FOUNDRY

CASTINGS: Casting is a process for making components by pouring molten metal into a cavity and allow to solidify. The solidified metal is called Casting.

PATTERN: Pattern is the model of the required casting.

MOULD: Mould is a cavity or the required shape made in moulding sand.

CLASSIFICATION OF PATTERNS: Patterns are classified into Size and Shape, Number of parts to be produced and Method of castings.

TYPES OF PATTERNS:

Solid or Single piece Patterns: Exact shape is obtained.

Split pattern: Made into two halves i.e. Upper pattern and lower pattern. A line separating is called parting line.

Loose piece Patterns: After making mould fist solid piece is removed and loose piece is removed.

Match plate Patterns: Runner and gates are required. Used in machine moulding and for large volume.

Sweep Patterns: Surfaces like cylinder, cone and spheres these patterns are used.

Skeleton Patterns: Larger in size. Used for water pipes, turbines.

Segmental Patterns: Circular parts like rings, wheels, rims are produced by using segmental patterns.

Shell Patterns: Hollow pattern and used in pipes and short bends.

PATTERN MATERIALS: The materials used for making patterns are Wood (Teak, Mahogany, White pine), Metals (Cast iron, Steel, Brass, Aluminium), Plasters, Plastics and wax.

Wood: Advantages: Light weight, cheap, easily available, repairs are easily made.

Disadvantages: Absorbs water, High wear and tear, Not used for mass production & M/c moulds.

Metal: Used for mass production. It can be used in machine moulding. Advantages : Long life, Used for mass production, Not absorbing moisture, Resistance to wear and abrasion. Limitations: Costly, Not easily repaired.

Plasters: Plaster of paris or gypsum cement, Difficult shapes can be made easily, Not affected by moisture and used for small patterns.

Plastics: Made from master pattern, light weight, Not affected by moisture.

Wax: Paraffin wax, Shellac wax, and Micro crystalline wax are used. Good surface finish can be obtained. Not affected by moisture. Cost is less and used for small patterns.

PATTERN ALLOWANCES: Extra size given to the pattern is called Pattern Allowance. Various allowances are Shrinkage allowance, Machining allowance, Draft or Taper allowance, Distortion & Shake allowances

Shrinkage allowance: Metal shrinks during solidification and contracts on cooling. Compensation is required. For Cast iron 1mm per 100mm, Aluminium 1.7 mm per 100 mm, Brass 1.5 mm per 100 mm, Steel 2 mm per 100 mm are the recommended shrinkage allowances.

Machining Allowance: Extra size given for machining. For Cast iron 2.5 mm and for non ferrous metals 1.6mm and for cast steel3 mm are the recommended machining allowances.

Draft or Taper allowance: For removal of pattern from the mould.

Distortion allowance: The metal get distortion during cooling and not shrinks uniformly. To avoid the bend the distortion allowance is provided in the pattern.

PROCEDURE FOR MAKING GREEN SAND MOULD

a. Two piece split pattern. The pattern is placed at the centre of the moulding board.
b. The drag box is placed around the pattern, Dowel pins are connected to the box.
c. 20 mm layer of facing sand is first placed around the pattern and then drag is filled with green sand.
d. Sufficient ramming is done by the rammer and add sand if necessary.
e. Excess sand is removed by strike of bar.
f. Vent holes are made by vent wire to escape the gases during pouring of metal.
g. The top surface is made smooth by trowel.
h. Then the drag is tilted upside down as shown in figure.
i. The parting sand is sprinkled over the drag box.
j. Top half of the pattern is placed correctly in position.

k. Cope box is placed correctly in position on the drag using dowel pins.

l. Riser pin and sprue pins are correctly placed in position.

m. Filling and ramming and venting of the sand are done similar to that of drag.

n. Sprue and riser pins are removed.

o. The pattern is removed from the box slowly.

