Part-B

Answer any ***five*** of the following :

2[a] What are primary and secondary manufacturing processes?

[b] What is pattern. why allowances are provided on pattern? Write only name of different types of pattern.

[c][Explain the function of the following :

(i) Core (ii) Gates (iii) Riser (iv) Spruee (v) Runner

[d] What is welding? Classify welding processes.

[e] What do you understand by Gas welding? Describe equipments required for oxy-acetylene welding process.

[f] Explain function of lathe. Briefly explain any three operations on lathe.

[g] Write short notes on any Two of the following:

(i) Milling process

(ii) Shaping process

(iii) Drilling process

(iv) Boring process

(v) Fabrication of Nuts and Bolts.

2x5=10

Ans 2 (a)

1.3.1 Classification of Manufacturing Processes

❖ ***Primary Shaping Processes.*** Primary shaping processes include :

(*a*) Casting	(*b*) Forging	(*c*) Smithy	(*d*) Drawing
(*e*) Rolling	(*f*) Bending	(*g*) Extruding	(*h*) Squeezing
(*i*) Shearing	(*j*) Crushing	(*k*) Spinning	(*l*) Piercing
(*m*) Forming	(*n*) Embossing		

❖ ***Machining Processes.*** Machining operations are performed on various machine tools (*e.g.* Lathe, Shaper, milling machines, drilling machines, grinder etc.)

(*a*) Shaping	(*b*) Turning	(*c*) Milling	(*d*) Drilling
(*e*) Grinding	(*f*) Boring	(*g*) Threading	(*h*) Slotting
(*i*) Planing	(*j*) Gear Cutting	(*k*) Knurling	(*l*) Sawing
(*m*) Broaching	(*n*) Hobbling.		

❖ ***Surface Finishing Processes.*** These processes are used to provide a good surface finish to the metal surface of the product. In this, either a negligible amount of metal is removed or a small amount of material is added to the surface of the product. Various surface finishing processes are :

(*a*) Sand blasting	(*b*) Buffing	(*c*) Lapping	(*d*) Belt grinding
(*e*) Polishing	(*f*) Honing	(*g*) Electroplating	(*h*) Metal spraying
(*i*) Anodizing	(*j*) Phosphating	(*k*) Super finishing	(*l*) Tumbling
(*m*) Pickling	(*n*) Hot dipping	(*o*) Parkerizing	(*p*) Galvanizing

2 (B) A pattern is a replica of the object to be made by the casting process, with some modifications.

Pattern Allowances

1. Shrinkage or contraction allowance
2. Draft or taper allowance
3. Machining or finish allowance
4. Distortion or camber allowance
5. Rapping allowance

Shrinkage or contraction allowance

All metals shrink when cooling. This is because of the inter-atomic vibrations which are amplified by an increase in temperature. The shrinkage allowance is always to be added to the linear dimensions. Even in case of internal dimensions.

- Liquid shrinkage refers to the reduction in volume when the metal changes from liquid to solid state at the solidus temperature. To account for this, risers are provided in the moulds.

- Solid shrinkage is the reduction in volume caused, when a metal loses temperature in the solid state. The shrinkage allowance is provided to take care of this reduction.

Draft

To reduce the chances of the damage of the mould cavity at the time of pattern removal, the vertical faces of the pattern are always tapered from the parting line. This provision is called draft allowance. Inner surfaces of the pattern require higher draft than outer surfaces. Draft is always provided as an extra metal.

Shake Allowance

- At the time of pattern removal, the pattern is rapped all around the vertical faces to enlarge the mould cavity slightly to facilitates its removal.
- It is a negative allowance and is to be applied only to those dimensions, which are parallel to the parting plane.

Distortion Allowance

A metal when it has just solidified is very weak and therefore is likely to be distortion prone. This is particularly so for weaker sections such as long flat portions, V, U sections or in a complicated casting which may have thin and long sections which are connected to thick sections. The foundry practice should be to make extra material provision for reducing the distortion.

Pattern Materials

- Wood patterns are relatively easy to make. Wood is not very dimensionally stable. Commonly used teak, white pine and mahogany wood.
- Metal patterns are more expensive but are more dimensionally stable and more durable. Commonly used CI, Brass, aluminium and white metal.
- Hard plastics, such as urethanes, and are often preferred with processes that use strong, organically bonded sands that tend to stick to other pattern materials.
- In the full-mold process, *expanded polystyrene* (EPS) is used.
- Investment casting uses wax patterns.

Properties of pattern materials

- Easily worked, shaped and joined
- Light in weight
- Strong, hard and durable

- Resistant to wear and abrasion
- Resistant to corrosion, and to chemical reactions
- Dimensionally stable and unaffected by variations in temperature and humidity.
- Available at low cost.

Types of Pattern (refer the book for diagrams. Diagrams are mandatory)

Single Piece Pattern These are inexpensive and the simplest type of patterns. As the name indicates, they are made of a single piece.

Gated Pattern Gating and runner system are integral with the pattern. This would eliminate the hand cutting of the runners and gates and help in improving the productivity of a moulding.

Split Pattern or Two Piece Pattern This is the most widely used type of pattern for intricate castings. When the contour of the casting makes its withdrawal from the mould difficult, or when the depth of the casting is too high, then the pattern is split into two parts so that one part is in the drag and the other in the cope.

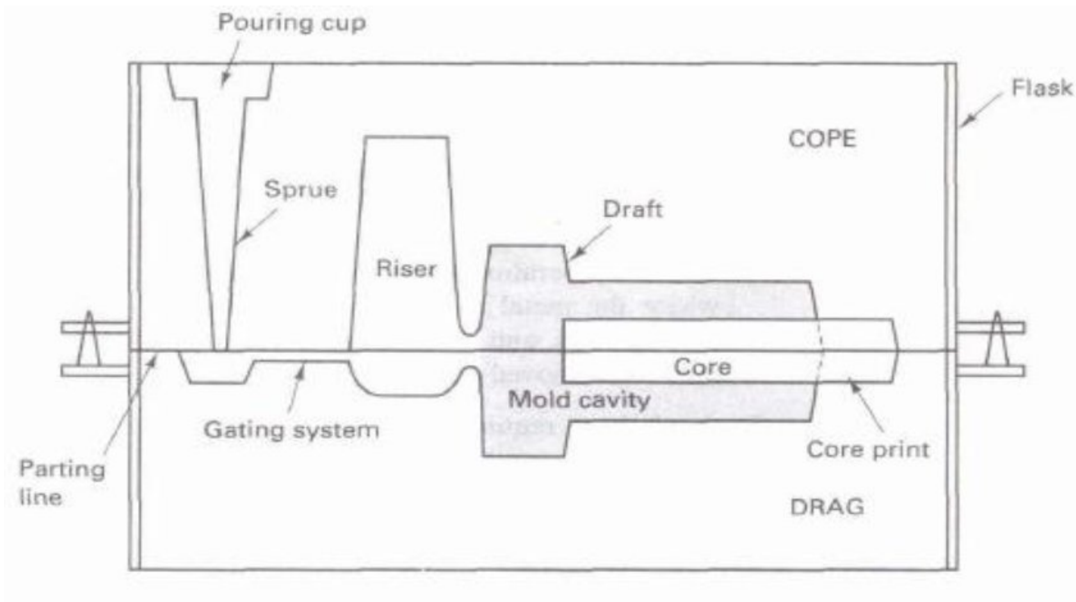
Cope and Drag Pattern These are similar to split patterns. In addition to splitting the pattern, the cope and drag halves of the pattern along with the gating and riser systems are attached separately to the metal or wooden plates along with the alignment pins. They are called the cope and drag patterns.

