rapid pouring of metal.

FORGING:

Forging is the process of changing the shape of a metal by heating it to plastic state and applying compressive force on it by sudden blows or steady pressure.

The shop in which forging is carried out is called smiths shop or smithy.

Advantages:

1. Improves structure of a metal and hence its

mechanical properties.

2. Can withstand heavy load conditions.
3. Higher reliability.
4. Metals can be easily shaped without damaging structure.
5. Renders uniform density as well as dimensions.
6. Defects like porosity gets eliminated.
7. Resistance to impact loads get increased.
8. No material wastage.
9. High rate of production.
10. Parts can be easily welded.
11. Parts can be made to close tolerance.
12. Smooth surface can be obtained.

Disadvantages:

1. High tool cost.
2. High tool maintanence cost.
3. Some metal may develop crack by forging.
4. Limitation in size and shape.
5. Temperature range for each material must be exactly maintained.

Classification Of Forging Process

Can be broadly classified as

1. Smith forging
2. Impression die forging

SMITH FORGING (OPEN-DIE FORGING)

- Process of reducing a metal billet using flat dies to obtain the required shape and size.
- Product of lesser accuracy compared to impression die forging.
- Less expensive and simple tooling.

1. Hand Forging

Smith forging done by hand hammering on heated work piece kept on an anvil is called hand forging.

2. Power Forging

In power forging, instead of hammering by hand, power hammers are employed.

The work piece is placed between the ram die and anvil die. Hammering occurs

when compressed air is admitted to the top of the piston (ram) in the ram cylinder. The hammer is pulled back by admitting air to the bottom side of piston, which rises the piston and ram die upwards.

IMPRESSION DIE FORGING

Process of reducing and shaping a metal billet using closed impression die of the required shape.

1. Drop Forging

Heated metal is placed in the cavity of the die and force is applied by impact due to hammer drop. The material shape changes gradually in each drop.

2. Press Forging

steady pressure is applied slowly over the heated metal placed in the die. A hydraulic press which exerts continuous pressure on the heated metal is employed. Due to the continuous pressure, the metal squeezes to the shape of the die.

3. Roll Forging

There are two rollers on parallel shafts. The rollers have grooves of required shape for about 50% of its roller. The heated workpiece is placed in groove and the roll is rotated to get pressed to the shape of the groove.

ROLLING

Rolling is the process of forming metal to the desired shape by passing it in between a pair of rolls.

* Hot rolling – above recrystallisation temp.
* Cold rolling – below recrystallisation temp.

When the hot metal is passed through the grooves in the rolls, the metal squeezes and its cross section reduces with increase in length.

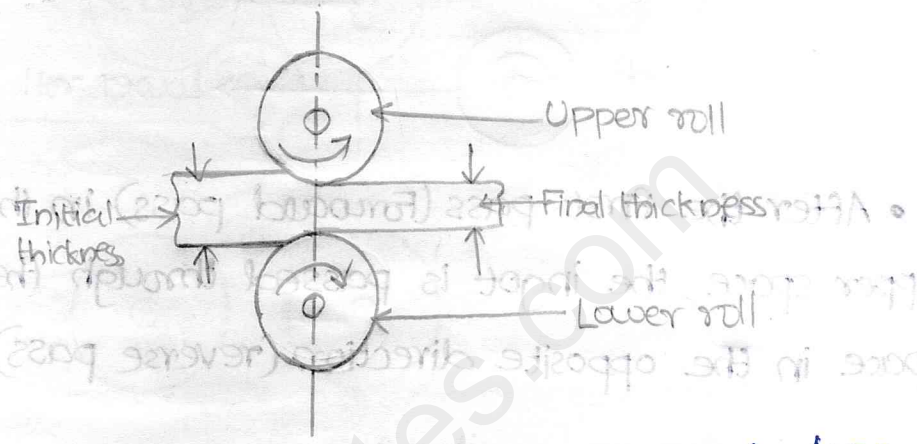
Intermediate shapes for Hot Rolling.