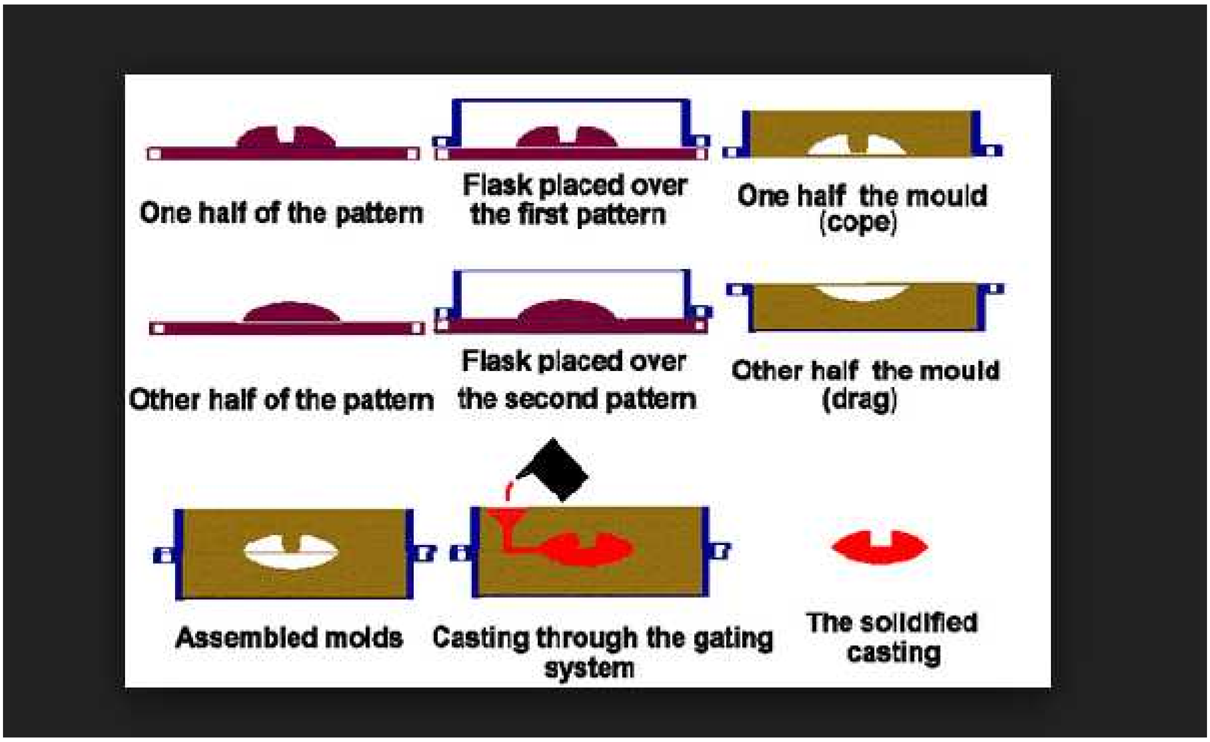
p. A gate is cut on the top surface of the drag. It should be exactly below the sprue.

q. The mould surfaces are coated with coating material like graphite to get smooth surface to the casting.

r. The core is set in position if necessary.

s. Finally, the cope and drag box are assembled. Weight is placed on the cope to prevent the cope from floating or lifting up when the molten metal is poured.

t. The mould is ready for pouring the metal.



WELDING

Welding: The process of joining similar metals by the application of heat is called "Welding".

Welding can be obtained with or without application of pressure and with or without addition of filler metal which is known as 'electrode'.

Classification of welding process: 1. Fusion welding 2. Plastic welding.

Fusion welding: The metal at the joint is heated to a molten state and then it is allowed to solidify. Pressure is not applied during the process and hence it is called "non pressure welding". Filler material is required for this welding.

Plastic welding: The metal parts are heated to a plastic state and are pressed together to make the joint. It is called as "pressure welding". No filler material is required.

TYPES OF WELDING: Thermit welding

Fusion welding ---- Arc welding ------Submerged,Plasma,Automic hydrogen,MIG, Metal, Carbon,Electro slagWELDING