Match Plate Pattern The cope and drag patterns along with the gating and the risering are mounted on a single matching metal or wooden plate on either side.

Loose Piece Pattern This type of pattern is also used when the contour of the part is such that withdrawing the pattern from the mould is not possible.

Follow Board Pattern This type of pattern is adopted for those castings where there are some portions, which are structurally weak and if not supported properly are likely to break under the force of ramming.

2 (c)



Core: Used for making cavities and hollow projections. All sides of core are surrounded by the molten metal and are therefore subjected to much more severe thermal and mechanical conditions and as a result the core sand should be of higher strength than the moulding sand.

Gate: A channel through which the molten metal enters the mould cavity. It is the connection between the gating system and the mould cavity. The gate is of different type

Top gate, bottom gate, parting gate, step gate.

Riser: Risers are added reservoirs designed to feed liquid metal to the solidifying casting as a means of compensating for solidification shrinkage. To perform this function, the risers must solidify after the casting. Riser provider metal for liquid to liquid and liquid to solid shrinkage during solidification of the metal.

Sprue: The passage through which the molten metal from the pouring basin reaches the mould cavity. It is the vertical portion of the gating system. It is tapered to avoid the aspiration effect.

Runner: : The passage ways in the parting plane through which molten metal flow is regulated before they reach the mould cavity. it is the horizontal portion of the gating system connecting the sprue and gate.

2 (d) welding: it is the process of joining similar or dissimilar metal of nonmetal with or without the application of heat and pressure.

In general, various welding and allied processes are classified as follows :

Gas Welding

- Air-acetylene welding.
- Oxy acetylene welding.
- Oxy-hydrogen welding.
- Pressure gas welding.

Arc Welding

- Carbon arc welding
- Shielded metal arc welding
- Flux cored arc welding
- Submerged arc welding
- TIG (Tungsten Inert Gas) welding. (Gas Tungsten Arc Welding)
- MIG (Metal Inert Gas) or GMAW (Gas Metal Arc Welding)
- Plasma arc welding

Resistance Welding

- Spot welding
- Seam welding
- Projection welding
- Resistance butt welding
- Flash butt welding
- Percussion welding
- High frequency resistance welding.

Solid State Welding

- Cold welding
- Diffusion welding
- Explosive welding
- Forge welding
- Friction welding
- Hot pressure welding
- Roll welding
- Ultrasonic welding

Thermo-chemical welding processes

- Thermit welding
- Atomic hydrogen welding

Radiant Energy Welding Processes

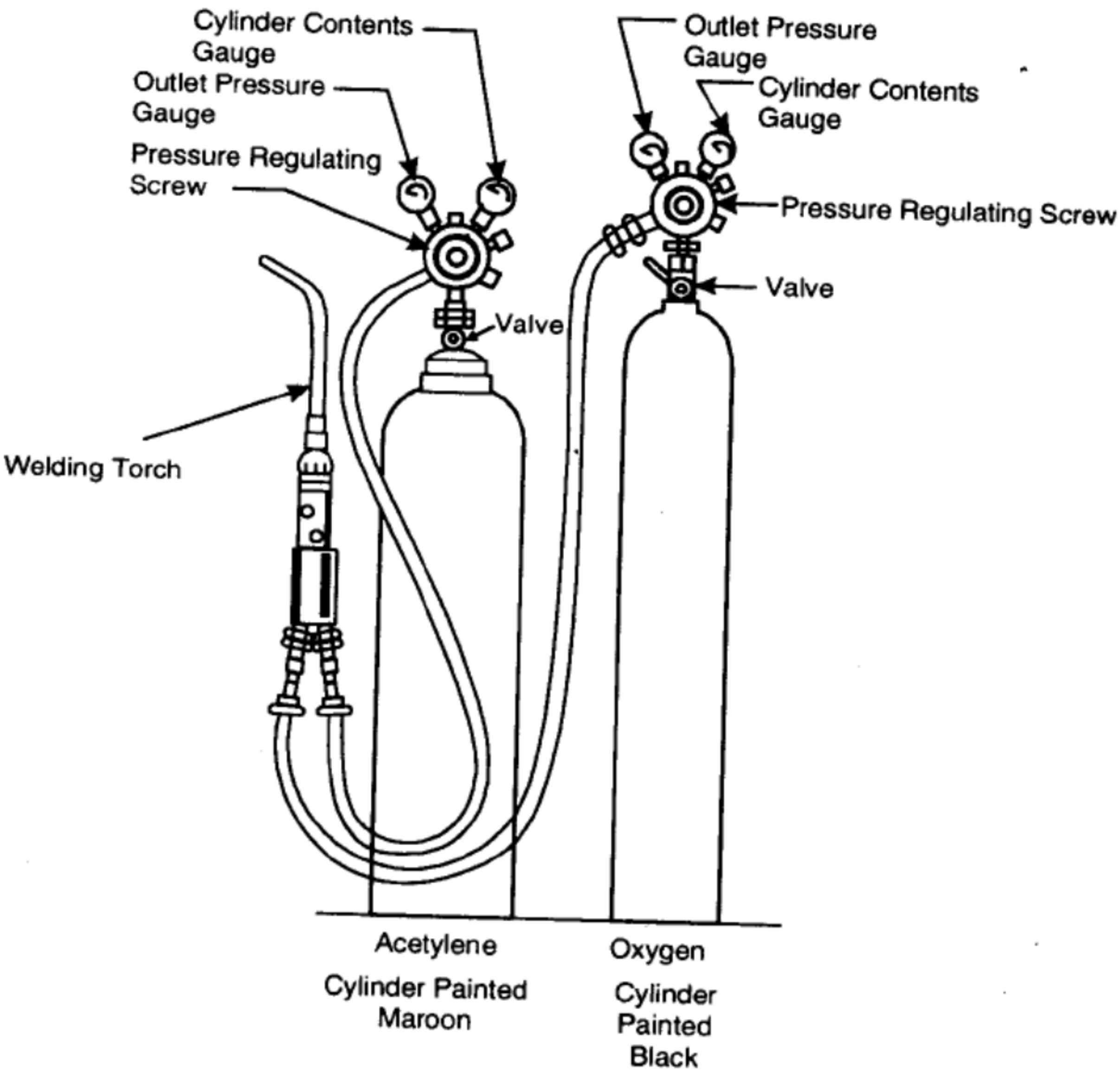
- Electron beam welding
- Laser beam welding.

2 (e)

Gas welding also called an oxy-fuel gas welding, derives the heat from the combustion of a fuel gas such as acetylene in combination with oxygen. The process is a fusion welding process wherein joint is completely melted to obtain the fusion.

The fuel gas generally used is acetylene because of the high temperature generated in the flame. This process is called oxy-acetylene welding.

List of equipments for gas welding can been seen from the fig below:



2 (F)

- The lathe, probably one of the earliest machine tools, is one of the most versatile and widely used machine tool, so also known as mother machine tool.
- An engine lathe is the most basic and simplest form of the lathe. It is called so because in early lathes, power was obtained from engines.
- The job to be machined is held and rotated in a lathe chuck, a cutting tool is advanced which is stationary against the rotating job. Since the cutting tool material is harder than the workpiece, so metal is easily removed from the job.
- Some of the common operations performed on a lathe are facing, turning, drilling, threading, knurling, and boring etc.