1. Bloom – rectangular/square piece of metal of standard sizes (150mm x 150 mm to 250 mm x 300 mm)
2. Billet – similar to bloom but smaller in cross section (50 mm x 50 mm to 150 x 150 mm).

3. Slabs – rectangular cross section with low thickness of order of 50 mm and width 350 mm to 1500 mm.

Types Of Rolling Mill

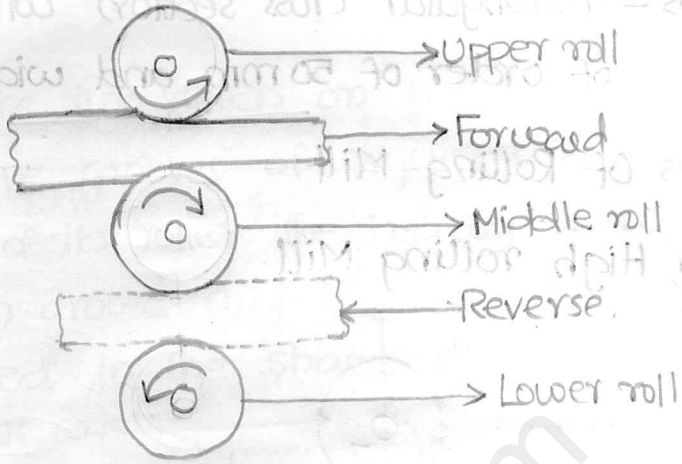
1. Two High rolling Mill.



Two rolls, in the same vertical plane, rotate in opposite direction. The ingot is passed between the roll. After first ~~roll~~ pass, the rolls are reversed in direction, so that ingot goes back to original position. Again, after adjusting space between rolls, it is further rolled. The process is repeated until the desired size is obtained.

2. Three High rolling Mill.

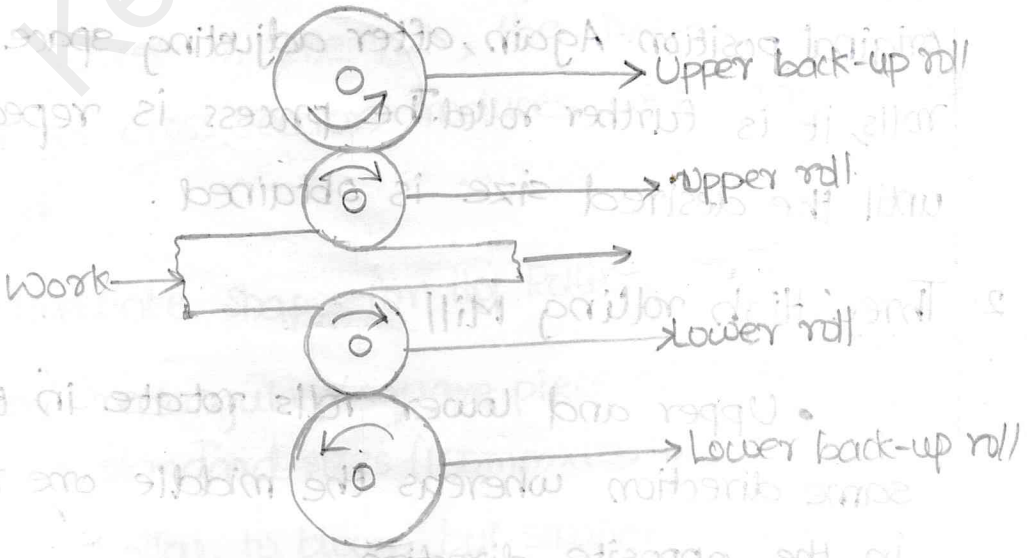
- Upper and lower rolls rotate in the same direction whereas the middle one rotate in the opposite direction.



- After the first pass (Forward pass) in the upper space, the ingot is passed through the lower space in the opposite direction (reverse pass).