Gas welding ------ Oxyacetylene, Oxyhydrogen

Plastic welding ---- Explosive welding

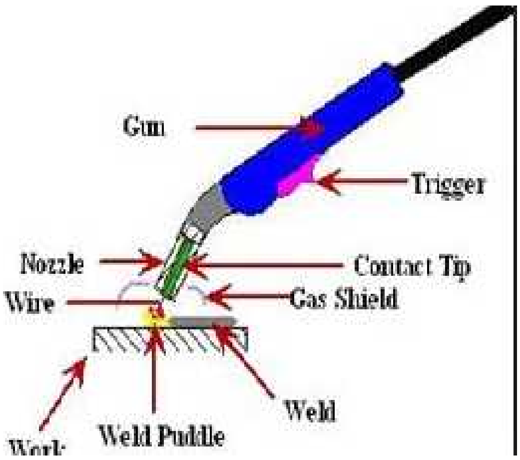
Ultrasonic welding

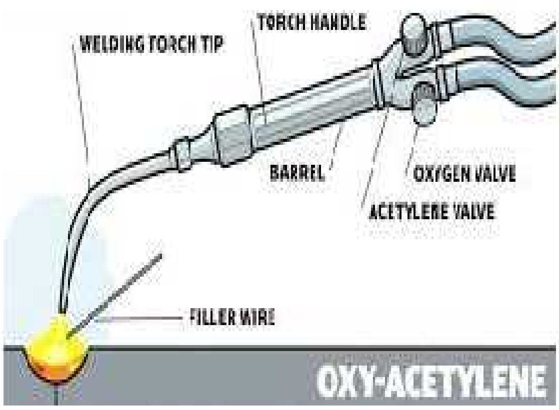
Electric resistance—Butt, Spot, Seam,

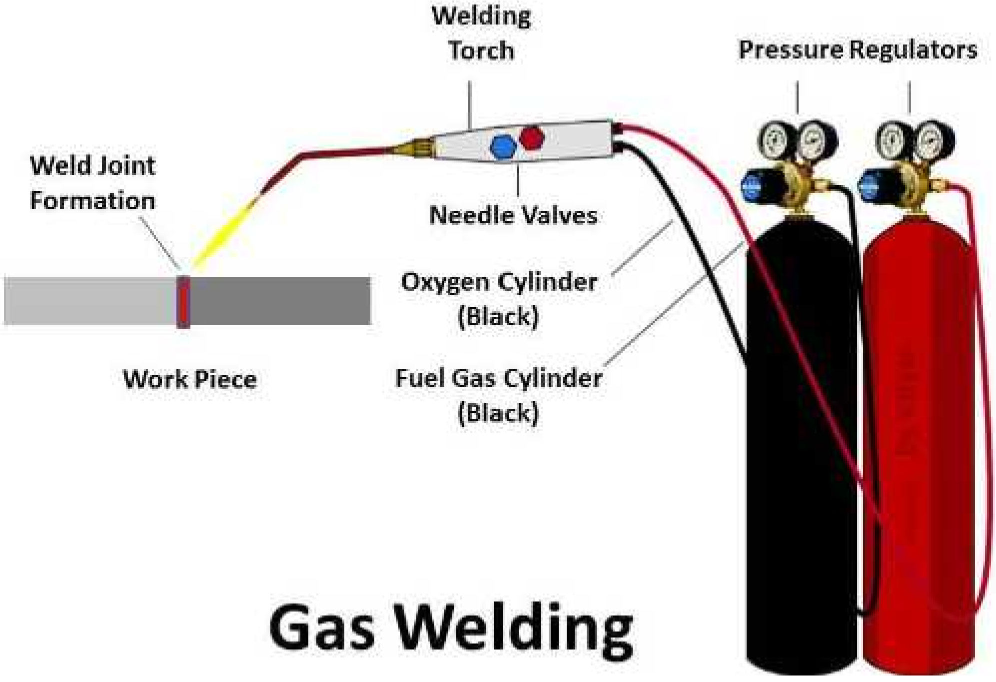
Projection,Percusion

Friction welding

Forge welding







GAS WELDING: 1.Oxy – acetylene welding 2) Oxy – hydrogen welding 3) Air – hydrogen

Oxy acetylene Welding: The edges of the metal to welded are melted by using a gas flame. No pressure is applied. The flame is produced at the tip of the welding torch. The welding heat is obtained by a mixture of oxygen and combustible gas. The gases are mixed in the required proportion in a welding torch which provides control for the welding flame.

The gases used are acetylene, hydrogen, propane and butane. Common gas is oxy acetylene. The flame only melts the metal and additional metal to the weld is supplied by filler rod. A flux is used during welding to prevent oxidation and to remove impurities. Metal 2 mm to 50 mm thick are welded. The temperature of the flame is about 3200 ^{o}C. There are two types of oxy acetylene systems, one is High pressure and the other is Low pressure system.

Oxy Hydrogen Welding: Similar to OA welding process. The oxygen and hydrogen gases are mixed with the required proportions for producing heat. It was once used extensively to weld low temperature metals like Al, Lead and Magnesium. Presently this process is not used.

Air Hydrogen Welding: Similar to OA welding process. Air is used instead of oxygen. The air is taken from the atmosphere is compressed in a compressor and mixed with acetylene to the required proportion in the torch. The temperature is low and used in welding of lead.

GAS WELDING EQUIPMENTS:

1) Gas cylinders: Oxygen in Black colour, Acetylene in maroon colour.
2) Pressure regulators: Each cylinder is fitted with pressure regulator. It is used to control the working pressure of the gases. Oxygen 0.7 to 2.8 kg/cm^2 Ace 0.07 to 1.03 kg/cm^2
3) Pressure gauges: Each cylinder is fitted with two pressure gauges. One is for cylinder pressure and the other one is working pressure pressure for welding.
4) Hoses: Each cylinder is connected to the torch through two long hoses. It should be flexible, strong, and light. Oxygen is fitted with black colour and Ace in red colour.
5) Welding torch: Oxygen and ace enters the torch through the hose is separate passage. Both the gases are mixed in the mixing chamber of the torch. When it is ignited a flame will be produced at the tip of the torch called nozzle. Two control valves are used to control the quantity of oxygen and ace to adjust the flame.The nozzles are made of copper and available in different sizes depending upon the type of metal to be welded.
6) Goggles: It is used the protect eyes from the flame heat, ultraviolet and infrared rays.
7) Welding gloves: It is used to protect hand from the injury by heat and metal splashes.
8) Spark lighter: It is an igniter to start the burning of the oxy ace gases.
9) Wire brush: It is used to clean the weld joint before and after welding'

GAS WELDING TECHNIQUE:

In gas welding the speed and quality of the welding can be improved by proper selection of torch size, filler material, method of moving the torch, angle at which the torch is held. Two techniques are used. 1) Leftward or forward welding 2) Rightward or backward welding.