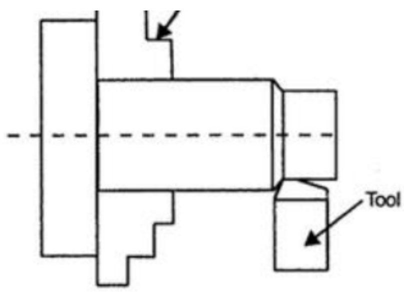


Fig. 29.17. *Plain Turning.*

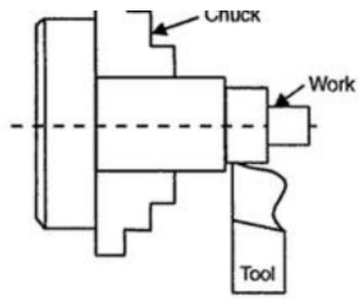
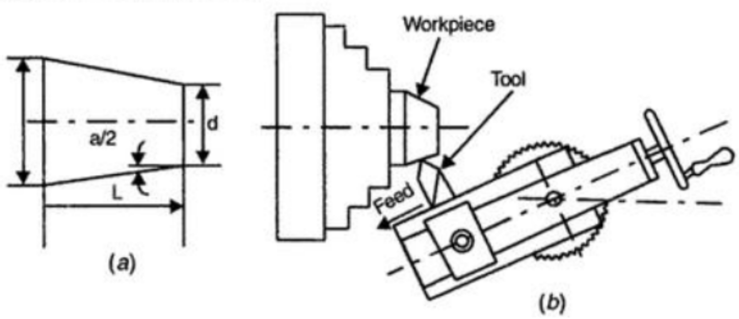


Fig. 29.18. *Step Turning.*

4. **Step Turning :** It is an operation of producing various steps of different diameters in the workpiece as shown in Fig. 29.18.
5. **Taper Turning :** It is an operation of producing an external conical surface on a workpiece. Taper turning can be performed by the tail stock set over method, by swivelling the compound rest, or using the taper turning attachment. Most commonly used is by swivelling the compound rest.



6. **Drilling :** It is an operation of making a hole in the workpiece with the help of a drill. The workpiece is held in a chuck and the drill is held in the tailstock. The drill is fed manually, into the rotating workpiece, by rotating the tailstock hand wheel.

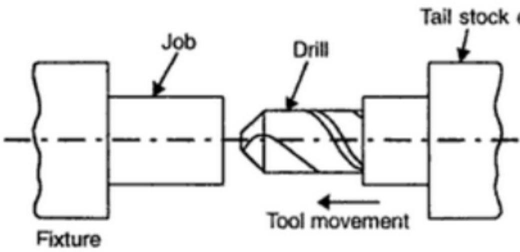


Fig. 29.20. *Drilling.*

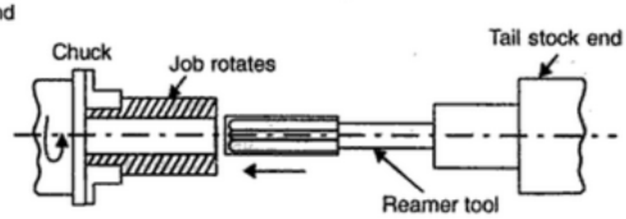


Fig. 29.21. *Reaming.*

7. **Reaming :** It is an operation of finishing the previously drilled role. In this case, reamer is held in the tailstock and is fed into the hole by rotating the tailstock hand wheel.
8. **Boring :** It is an operation of enlarging a hole already made in a workpiece. In this, boring tool is held in the tool post and is fed into the work similarly as in plain turning.

2 (g) 1 milling process: The basic function of milling machines is to produce flat surfaces in any orientation as well as surfaces of revolution, helical surfaces and contoured surfaces of various configurations. Such functions are accomplished by slowly feeding the workpiece into the equispaced multiedge circular cutting tool rotating at moderately high speed. The milling operation may be up milling or down milling depending on the relative movement between tool and workpiece.

2 Shaping process: The relative motions between the tool and the workpiece, shaping use a straight-line cutting motion with a single-point cutting tool to generate a flat surface. In shaping, the workpiece is fed at right angles to the cutting motion between successive strokes of the tool.

3 Drilling process: in drilling the relative motion between the tool and the workpiece is perpendicular to each other. The workpiece is rested on the bed of the machine and the rotation toll is moved perpendicular to it. The cutting action is performed by the double point cutting toll.

4 Boring process: Boring always involves the enlarging of an existing hole, which may have been made by a drill. The purpose of boring may be to make the hole concentric with the axis of rotation of the workpiece and thus correct any eccentricity that may have resulted from the drill drifting off the centerline. Concentricity is an important attribute of bored holes.

When boring is done in a lathe, the work usually is held in a chuck or on a faceplate. Holes may be bored straight, tapered, or to irregular contours.

Boring is essentially internal turning while feeding the tool parallel to the rotation axis of the workpiece.

Part-B

1[a] What is pattern? What are various allowances? Why are allowances necessary for pattern making? Name the types of moulding boxes. 7

[b] With the help of neat sketches discuss the equipments required for oxyacetelene welding. How are neutral, oxydising and reducing flames obtained in welding torch? 7

2[a] What is the principle of electric arc welding? Explain the term polarity indicating advantages and disadvantages of different polarities. 7

[b] Draw a neat diagram of a lathe machine showing various parts. 4

[c] Explain the working principle of shaper machine. 3

3[a] Explain briefly the following:

(i) Line Standards (ii) End standards 4

[b] Explain construction and working of micrometer with the help of neat sketch. 5

[c] What is a comparator? How are comparator classified? Explain any one mechanical compactor. 5

4 Write short notes on any TWO of the following:

(i) CNC (ii) EDM (ii) CHM (iv) SMT 2x7=14

1 (a) already explained.

2 (b) Oxy-fuel gas Welding (OFW): Heat source is the flame produced by the combustion of a fuel gas and oxygen. OFW has largely been replaced by other processes but it is still popular because of its portability and the low capital investment. Acetylene is the principal fuel gas employed.

- Combustion of oxygen and acetylene (C_2H_2) in a welding torch produces a temp. in a two stage reaction.
- In the first stage

$$C_2H_2 + O_2 \rightarrow 2CO + H_2 + \text{Heat}$$

This reaction occurs near the tip of the torch.

- In the second stage combustion of the CO and H_2 and occurs just beyond the first combustion zone.

$$2CO + O_2 \rightarrow 2CO_2 + \text{Heat}$$

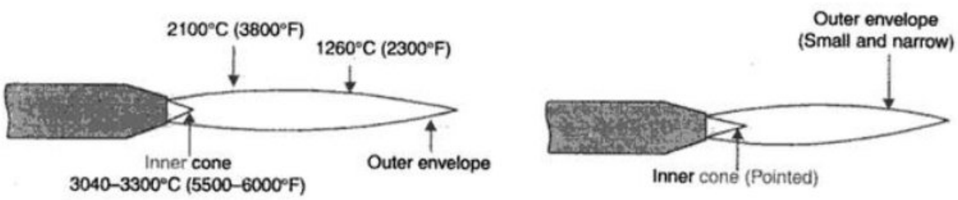
$$H_2 + \frac{1}{2}O_2 \rightarrow H_2O + \text{Heat}$$

Oxygen for secondary reactions is obtained from the atmosphere.

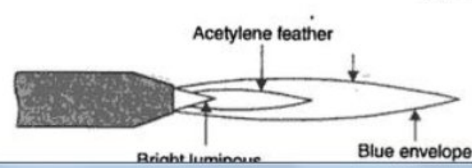
1. Neutral flame

A neutral flame is produced when oxygen to acetylene ratio is 1.1 to 1.