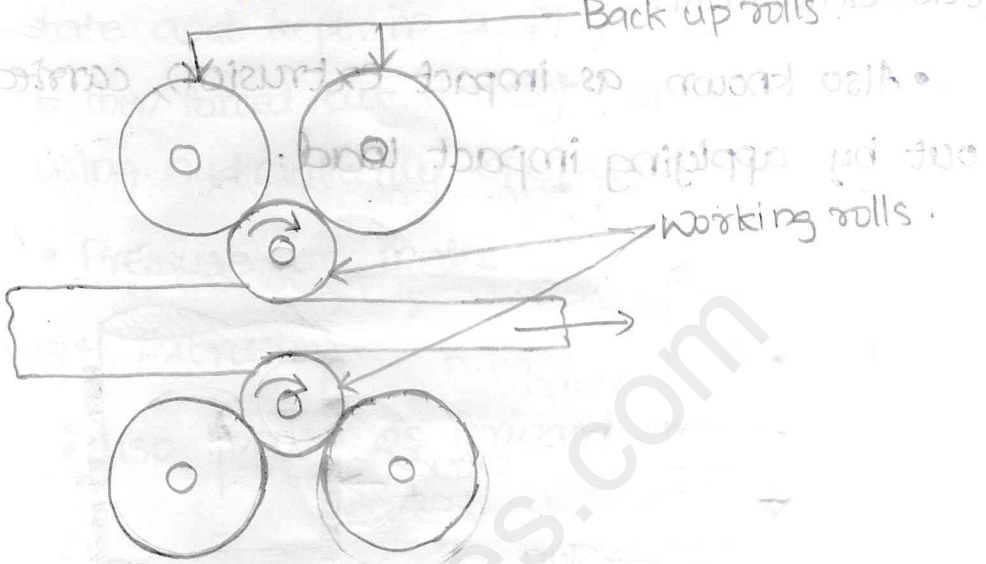
3. Four High Rolling Mill

- Two working rolls – exert pressure on the metal.
- Two backup rolls – prevent deflection of working rolls



- e.g., Slabbing mills.

4. Cluster Rolling Mill



- Consist of several rolls.
- Used as finishing mills.

5. Continuous Rolling Mills

- Number of two high rolling mills kept in series
- Metal out from first one continuously passed through next and so on.

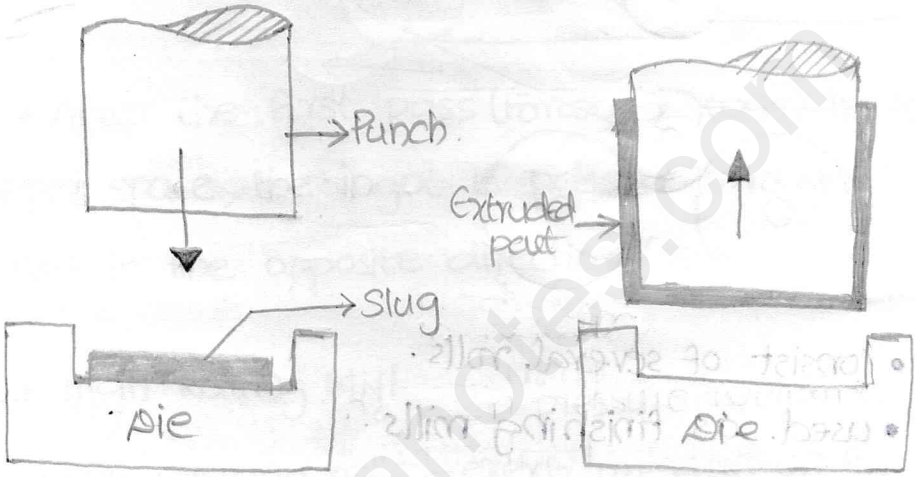
EXTRUSION

- The process of forming tubes, rods, etc., by compressing the material inside a chamber and forcing it out through a small opening of desired shape.