1. Leftward or forward welding: The torch moves from right to left. The torch is held on right hand and the welding rod is held on left hand. The torch angle 60 to 70^0 and welding rod at 30 to 40^0. It allows the preheating of the plate immediately ahead of the molten pool. It is suitable for welding m s plates up to 5 mm thick.
2. Rightward or backward welding: The torch moves from left to right. The torch is held at angle 40 to 50^o and welding rod at 30 to 40$^{o.}$ Better shielding. It is suitable for welding ms plate more than 5 mm.

FILLER RODS FOR GAS WELDING:

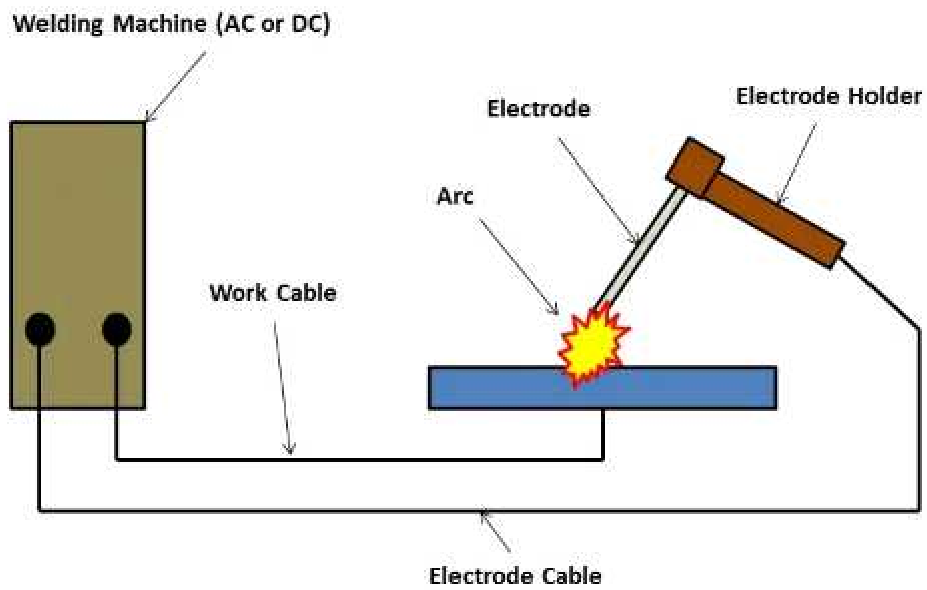
Filler rods/welding rods used in gas welding to supply additional metal to make the joint. It is metal rod made of the same material as parent material. The diameter of the filler rod is depending upon the thickness of the metal to be weld. d = t / 2 + 1. Filler rods are coated with copper to prevent oxidation of the molten metal.

ADVANTAGES AND LIMITATIONS OF GAS WELDING:

Advantages: 1) Temperature of the flames can be easily controlled. 2) Filler metal deposits can be controlled easily 3) All types of metals can be welded 4) Cost of the equipment is less 5) It can be used in factory or in the field 6) Maintenance cost is less.

Limitations: 1) It is not suitable for joining thick plates 2) It is slow process 3) Strength of weld is not so good as arc welding 4) Handling and storing needs more care.

ARC WELDING:



The heat is developed by an electric arc. The arc is produced between and electrode and the work. It is a process of joining two metals by melting their edges by an electric arc. The electrical energy is converted to heat energy. The gap between the electrode and the work is 3mm. The current is passed through the workpiece and the electrode to produce an electric arc. The workpiece is melted by the arc. The electrode is also melted and hence both the workpieces becomes a single piece without applying any external pressure. The temperature of the arc is 5000 to 6000 ^{o}C. A transformer or generator is used for supplying the current. The depth to which the metal is melted and deposited is called Depth of fusion. To obtain better depth of fusion the electrode is kept at 70^{o} inclination to vertical.

Electrodes used in arc welding are generally coated with a flux. The flux is used to prevent the reaction of the molten metal with the atmospheric air. It removes the impurities from the molten metal and forms a slag. The distance between the tip of the electrode and bottom of the arc crater is called “arc length”

ARC WELDING EQUIPMENTS:

The equipments used in arc welding are 1) Welding generator DC or Transformer AC 2) Electorde 3) Electrode holder 4) Two cables, one for work and other for electrode 5) Gloves 6) Protective shield 7) Apron 8) Wire brush 9) Chipping hammer 10) Safety goggles.