- The temperature is of the order of about 5900°F (3200°C).
- The flame has nicely defined inner cone (light blue in colour) and is surrounded by outer envelope which is dark blue in colour than the inner cone.
- It is called neutral because it will not oxidize or carburise the metal.
- It is used for welding of :
  - ❖ Mild steel
  - ❖ Stainless steel
  - ❖ Copper
  - ❖ Cast iron
  - ❖ Aluminium



(*a*) Neutral Flame (*b*) Oxidizing Flame



2. Oxidizing flame

- After the neutral flame, if the supply of oxygen is further increased, the result will be an oxidizing flame.
- Its inner cone is more pointed, outer flame envelope is much shorter.
- It burns with a loud roar.
- The temperature is of the order of about 6300°F (because of exess O_2 so complete combustion takes place).
- This flame is harmful for steels, because it oxidizes the steels.
- Only in the welding of copper and copper based alloys, oxidizing flame is desirable, because in those cases a thin protective layer of slag forms over the molten metal.

3. Reducing flame

If the volume of oxygen supplied to the neutral flame is reduced, the resulting flame will be a carburising or reducing flame *i.e.* rich in acetylene.

- In this flame, acetylene feather exists between the inner cone and outer envelope.
- Temperature is of the order of about 5500 °F (less because it does not completely consume the available carbon).
- Metals that tend to absorb carbon should not be welded with reducing flame.
- Carburizing flame conations more acetylene than a reducing flame.
- Carburizing flame is used in the welding of lead and for carburizing (surface hardening) purposes.
- Reducing flame is used with low alloy steel rod for welding high carbon steel.

2(a)

ARC WELDING PRINCIPLE

In arc welding, arc is generated between the positive pole of D.C. (direct current) called anode and negative pole of D.C. called cathode. When these two poles are brought together, and separated for a small distance (1.5 to 3 mm) such that the current continues to flow through a path of ionized particles, called plasma, an electric arc is formed. Since the resistance of this ionized gas column is high, so more ions will flow from anode to the cathode. Heat is generated as the ions strike the cathode.

Polarity is defined as the type of potential given to the workpiece or electrode. In case of direct current (D.C.) power source, positive and negative terminals are fixed whereas in case of alternating current (A.C.) power source, positive and negative terminals are not fixed *i.e.* the terminal which is positive during one half of cycle becomes negative in another half. So polarity principle is applicable only in case of direct current power source.

Polarity are of following two types :

1. **Straight Polarity.** In straight polarity, electrode is having negative terminal while workpiece is connected to the positive terminal of the direct current power source.
2. **Reverse Polarity.** In reverse polarity, electrode is connected to positive terminal whereas workpiece is connected to the negative terminal of the direct current power source.

Application. About 2/3 (67%) of total heat produced during welding is generated at positive terminal while rest of total heat is generated at negative terminal. So, if our job is thick, means we want more heat on workpiece so we connect workpiece to the positive terminal hence we adopt straight polarity. Similary, if job is thin, means we want less heat on job so we connect workpiece to the negative terminal hence we adopt reverse polarity.

If our electrode is non-consumable, means we want less heat on electrode (generally) so connect electrode to the negative terminal *i.e.* use straight polarity for doing welding.

2(b) diagram of the lathe machine is must. No need to make separate diagram of each part.

The principal parts of lathe are :

1. Bed, 2. Headstock, 3. Tailstock, 4. Carriage, 5. Feed mechanisms.

1. Bed

- It is the base or foundation of the lathe.
- It is heavy, rugged and single piece casting made to support the working parts of the lathe.
- On the top of the bed, there are two sets of guide ways—outer ways and innerways. Outer ways is for the carriage and the innerways for the tailstock.
- The guideways are of two types wide flat guideways and inverted V-guideways. With flat guideways, chip accumulation is a problem but life is more but for V-guideways life is less. So combination of both the flat and inverted V-guideways are used.

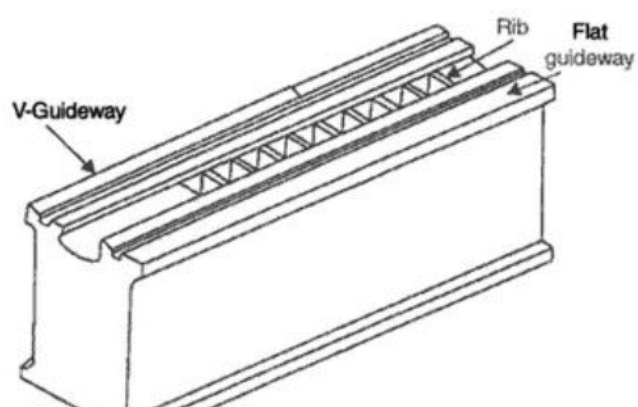


Fig. 29.3 *Lathe Bed.*

2. Headstock

- The headstock is permanently fastened on the innerways at the left side of the bed.
- The headstock spindle, a hollow cylindrical shaft supported by bearings, provides a drive from the motor to the work holding device.

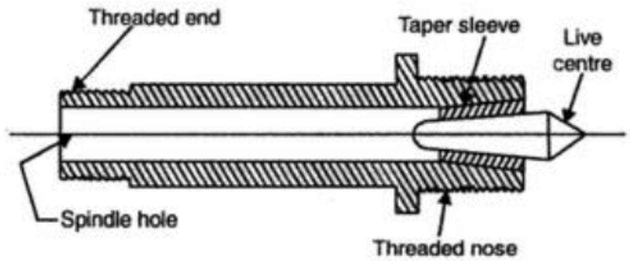


Fig. 29.4. *Headstock Spindle.*

- A live centre and sleeve, a face plate, or a chuck can be fitted to the spindle nose to hold and drive the work.
- Spindle nose may have threaded design or flanged type. Threaded type is commonly used and enables the chucks, driving plates and face plates to be screwed.
- All lathes receive their power with the help of a head stock. The power transmission device may be step cone pulleys or a geared head drive. Most modern lathes are having geared head to get large range of spindle speeds.

3. Tailstock

- It is situated at the right hand end of the bed and is mounted on the innerguideways. It can be moved towards or away from the operator.
- Tailstock can be locked in any position along the bed of the lathe by tightening the clamp lever or nut.
- The tailstock spindle is a hollow tapered shaft (left side end). It can be used to hold the dead centre or other tools having the same tapers such as drills and reamers.
- The tailstock handwheel is used to move the tailstock spindle in or out of the tailstock casting and a spindle binding (clamping) lever or lock handle is used to hold the tailstock spindle in a fixed position.

carriage - this part of the lathe carries the cutting tool and moves based on the rotation of the lead screw or rod.

Feed Mechanism:

Lead screw - A large screw with a few threads per inch used for cutting threads. It has ACME threads with included angle of 29^{o} for easy engagement and disengagement of half nut. Lead rod - a rod with a shaft down the side used for driving normal cutting feeds. The critical parameters on the lathe are speed of rotation (speed in RPM) and how far the tool moves across the work for each rotation (feed in IPR)

3 (a) Line Standards

In the line standards the unit of length is defined as the distance between the centres of engraved lines as in a steel rule. The International prototype metre and the imperial standard yard are line standards, since the measure of length is determined as between two lines. This form of measurement is not very convenient to use. Commercial line standards have the disadvantages that there is a limit to the accuracy with which the line can be produced, and their employment involves the use of microscopes and other special equipment.

The characteristics of line standards are given as follows –

1. Scales are subjected to the parallax effect, a source of both positive and negative reading errors.
2. Scales are nor convenient for close tolerance length measurement except in conjunction with microscope.
3. Scales can be accurately engraved but it is difficult to take full advantage of this accuracy, e.g. a steel rule can be read to about ±2 mm of true dimension.
4. A scale does not possess a 'built in' datum which would allow easy scale alignment with tile axis of measurement, this leads to 'under sizing'.
5. A scale is quick and easy to use over a wide range since only one is required.
6. The scale markings are not subject to wear although significant wear on leading end leads to 'under sizing', i.e. a bias towards negative component error.

End Standards

When the length being measured is expressed as the distance between two surfaces, this is referred to as end standard.