- Principle similar to squirting of toothpaste from its tube.

COLD EXTRUSION:

- Also known as impact extrusion, carried out by applying impact load.



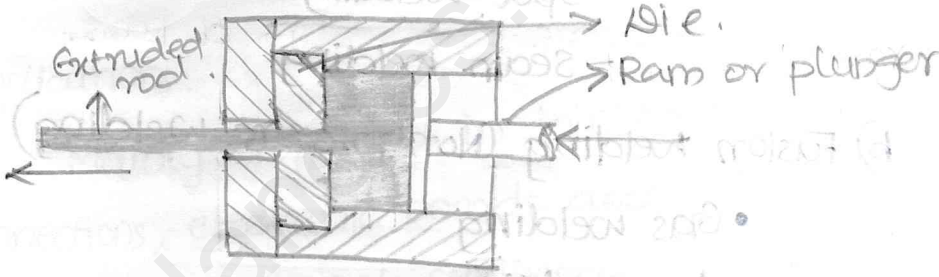
- Material in the form of slug is placed on the die and the impact load is applied by a punch.
- Material flows up along the surface of the punch forming the component of desired shape and size.
- Extruded part is removed from punch using compressed air.

HOT EXTRUSION:

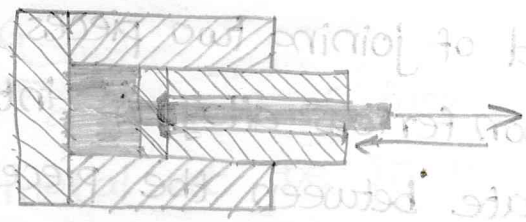
- Metal to be extruded is heated to plastic state and kept in a pressure chamber. It is then forced out through specially made dies using hydraulically operated press.
- Pressure on metal varies from 50 to 75 kPa.

1. Direct Extrusion:

- Also known as forward extrusion.



2. Indirect Extrusion



- Also known as backward extrusion.

3. Tube Extrusion.

METAL JOINING PROCESS

Metal joining process is the technique of uniting two or more metal parts to make a subassembly or a final product.

1. Welding (joining by establishing atom to atom bond)
   a) Plastic Welding (Pressure welding)
      - Forge welding
      - Resistance welding
        - Spot welding
        - Seam welding
   b) Fusion welding (Non-pressure welding)
      - Gas welding
      - Arc welding

2. Brazing:

Method of joining two pieces of metals in which a non ferrous alloy is introduced in a liquid state between the pieces of metal being joined and allowed to solidify.

Types:
- Torch brazing
- Furnace brazing
- Resistance brazing
- Induction brazing

Applications:

For fastening pipe fittings, stove burners, carbide tip on tools, radiators, heat exchangers, etc.

3 Soldering:

Method of joining two or more metal pieces by means of a fusible alloy or metal called solder, applied in a molten state.

Types: • Soft soldering (150 to 300°C – m.p of solder)
• Hard soldering (300 to 400°C – ").

Applications:

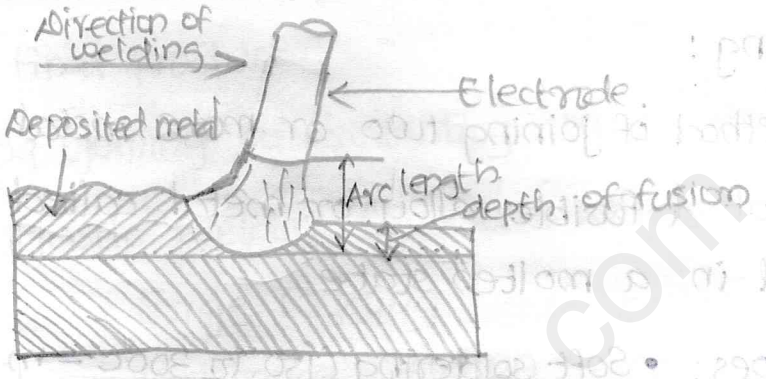
Mainly employed in joining wires in electric connections, electronic boards and similar small parts which are not subjected to load and temperature.