In the electric arc welding both DC and AC are used for producing arc. In DC machines and DC generators are driven by an electric motor of an IC engine. In AC welding machine transformers which are used for stepping down the main supply voltage. 220/440 V Normal welding requires 20 to 90 Volts.

COMPARISION OF ARC WELDING AND GAS WELDING:

Arc welding	Gas welding
Heat is produced by electric arc	Heat is produced by the gas flame
The arc temperature is about 4000^{o}C	The flame temperature is about 3200^{o}C
Filler rod is used as electrode	Filler rod is introduced separately
It is suitable for medium and thick work	It is suitable for thin work
Arc weld joints have very high strength	Gas weld joints do not have much

SOLDERING: Soldering is a process of joining two metal parts with a third metal. The third metal has a very low melting point. It is known as Solder. It is used as a filler rod. Most of the solders are alloys of tin and lead. They melt at a temp of about 215^{o}C. The work pieces are not melted. Electrically heated soldering irons are available.

The two sheets are properly cleaned to remove oil, grease, oxides and dirt. This is done by chemical cleaning, filing, or by emery cloth. Two sheets are positioned. A flux is applied using a brush. The flux prevents oxidation. The flux used is in the form of liquid or paste. The flux used are zinc chloride and hydrochloric acid. The soldering iron is heated to proper temp. It is dipped in the flux and then rubbed on the solder. This is known as tinning of the tip.

Applications: Used in electrical appliances, computers, automobile radiators.

BRAZING: It is the process of joining two similar or dissimilar metals by using a fusible alloy called “spelter”. Spelter is a harder filler rod. Its melting temp is about 600^{o}C. This is below the melting point of the work materials. The most commonly used spelters are copper alloys and silver alloys. For brazing ferrous metals copper alloys made of copper, zinc and tin are used. Silver alloys made of silver and copper are used for any metals.

The metal parts are thoroughly cleaned. The parts are assembled with a gap between them so that the filler material may flow inside the joint. Now the flux (borax powder) in the paste form (mixed with water) is applied over the joint, this is done before heating the parts. Then the parts are heated below their melting point. The heating may be done in a furnace or by oxy-acetylene flame. The flux melts and flows in the gap between the surfaces. When the spelter is applied to the joint it gets melted. It flows in the gap between the work piece and solidifies. Thus a hard brazed joint is formed.

finishing operation is required for good brazing d) Less distortion

Comparisionof Soldering and Brazing:

Soldering	Brazing
Filler material is known as solder	Filler material known as spelter
Low melting point alloys used	High melting point alloys used
Alloys of tin and lead are used	Copper and silver base alloys used
Strength of the joint is relatively low	Relatively high strength
Fluxes are Zinc chloride and hcl acid	Flux is borax powder
Mostly used for elec connections, tins and cans	Joining of dissimilar metals,

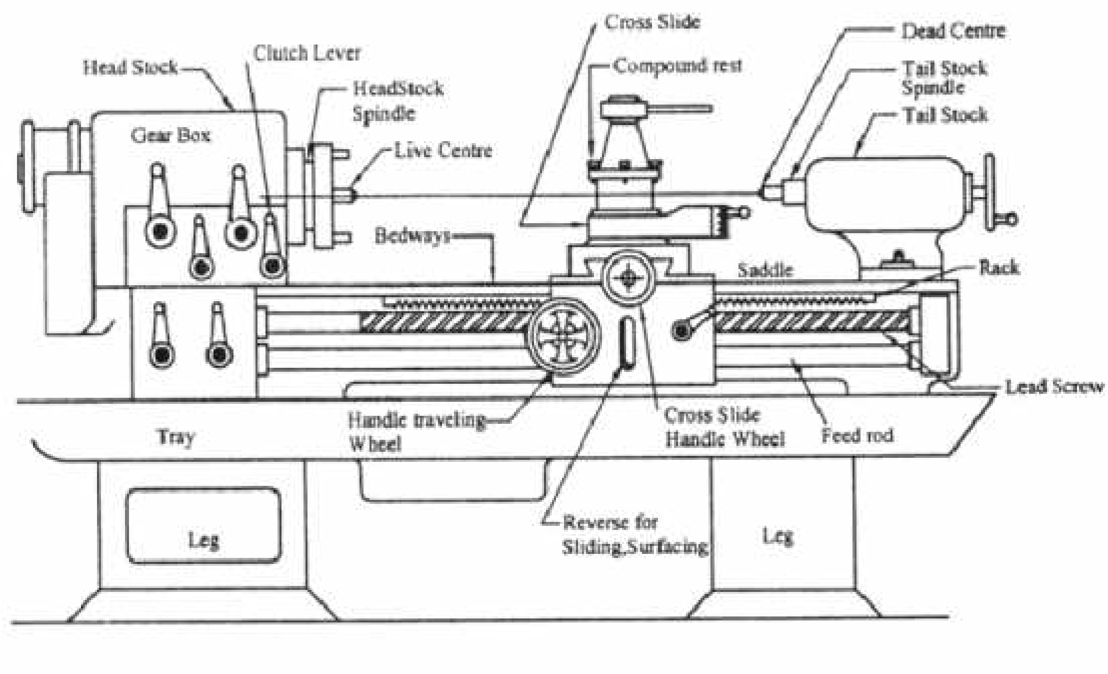
LATHE

Introduction:

Lathe is a machine tool, which is used to remove metal from work piece for required shape and size. This is done by holding the work piece firmly on the machine and turning it against the cutting tool, which will remove metal from the work in the form of chips.

Center lathe:

This lathe is the most important member of lathe family and most widely used. This lathe is also known as engine lathe. The basic parts of center lathe are bed, headstock, tailstock, and carriages, cross slide, compound rest, tool post and apron.



Centre Lathe

Bed:

It is the base of the lathe; the headstock and tailstock are located at either end of the bed and the carriage rests over the lathe bed and slides on it.

Headstock:

It carries a hollow spindle .A live center can be fitted in to hollow spindle. The live center rotates with the work piece and hence called live center.

Tailstock:

It is mounted on the bed at right angles end. It is used for supporting the right end of the work piece by means of a dead center. The dead center does not revolve with the work piece and hence called dead center.

Carriage:

It is supported on the lathe bed ways and can move in a direction parallel to the lathe axis .It carries saddle, cross slide, compound rest, tool post and apron. It is a H- shaped casting fitted over the bed. It moves along the guide way.

Cross slide:

It carries the compound rest and tool post. It is mounted on the top of the saddle. It may be moved by hand or may be given feed through apron mechanism.

Compound rest:

It is mounted on the cross –slide .It carries a circular bar called swivel plate, which is graduated on degrees. The upper part is known as the compound slide, and it can be moved by means of the hand wheel.

Tool post:

The tool post is fitted over the compound rest. the tool is clamped in the tool post.

Apron:

Lower part of the carriage is termed as the apron. It is attached to the saddle and hangs in front of the bed .It contains gear, clutch and lever for moving the carriage by a hand wheeler power feed.

Feed mechanism:

The movement of tool relative to the work is termed as feed. A lathe may have three types of feed: longitudinal, cross, and angular feed. The feed mechanisms have different units through which motion id transmitted from the head stock spindle to the carriage. Following are the units: end of bed gearing, feed gear box, feed rod and lead screw, apron mechanism.

Important operations of a Lathe

Turning:

The work piece is held in the chuck or between the centers. The turning tool is held parallel to the axis of the lathe spindle and a cylindrical surface is produced. For rough turning, the rate of feed of the tool is fast and the depth of cut is heavy. For rough turning the depth of cut may be from 2 to 5mm.For finishing turning the feed and depth of cut will be small. For this a finish turning tool is used and the depth of cut may be from 0.5 to 1mm.

Facing:

Facing is the machining of the end face of the work piece to make it flat. The work piece may be held in the chuck as between the centers. A facing too is fed perpendicular to the axis of operation of the work piece. Only the face of the tool is machined in this processes and hence called facing.

Chamfering:

It is the process of leveling extreme end of the work piece. This is done to protect the end of the work piece from getting damaged. This operation is performed after turning, drilling, boring etc., It is a critical operation to be performed after thread cutting so that the end may pass firstly on the threaded work piece.

Knurling:

The adjustment screw of a micrometer is not smooth either axis cross or diamond shaped pattern is seen. The process by which such patterns are made is call knurling. It is done to give good gripped surface on the work piece. The teeth may be fine, medium or coarse. Very slow speeds are adapted for knurling.

Reaming:

The operations for finishing a drilled or bored hole for smooth finishing are called as reaming. The tool used is called as reamer. It has multiple cutting edges. The reamer is fitted in the tail stock spindle.

Drilling:

It is an operation for making a hole on a work piece. For drilling, work piece is held in the chuck on one side where as the other side remains free. The tool for drilling is called drill. The drill is inserted on the tailstock. When the job rotates, the drill bit is inserted in the tailstock by rotating the hand wheel.

Boring:

It is a process for enlarging a hole produced by drilling. Boring itself cannot produce a hole. The work piece is held in a chuck or face plate. The boring tool is fixed and fed into the job.

Taper turning:

A large number of components used in engineering have a conical shape or a tapered shape. A taper is defined as the uniform change in diameter measured along its length.