For all the important works in the shop, the users prefer end standards e.g. slip gauges, length bars, the ends of micrometre anvils, gap gauges, and so on. The distance between the end faces directly determines the length 0 the standard. The end faces are hardened, lapped, flat and parallel to a very high degree of accuracy. A modern end standard consists of a block or bar of steel, generally hardened whose end faces are lapped flat and parallel to within a few tenths of a micrometre. By the process of lapping, its size too can be controlled very accurately. Various types of end bars have been constructed some having flat and some spherical faces, the flat, parallel-faced bar is firmly established as the most practical method of end measurement.

Various characteristics of end standards are given as follows –

1. They are time consuming in use and prove only one dimension at a time.
2. End standards are highly accurate and are well suited to measurements of close tolerance.
3. They are subjected to wear on their measuring faces.
4. Dimensional tolerance as small as 0.0005 mm can be obtained.
5. End standards have a 'built in' datum because their measuring faces are flat and parallel and can be positively located on a datum surface.
6. They are not subjected to parallax effect as their use depends on "feel".
7. Groups of blocks are 'wrung' together to provide a given size, fault wringing leads to damage.
8. **Difference between line standards and end standards**
9. The differences between line standards and end standards are given as follows:

Line Standard	**End Standard**
1. Line standards do not provide high accuracy.	1. End standards more suited to accuracy requirements of higher order.
2. They are quick and easy to use over a wide range.	2. They are time consuming in use, and prove only

3. They are not subjected to wear although significant wear on leading end leads to under-sizing.

4. They are subjected to the parallax effect, a source of both positive and negative reading errors.

one dimension at a time.

3. They are subjected to wear on their measuring faces.

4. They are not subjected to parallax effect as their use depends on ‘feel’.

3 (b) Metric Micrometer

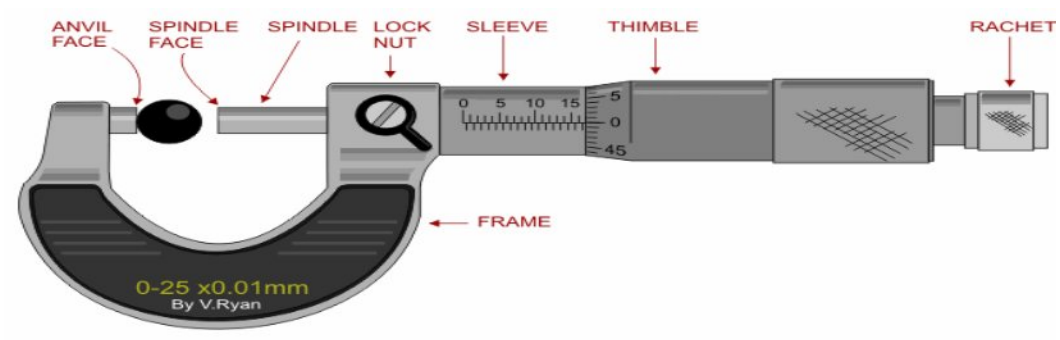
A *micrometer* allows a measurement of the size of a body. It is one of the most accurate mechanical devices in common use. It consists a main scale and a thimble

Method of Measurement

Step-I: Find the whole number of mm in the barrel

Step-I: Find the reading of barrel and multiply by 0.01

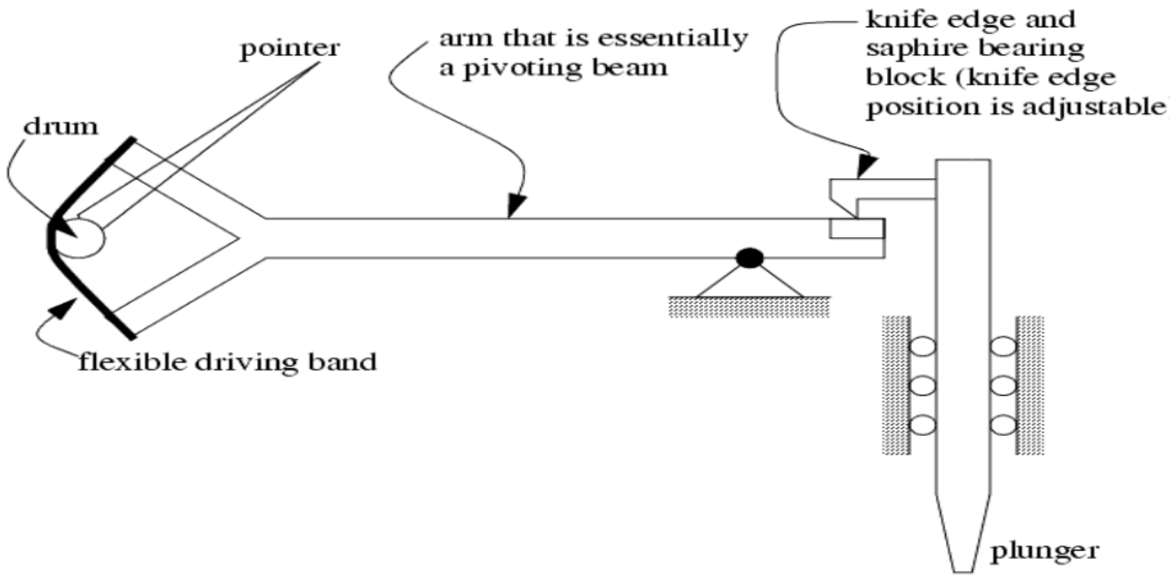
Step-III: Add the value in Step-I and Step-II



3 (c) Comparators: Comparator is another form of linear measuring method, which is quick and more convenient for checking large number of identical dimensions. During the measurement, a comparator is able to give the deviation of the dimension from the set dimension. Cannot measure absolute dimension but can only compare two dimensions. Highly reliable.
They may be classify as mechanical, optical, pneumatic and electrical.

Sigma Mechanical Comparator

The Sigma Mechanical Comparator uses a partially wrapped band wrapped about a driving drum to turn a pointer needle. The assembly provides a frictionless movement with a resistant pressure provided by the springs.



4 (1)

What is Computer Numerical Control?

Modern precision manufacturing demands extreme dimensional accuracy and surface finish. Such performance is very difficult to achieve manually, if not impossible, even with expert operators. In cases where it is possible, it takes much higher time due to the need for frequent dimensional measurement to prevent overcutting. It is thus obvious that automated motion control would replace manual "handwheel" control in modern manufacturing. Development of computer numerically controlled (CNC) machines has also made possible the automation of the machining processes with flexibility to handle production of small to medium batch of parts.

In the 1940s when the U.S. Air Force perceived the need to manufacture complex parts for high-speed aircraft. This led to the development of computer-based automatic machine tool controls also known as the Numerical Control (NC) systems. Commercial production of NC machine tools started around the fifties and sixties around the world. Note that at this time the microprocessor has not yet been invented.

Initially, the CNC technology was applied on lathes, milling machines, etc. which could perform a single type of metal cutting operation. Later, attempt was made to handle a variety of workpieces that may require several different types machining operations and to finish them in a single set-up. Thus CNC machining Centres capable of performing multiple operations were developed. To start with, CNC machining centres were developed for machining prismatic components combining operations like milling, drilling, boring and tapping. Gradually machines for manufacturing cylindrical components, called turning centers were developed.

4 (2)

Electro Discharge Machining (EDM) is an electro-thermal non-traditional machining process, where electrical energy is used to generate electrical spark and material removal mainly occurs due to thermal energy of the spark.

EDM is mainly used to machine difficult-to-machine materials and high strength temperature resistant alloys. EDM can be used to machine difficult geometries in small batches or even on job-shop basis. Work material to be machined by EDM has to be electrically conductive.