ARC WELDING.

* It is a method of fusion welding in which the metal at the joint is heated to molten state by an electric arc.

* When the anode, positive pole of a DC power supply (electrode) and the cathode, negative pole (metal to be joined) are brought together

and separated by a small distance (2 to 4 mm), electric arc is formed whose temp. is about 6000 to 7000°C.



* Heat of arc raises the temp. of the metal, melts at the point of arc and forms a pool of molten metal.

* Electrode is also melted and provides the joint between metals to be joined.

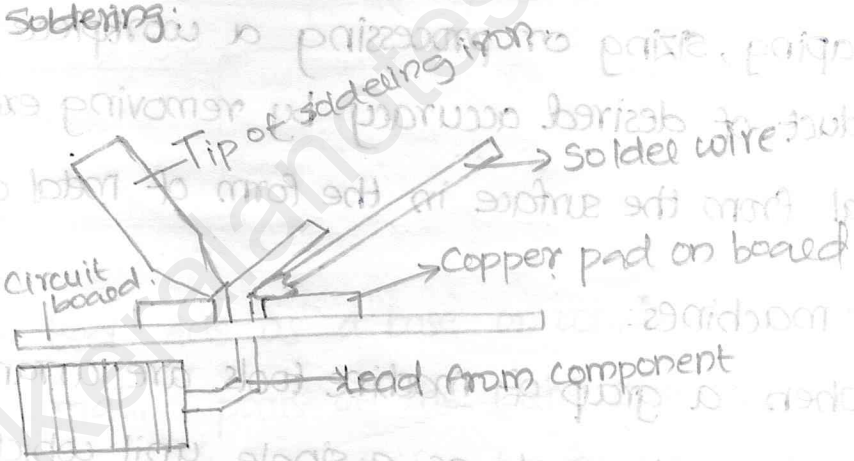
Electrodes

1. Non-consumable electrodes
   (carbon, graphite or tungsten)
2. Consumable electrodes.
   - Bare (uncoated) electrode
   - Coated electrode.

Difference b/n brazing and soldering

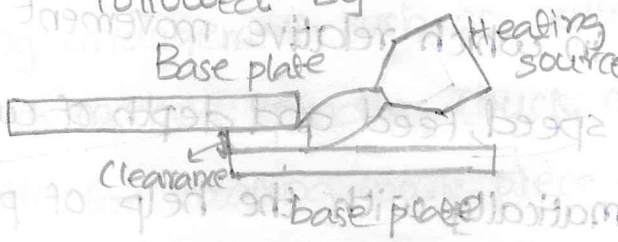
Brazing	Soldering
• Melting point of filler metal >450°C	• Melting point of filler metal <450°C
• Copper base or silver base alloy.	• Tin and lead alloy.
• High joint strength.	• Low joint strength
• Flux: Borax and mixture of borax and boric acid	• Flux: Aluminium chloride, zinc chloride, rosin with alcohol
• Cast iron and steel parts are braze welded.	• Copper alloys, nickel alloy etc, are joined by soldering.

Soldering:



Brazing:

Filling of molten metal by capillary action followed by solidification



MACHINING PROCESS

Machining:

Manufacturing process by which a work piece is given desired size, shape and surface finish by removing the excess (or undesired) material from the workpiece with the help of a properly shaped cutting tool.

Machine Tool:

A power driven cutting machine which is used for shaping, sizing or processing a workpiece to a product of desired accuracy by removing excess material from the surface in the form of metal chips.

Transfer machines:

When a group of machine tools are arranged in a sequence to work as a single unit which is automated, then they are called transfer machines.