Thread cutting:

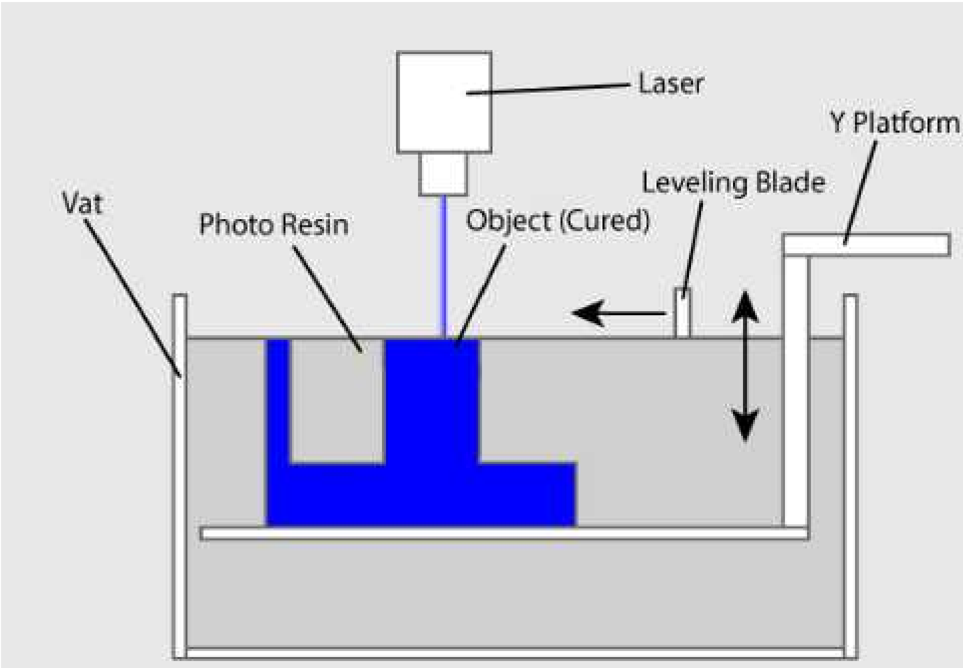
It is the operations by which threads are cut on the surface of the work piece. The change of gear may be selected as

No of teeth on spindle gear= no. of teeth on lead screw.

Pitch of a thread to be cut = pitch of the lead screw threads.

3D PRINTING

3D printing, also known as additive manufacturing, is a process of creating three-dimensional objects from a digital file by adding material layer by layer. This technology has gained significant popularity and applications in various industries due to its versatility, cost-effectiveness, and ability to produce complex and customized objects. Here are some key points to understand about 3D printing:



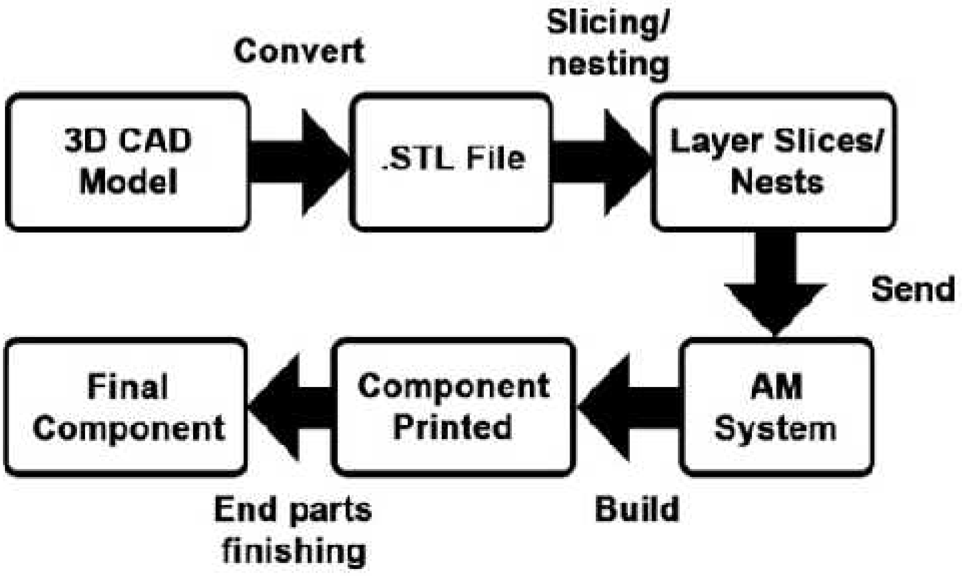
Working Principle

- 3D printing starts with a digital 3D model of the object to be printed. This model is typically created using computer-aided design (CAD) software or obtained from 3D scanning.
- The 3D printer reads the digital file and then adds material layer by layer to build the physical object. The material used can vary widely, including plastics, metals, ceramics, and even organic materials like food and biological tissue.