4(3) Chemical machining (CM) is the controlled dissolution of workpiece material (etching) by means of a strong chemical reagent (etchant). In CM material is removed from selected areas of workpiece by immersing it in a chemical reagents or etchants; such as acids and alkaline solutions. Material is removed by microscopic electrochemical cell action, as occurs in corrosion or chemical dissolution of a metal. This controlled chemical dissolution will simultaneously etch all exposed surfaces even though the penetration rates of the material removal may be only 0.0025–0.1 mm/min. The basic process takes many forms: chemical milling of pockets, contours, overall metal removal, chemical blanking for etching through thin sheets; photochemical machining (pcm) for etching by using of photosensitive resists in microelectronics; chemical or electrochemical polishing where weak chemical reagents are used (sometimes with remote electric assist) for polishing or deburring and chemical jet machining where a single chemically active jet is used

4 (4) Surface-mount technology (SMT) is a method for producing electronic circuits in which the components are mounted or placed directly onto the surface of printed circuit boards (PCBs).

Steps in SMT:

SMT - The Manufacturing Steps

1. Attachment media dispensing ?
2. Component placement X, Y data co-ordinates
3. Attachment media curing
4. Soldering- attachment, joining
5. Cleaning the joints
6. Testing – shorts, opens
   Quality

Boards
Components known

2(a) Discuss types of welding. Also explain welding defects. 2

(b) Name different pattern materials and pattern allowances. What are important moulding materials? 2

(c) Explain different types of flames with their applications. 2

(d) Explain the different elements of gating system. 2

(e) State that principle and working of metal arc welding? 2

(f) Explain the casting process and various casting defects. 2

2 (a) type of welding: already explained

Welding Defects:

Cracks : Cracks may be of micro or macro size and may appear in the weld metal or base metal or base metal and weld metal boundary.

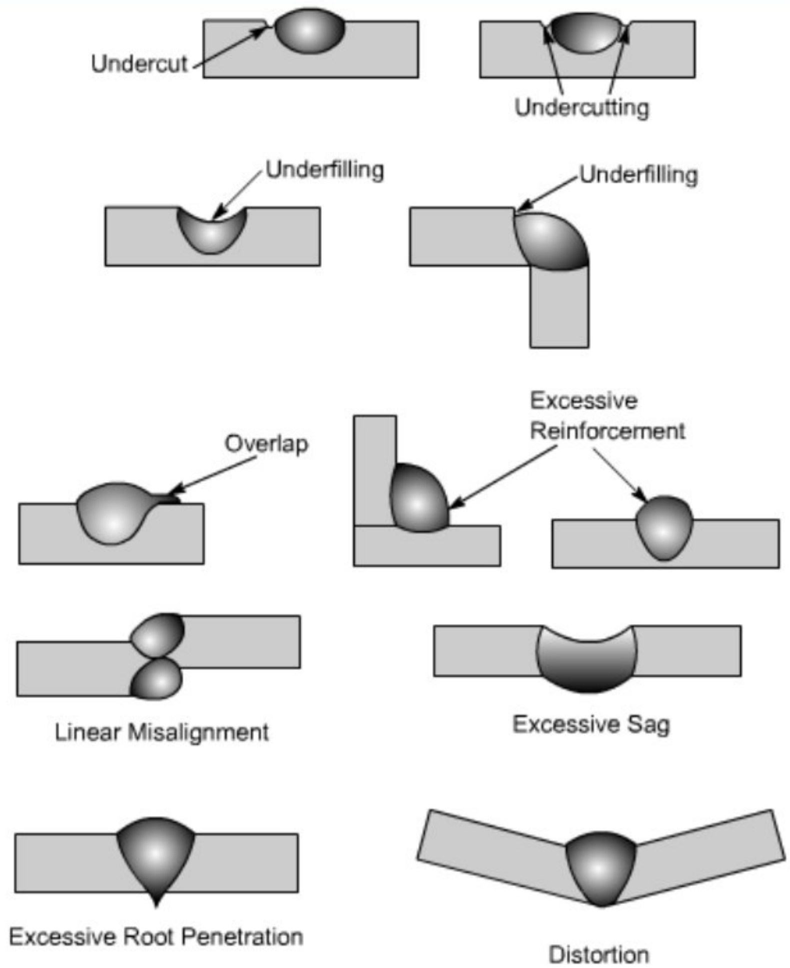
Hydrogen Induced Cracking: Due to the presence of moisture, grease, rust etc., hydrogen may enter the weld pool and get dissolved in the weld metal. During cooling hydrogen diffuses to the HAZ. Cracking may develop due to residual stresses assisted by hydrogen coalesence.

Porosity: Porosity results when the gases are entrapped in the solidifying weld metal. These gases are generated from the flux or coating constituents of the electrode or shielding gases used during welding or from absorbed moisture in the coating.

Solid Inclusion: Solid inclusions may be in the form of slag or any other nonmetallic material entrapped in the weld metal as these may not able to float on the surface of the solidifying weld metal.

Lack of Fusion : Lack of fusion is the failure to fuse together either the base metal and weld metal or subsequent beads in multipass welding because of failure to raise the temperature of base metal or previously deposited weld layer to melting point during welding.

Incomplete Penetration: Incomplete penetration means that the weld depth is not upto the desired level or root faces have not reached to melting point in a groove joint. If either low currents or larger arc lengths or large root face or small root gap or too narrow groove angles are used then it results into poor penetration.



2 (b) Already explained

2(c) Already explained

2 (d) preferred to read from classroom notes

Gating system means all the passages through which the molten metal enters the mould cavity *i.e.* it includes the pouring basin, runner, gate and riser etc. The manner in which the molten metal enters the mould has a great impact on the quality of the casting produced. So the gating system should be carefully designed and produced.

The various elements connected with a gating system are :

1. Pouring basin or pouring cup
2. Sprue
3. Sprue base well
4. Runner
5. Runner extension
6. Ingate
7. Riser

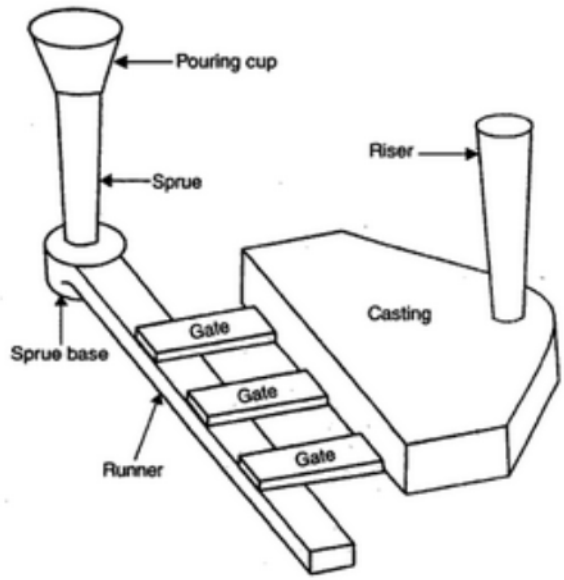


Fig. 16.10. *Gating System.*

Pouring Basin : Molten metal is poured into a pouring basin which acts as a reservoir from which it moves smoothly into the sprue. The pouring basin is also able to stop the slag from entering the mould cavity by means of a skimmer.

Sprue : It is the channel through which the molten metal is brought into the parting plane where it enters the runners and then gates. Sprues are conical in shape because :

- The molten metal when moving from top of the cope to the parting plane gains in velocity so requires a smaller area of cross section for the same amount of metal to flow at the bottom.
- Liquid tries to attain the minimum area at the bottom so there is an air gap between the liquid jet and sprue wall so air inspiration will be there which causes problem.