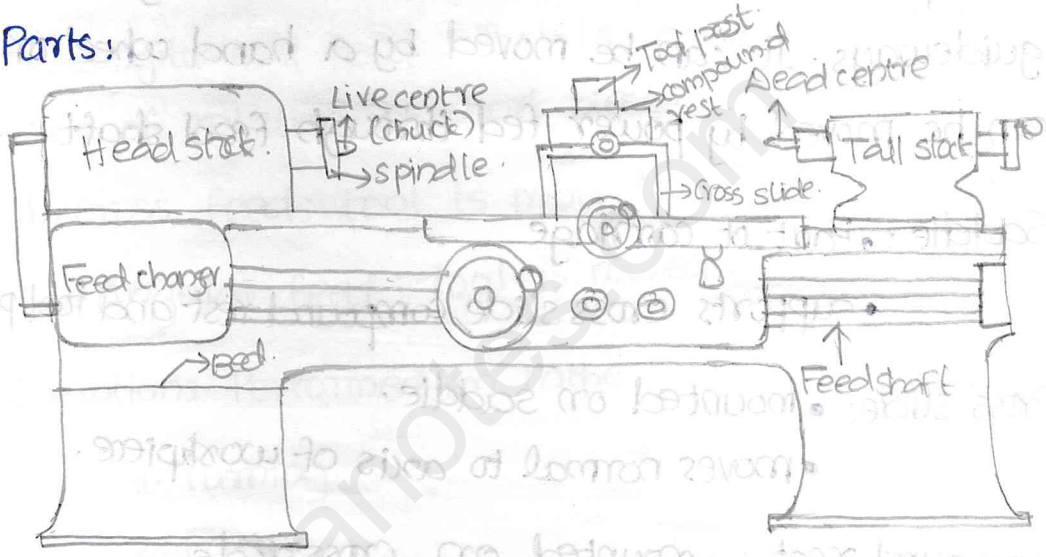
CNC Machines:

Machine tool, in which relative movement of tool and work, cutting speed, feed and depth of cut, etc are controlled automatically with the help of prearranged program fed into a computer is called CNC machine.

LATHE

Lathe is a general purpose machine tool which removes excess material from the workpiece, in the form of chips, by rotating the work piece against a single point cutting tool.

Parts:



1. Lathe Bed: Acts as a base on which different fixed and operating parts of the lathe are mounted. Guide ways are made on top for fixing and sliding tailstock and gear carriage.

2. Headstock: Located at left end of bed and houses driving arrangement such as pulleys and gears. Also supports machine spindle. Chuck can be attached to spindle for rotating work piece.

3. Tailstock: Located at right end of bed and is capable of sliding along the guideways. It houses dead centre which supports right end of workpiece.

4. Carriage: Supports, guides and feeds the tool against workpiece. It can be moved longitudinally on guideways. It can be moved by a hand wheel or can be moved by power fed through feed shaft.

5. Saddle: • Part of carriage
• supports cross slide, compound rest and tool post.

6. Cross slide: • mounted on saddle.
• moves normal to axis of workpiece.

7. Compound rest: • mounted on cross slide.
• carries a circular plate called swivel plate.

8. Tool post: • Uppermost part of carriage.
• holds the cutting tool and enable the cutting tool to be adjusted to the convenient working position.

Principle of working

Cutting tool is fed either parallel or perpendicular to the axis of the work piece removes material

from the rotating work to give the required size and shape.

- Tool moved parallel, gives a cylindrical surface.
- Tool moved perpendicular, gives a flat surface.

Feed Mechanism (Movement of tool relative to workpiece)

a) Longitudinal feed : Tool is moved parallel to the axis of rotation of work piece.

b) Cross feed: tool is moved $\perp^{lar}$.

c) Angular feed : tool is moved at an angle.

Operations Performed on Lathe.

1. Turning
2. Facing
3. Step Taper turning
4. Thread cutting
5. Knurling
6. Drilling
7. Boring
8. Reaming
9. Filing
10. Grinding.