Types of 3D Printing Technologies:

- There are several 3D printing technologies, each with its unique characteristics. Common methods include

1.Fused Deposition Modeling (FDM),
2.Stereolithography (SLA),
3.Selective Laser Sintering (SLS), and
4.Digital Light Processing (DLP)



Applications:

- 3D printing is used in a wide range of applications, including rapid prototyping, product design, aerospace and automotive manufacturing, healthcare (custom prosthetics and implants), dental (orthodontics and crowns), fashion, art, education, and even food production.

Advantages:

- Customization: 3D printing allows for the creation of highly customized and personalized products.
- Rapid Prototyping: It's a valuable tool for quickly creating prototypes and testing product designs.
- Complex Geometries: 3D printing can produce intricate and complex shapes that are difficult or impossible to achieve with traditional manufacturing methods.
- Reducing Waste: It can be more resource-efficient because it only uses the material needed for the object.

Challenges:

- Speed: 3D printing can be a slow process, making it unsuitable for large-scale production.
- Material Limitations: The materials used in 3D printing may not have the same properties as those used in traditional manufacturing.
- Quality Control: Achieving consistent quality can be a challenge.
- Intellectual Property: The ease of copying 3D models can raise intellectual property concerns.

3D Printing in the Future:

- 3D printing is continually evolving, with ongoing research into new materials, faster printing methods, and expanded applications. It has the potential to disrupt traditional manufacturing processes and supply chains.

Open-Source 3D Printing:

- There is a growing open-source 3D printing community, with enthusiasts and experts sharing designs, software, and knowledge to promote collaboration and innovation.

3D Printing in Space: 3D printing is being used in space exploration to create tools, spare parts, and even structures on extraterrestrial bodies like the Moon and Mars, where traditional manufacturing isn't feasible.

In summary, 3D printing is a revolutionary technology that has the potential to transform various industries by enabling customization, rapid prototyping, and the creation of complex objects. It continues to advance and find new applications as technology and materials improve.

Interdisciplinary concepts in mechanical Engineering

Mechanical engineering is a broad field that often intersects with various other disciplines. Interdisciplinary concepts in mechanical engineering are essential for addressing complex engineering problems and advancing technology. Here are some key interdisciplinary concepts in mechanical engineering:

1. **Mechatronics:** Mechatronics is the integration of mechanical engineering with electronics and computer science. It involves the design and development of intelligent and automated systems, such as robotics, where mechanical components interact with sensors, actuators, and control systems.
2. **Materials Science:** Understanding the properties and behavior of materials is crucial for mechanical engineers. Knowledge of materials science helps in selecting the right materials for specific applications, ensuring durability, strength, and performance.
3. **Thermodynamics:** Thermodynamics is a fundamental concept in both mechanical engineering and physics. It deals with the transfer of energy and heat, which is essential for designing engines, refrigeration systems, and other mechanical devices.

4. **Fluid Dynamics:** Fluid dynamics is a branch of physics and engineering that focuses on the behavior of fluids (liquids and gases). Mechanical engineers often work with fluid systems in applications like pumps, turbines, and HVAC systems.
5. **Control Systems**: Control systems engineering involves designing and implementing control strategies for regulating the behavior of mechanical systems. This is crucial in applications like industrial automation, automotive control systems, and aircraft flight control.
6. **Environmental Engineering:** As sustainability and environmental concerns become more prominent, mechanical engineers need to consider the environmental impact of their designs. This includes concepts related to energy efficiency, emissions reduction, and eco-friendly materials.
7. **Structural Engineering:** Mechanical engineers often collaborate with structural engineers to design and analyze the structural components of machines and buildings. Understanding how loads are transferred and distributed is crucial for ensuring safety and reliability.
8. **Aerospace Engineering:** Aerospace engineering is closely related to mechanical engineering, particularly in the design and analysis of aircraft and spacecraft. It involves aerodynamics, propulsion, and structural considerations.
9. **Biomechanics:** Biomechanics combines principles of mechanical engineering with biology to study the mechanical behavior of biological systems, including the human body. It is used in medical device design, sports equipment, and rehabilitation engineering.
10. **Acoustics:** Acoustics deals with the study of sound and vibration. Mechanical engineers may work on projects related to noise reduction, sound insulation, and the design of acoustic systems.
11. **Computer-Aided Design (CAD) and Finite Element Analysis (FEA):** These computer-based tools are essential for mechanical engineers to model, simulate, and analyze complex systems and structures, bridging the gap between mechanical design and computational science.
12. **Nanotechnology:** Mechanical engineering can intersect with nanotechnology, where small-scale mechanical systems and materials are developed for various applications, including electronics, medicine, and materials science.
13. **Energy Systems:** Mechanical engineers play a crucial role in designing energy systems, such as power generation, energy storage, and energy conversion technologies.

Interdisciplinary collaboration and knowledge in these areas enhance a mechanical engineer's ability to address multifaceted challenges and create innovative solutions. The evolving nature of technology also means that mechanical engineers must stay current with developments in these interdisciplinary fields to remain competitive in their careers.