Sprue Base Well : This is a reservoir for metal at the bottom of the sprue to reduce the momentum of the molten metal.

Runner : It is generally located in the horizontal plane (parting plane) which connects the sprue to its ingates.

Runner Extension : This extension is provided to trap the slag in the molten metal.

Gates : These are the openings through which the molten metal enters the mould cavity.

2 (e) already explained.

2 (f) Casting Defects: (refer book for diagrams.)

The following are the major defects, which are likely to occur in sand castings:

- Gas defects
- Shrinkage cavities
- Molding material defects
- Pouring metal defects
- Mold shift.

Shrinkage: These are caused by liquid shrinkage occurring during the solidification of the casting. To compensate for this, proper feeding of liquid metal is required. For this reason risers are placed at the appropriate places in the mold. Sprues may be too thin, too long or not attached in the proper location, causing shrinkage cavities.

Cut and washes: These appear as rough spots and areas of excess metal, and are caused by erosion of molding sand by the flowing metal. This is caused by the molding sand not having enough strength and the molten metal flowing at high velocity. The former can be taken care of by the proper choice of molding sand and the latter can be overcome by the proper design of the gating system.

Scab: This defect occurs when a portion of the face of a mould lifts or breaks down and the recess thus made is filled by metal. When the metal is poured into the cavity, gas may be disengaged with such violence as to break up the sand, which is then washed away and the resulting cavity filled with metal. The reasons can be: - too fine sand, low permeability of sand, high moisture content of sand and uneven mould ramming.

Metal penetration: When molten metal enters into the gaps between sand grains, the result is a rough casting surface. This occurs because the sand is coarse or no mold wash was applied on the surface of the mold. The coarser the sand grains more the metal penetration.

Swell: Under the influence of metallostatic forces, the mold wall may move back causing a swell in the dimension of the casting. A proper ramming of the mold will correct this defect.

Inclusions: Particles of slag, refractory materials sand or deoxidation products are trapped in the casting during pouring solidification. The provision of choke in the gating system and the pouring basin at the top of the mold can prevent this defect

mis-run: A mis-run is caused when the metal is unable to fill the mold cavity completely and thus leaves unfilled cavities.

cold shut: A cold shut is caused when two streams while meeting in the mold cavity, do not fuse together properly thus forming a discontinuity in the casting.

Mold Shift: The mold shift defect occurs when cope and drag or molding boxes have not been properly aligned.

PART – B

Answer any five f the following :

2. [a] What are primary and secondary manufacturing processes?
   [b] What is pattern. Why allowances are provided on pattern? Write only name of different types of pattern.
   [c] Explain the function of the following :
   (1) Core (2) Gates (3) Riser (iv) Spruee (v) Runner

All are explained.

4

PART-B

3[a] Explain "Gating System" with schematic diagram. 2

[b] Define pattern? List out the types of patterns. What do you mean by pattern allowances. 2

[c] Explain and classify various manufacturing process. 2

[d] Write down the steps involved in sand casting process. 2

4 Write short notes: (Any four):

[a] Chills [b] Facing sand [c] Chaplet [d] Core

[e] Parting Line [f] Rammer.

2

3 (d) Sequential steps in making a sand casting:

- A pattern board is placed between the bottom (drag) and top (cope) halves of a flask, with the bottom side up.
- Sand is then packed into the drag half of the mold.
- A bottom board is positioned on top of the packed sand, and the mold is turned over, showing the top (cope) half of pattern with sprue and riser pins in place.
- The cope half of the mold is then packed with sand.
- The mold is opened, the pattern board is drawn (removed), and the runner and gate are cut into the surface of the sand.
- The mold is reassembled with the pattern board removed, and molten metal is poured through the sprue.
- The contents are shaken from the flask and the metal segment is separated from the sand, ready for further processing.

4 Chaplet: Chaplets are used to support cores inside the mould cavity.

Chill: Chills are metallic objects, which are placed in the mould to increase the cooling rate of castings.

Core: Used for making hollow cavities in castings.

Parting line: This is the dividing line between the two moulding flasks that makes up the sand mould.

Facing sand: The small amount of carbonaceous material sprinkled on the inner surface of the mold cavity to give a better surface finish to the castings.

Part-B

5[a] Define any four manufacturing process. 4

[b] Discuss the different types of allowances in casting process. 3

[c] Discuss the basic steps of sand casting process. 7

6[a] Explain Arc welding process in detail with neat sketch. 7

[b] Explain the following measuring instruments (i) Limit Gauges (ii) Micrometer. 7

7[a] Discuss the basic operations performed on lathe machine. 7

[b] Draw and explain the shaper machine. 7

8[a] Discuss the basic principles of electric discharge machining. 7

[b] Discuss Surface Mount technology. 4

[c] Discuss Automated Assembly. 3

Question no 5 already explained

Limit gauges:

Gauge	For Measuring
Snap Gauge	External Dimensions
Plug Gauge	Internal Dimensions
Taper Plug Gauge	Taper hole
Ring Gauge	External Diameter
Gap Gauge	Gaps and Grooves
Radius Gauge	Gauging radius
Thread pitch Gauge	External Thread

8(a)

Electro Discharge Machining (EDM) is an electro-thermal non-traditional machining process, where electrical energy is used to generate electrical spark and material removal mainly occurs due to thermal energy of the spark.

EDM is mainly used to machine difficult-to-machine materials and high strength temperature resistant alloys. EDM can be used to machine difficult geometries in small batches or even on job-shop basis. Work material to be machined by EDM has to be electrically conductive.

2. Process

Fig. 1 shows schematically the basic working principle of EDM process.

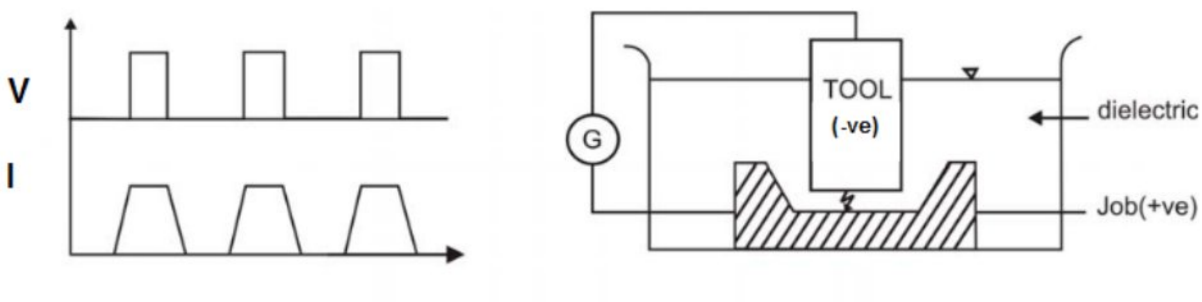


Fig. 1 *Schematic representation of the basic working principle of EDM process.*

In EDM, a potential difference is applied between the tool and workpiece. Both the tool and the work material are to be conductors of electricity. The tool and the work material are immersed in a dielectric medium. Generally kerosene or deionised water is used as the dielectric medium. A gap is maintained between the tool and the workpiece. Depending upon the applied potential difference and the gap between the tool and workpiece, an electric field would be established. Generally the tool is connected to the negative terminal of the generator and the workpiece is connected to positive terminal. As the electric field is established between the tool and the job, the free electrons on the tool are subjected to electrostatic forces. If the work function or the bonding energy of the electrons is less, electrons would be emitted from the tool (assuming it to be connected to the negative terminal). Such emission of electrons are called or termed as cold emission. The “cold emitted” electrons are then accelerated towards the job through the dielectric medium. As they gain velocity and energy, and start moving towards the job, there would be collisions between the electrons and dielectric molecules. Such collision may result in ionisation of the dielectric molecule depending upon the work function or ionisation energy of the dielectric molecule and the energy of the electron. Thus, as the electrons get accelerated, more positive ions and electrons would get generated due to collisions. This cyclic process would increase the concentration of electrons and ions in the dielectric medium between the tool and the job at the spark gap. The concentration would be so high that the matter existing in that channel could be characterised as “plasma”. The electrical resistance of such plasma channel would be very less. Thus all of a sudden, a large number of electrons will flow from the tool to the job and ions from the job to the tool. This is called avalanche motion of electrons. Such movement of electrons and ions can be visually seen as a spark. Thus the electrical energy is dissipated as the thermal energy of the spark.