Steps:

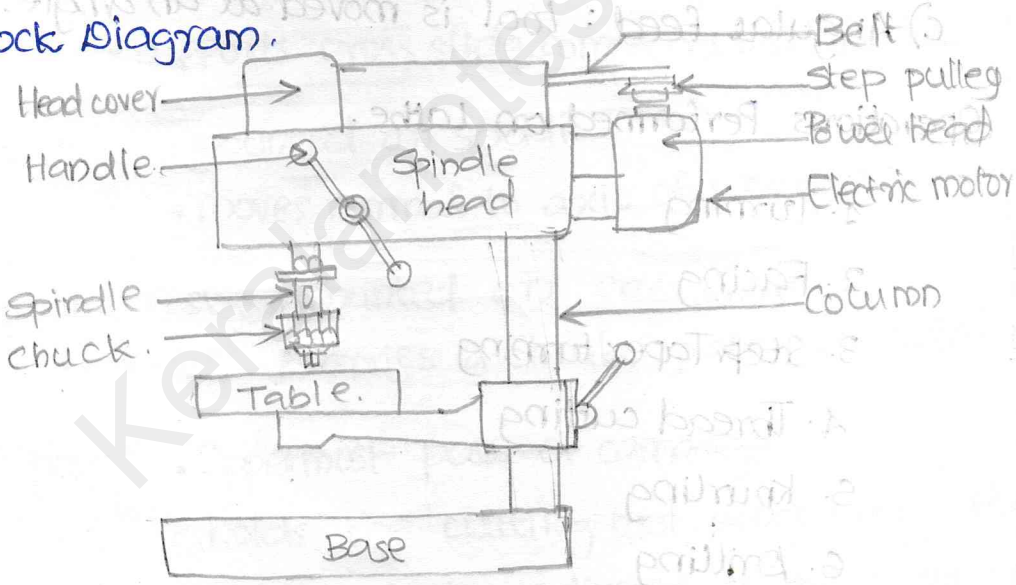
(From text).

DRILLING MACHINE

- One of the simplest machine tool used in production shops.
- It performs the operation of drilling holes on workpiece.
- Drilling operation is carried out by forcing a rotating tool called 'drill' against the work piece.

*Working Principle

* Block Diagram.



* Principle Parts:

1. Base – heavy rectangular casting which supports the entire machine.
2. Column – heavy cylindrical structure resting on base and supports spindle head, power head and table of the machine.

3. Spindle : Rotating part on to which chuck is attached. Chuck holds the drill, so that when the spindle rotates, the tool also rotates.

4. Table : Support workpiece or workpiece holding device.

5. Power head : contains electric motor, V-pulleys and V-belt which transmit rotary motion to drill spindle.

Operations Performed:

1. Drilling : Process of producing holes on workpiece by cutting and removing material from it, with the help of a twist drill.

2. Reaming : The operation of sizing and finishing the inside surface of a drilled hole.

3. Boring : Operation of enlarging a drilled hole for producing more accurate hole.

4. Counter boring : Operation of enlarging a drilled hole for a specific ~~hea~~ length.

5. Counter sinking : Operation of making a cone shaped enlargement at the beginning of a hole.

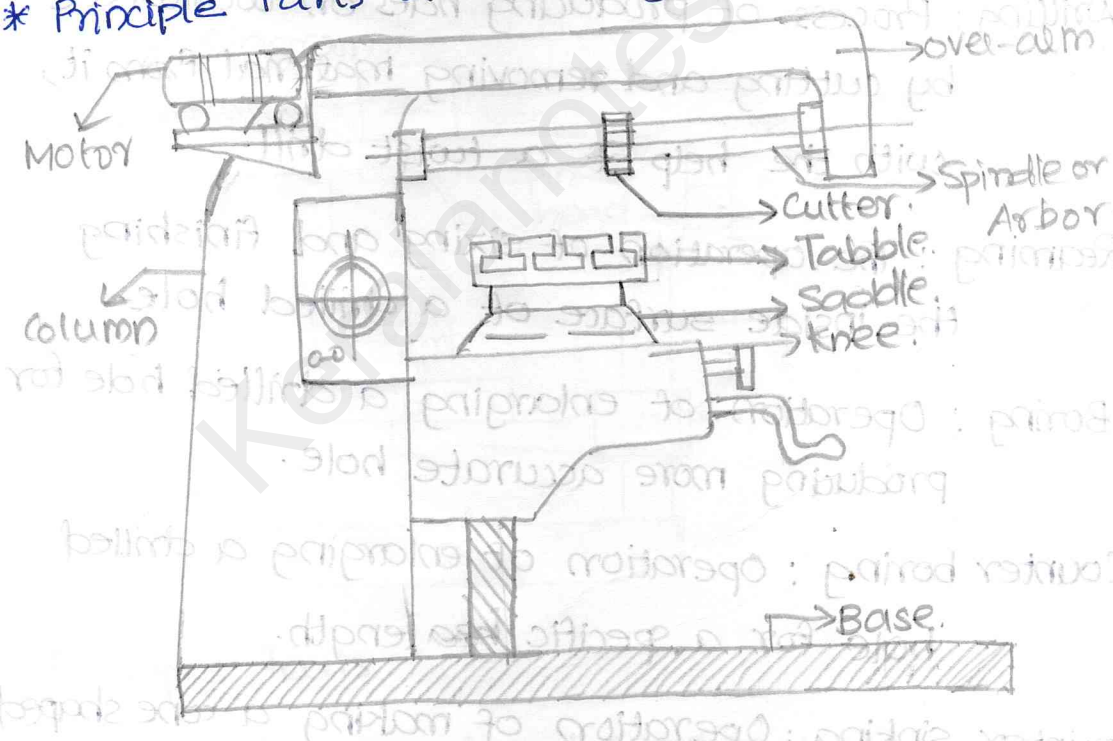
6. Tapping : Operation of cutting internal thread in a drilled hole with an externally threaded tool called tap.

~~GRINDING~~

MILLING MACHINE

- One of the commonly used machine tools which produce flat and curved surface on workpiece.
- most preferred tool due to its accuracy and high production rate.

* Principle of Milling.
* Principle Parts of a Milling Machine.



1. Base – heavy member on which all other parts rest.
2. Column – main supporting frame to which driving mechanism is fixed. Supports and guides the knee during its vertical travel.

3. Knee – structural member attached to column; can move vertically for adjusting depth of cut.

4. Saddle – supports the work table

5. Table – supports workpiece; travel longitudinally

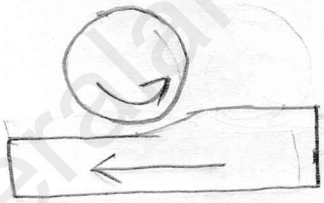
6. Overarm – mounted on top of column for supporting the spindle.

7. Spindle – mounted on upper part and receives power from motor by belt or gear.

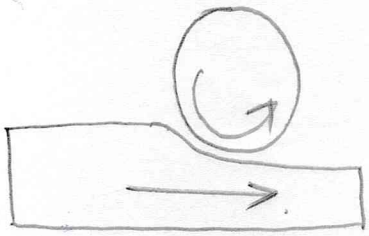
8. Arbor – Extension of spindle on to which the cutter can be mounted.

Milling Methods:

1. Up-Milling (Conventional Milling)



2. Down-Milling (Climb milling)



Milling Machine operations:

1. Plain or slab milling
2. Face milling
3. Straddle milling
4. Angular milling.

CAD

- Computer Aided Design
- CAD may be defined as any design activity that involves effective use of computer to create and modify an engineering design.

CAM

- Computer Aided Manufacturing
- CAM may be defined as the use of computer system to plan, manage and control the operations in a manufacturing plant.