The high speed electrons then impinge on the job and ions on the tool. The kinetic energy of the electrons and ions on impact with the surface of the job and tool respectively would be converted into thermal energy or heat flux. Such intense localised heat flux leads to extreme instantaneous confined rise in temperature which would be in excess of $10,000^{o}C$.

Such localised extreme rise in temperature leads to material removal. Material removal occurs due to instant vapourisation of the material as well as due to melting. The molten metal is not removed completely but only partially.

As the potential difference is withdrawn as shown in Fig. 1, the plasma channel is no longer sustained. As the plasma channel collapse, it generates pressure or shock waves, which evacuates the molten material forming a crater of removed material around the site of the spark.

Thus to summarise, the material removal in EDM mainly occurs due to formation of shock waves as the plasma channel collapse owing to discontinuation of applied potential difference.

Generally the workpiece is made positive and the tool negative. Hence, the electrons strike the job leading to crater formation due to high temperature and melting and material removal. Similarly, the positive ions impinge on the tool leading to tool wear.

In EDM, the generator is used to apply voltage pulses between the tool and the job. A constant voltage is not applied. Only sparking is desired in EDM rather than arcing. Arcing leads to localised material removal at a particular point whereas sparks get distributed all over the tool surface leading to uniformly distributed material removal under the tool.

8 (b) Already Explained.

8(c) Automated Assembly Systems

Assembly involves the joining together of two or more separate parts to form new entity which may be assembly or subassembly. Automated assembly refers to the use of mechanized and automated devices to perform the various functions in an assembly line or cell. Automated assembly system performs a sequence of automated operations to combine multiple components in to a single entity which can be a final product or sub assembly. Automated assembly technology should be considered when the following condition exists.

- ✓ High product demand
- ✓ Stable product design
- ✓ The assembly consists of no more than a limited number of components.
- ✓ The product is designed for automated assembly.

Automated assembly system involves less investment compared to transfer lines because

1. Work part produced are smaller in size compared to transfer lines.
2. Assembly operations do not have the large mechanical forces and power requirement
3. Size is very less compared to transfer lines.

5[a] Explain various types of manufacturing process with examples. 5

[b] Discuss NC, CNC & DNC machines. How a CNC machine has changed the whole machine scenario. 5

[c] Discuss the desirable properties of moulding sand. 4

6[a] Discuss various types of welding. Explain TIG welding. Also explain the defects occurred during welding. 7

[b] What is surface Mount Technology? Explain the automated assembly system. 7

7[a] What are the line & angular measurements? Explain the comparators. 5

[b] Write advantages and limitations of unconventional machining process. 5

[c] Discuss the steps involved in making a mould. 4

8 Write short notes on any two of the following while discussing their types and basic operation performed on them. 2x7=14

[a] Lathe

[b] Shaper

[c] Planer

5(a) already explained

5(b) already explained

5(c) Moulding Sand Properties:

Porosity or Permeability: Permeability or porosity of the moulding sand is the measure of its ability to permit air to flow through it.

Strength: It is defined as the property of holding together of sand grains. A moulding sand should have ample strength so that the mould does not collapse or get partially destroyed during conveying, turning over or closing.

Refractoriness: It is the ability of the moulding sand mixture to withstand the heat of melt without showing any signs of softening or fusion.

- Plasticity: It is the measure of the moulding sand to flow around and over a pattern during ramming and to uniformly fill the flask.
- Collapsibility: This is the ability of the moulding sand to decrease in volume to some extent under the compressive forces developed by the shrinkage of metal during freezing and subsequent cooling.
- Adhesiveness: This is the property of sand mixture to adhere to another body (here, the moulding flasks). The moulding sand should cling to the sides of the moulding boxes so that it does not fall out when the flasks are lifted and turned over. This property depends on the type and amount of binder used in the sand mix.

6 (a) already explained.

6 (b) already explained.

7 (a) linear measurements: This involves the measurement of linear dimensions. Some of the instruments used for the linear measurements are:

- Rules Vernier
- Micrometer
- Height gauge
- Bore gauge
- Dial indicator
- Slip gauges or gauge blocks

Angular Measurement: This involves the measurement of angles of tapers and similar surfaces. The most common angular measuring tools are:

- Bevel protractor
- Sine bar

7 (b) advantage of unconventional machining: it can be used for machining of:

— Workpiece material is too hard, strong, or tough.
— Workpiece is too flexible to resist cutting forces or too difficult to clamp.
— Part shape is very complex with internal or external profiles or small holes.
— Requirements for surface finish and tolerances are very high.
— Temperature rise or residual stresses are undesirable or unacceptable.

Disadvantage of unconventional machining:

The unconventional machines will require high power to operate.

They require highly skilled operator.

The initial tooling cost is very high.

Running cost is very high.

7(c) Already explained.

8 Already explained.

7. Draw the Gating system diagram and label the elements. 2
8. Discuss the difference between split pattern and loose piece pattern. 2
9. Name the pattern allowances and briefly explain. them 2
10. Write the properties of molding sand. 2
11. Discuss the different foundry tools. 2
12. Briefly explain the shielded metal Arc welding with figure. 2
13. What are the functions in coating electrode. 2

7 Already explained.

8 Already explained.

9 Already explained.

10 Already explained.

11 Showel:

Showel tool is used for mixing and tempering moulding sand and for moving the sand pile to flask.

Trowel:

Trowel tool is used to shape and smooth the surfaces of the mould and for doing small repairs. They are made of steel and are relatively long and narrow.

Riddle:

Riddle tool is a screen or sieve used to remove small pieces of metal and foreign particles from the moulding sand.

Rammer:

Rammer tool is used to compress the moulding sand. The hand rammer is made of tool and resembles like a handless mallet with one end flat and the other end blunt edge.

Draw spike:

Draw spike tool is used to remove the pattern from the mould and also used for rapping the pattern gently the loosen it from the sand to assure a clean draw.

Swab:

Swab tool is made of flax or hemp and is used for applying water to the mould around the corners and edges of the patterns. This tool prevents the sand edges from crumbling, when the pattern removed from the mould.

Vent wire:

Vent wire is a thin rod or wire carrying a pointed edge at one end and a wooden handle at the other end. Vent wire is used to make small holes called vents in the sand mould.

Slick tool:

Slicks tools are the spoon shaped trowels used for repairing or smoothening a mould surface.

12 shielded metal arc welding

In this arc welding process, welding heat is produced from an electric arc set up between a flux coated electrode and the workpiece. The electrode is consumable so supplies the necessary filler metal. The covering on the electrode serves the purpose of flux.

During the welding process, the metal electrode is melted by the heat of the arc and fuses with the workpiece. The temperature produced by the heat is about 2400°C to 2700°C. The arc temperature and thus the arc heat can be increased or decreased by employing higher or lower arc currents. A high current arc with a smaller arc length produces a very intense heat. Both D.C. and A.C. may be used. For current over 750 amperes, A.C. equipment is preferred as it has high efficiency, negligible loss at peak load and minimum maintenance. The basic setup is shown in Fig. 21.6.

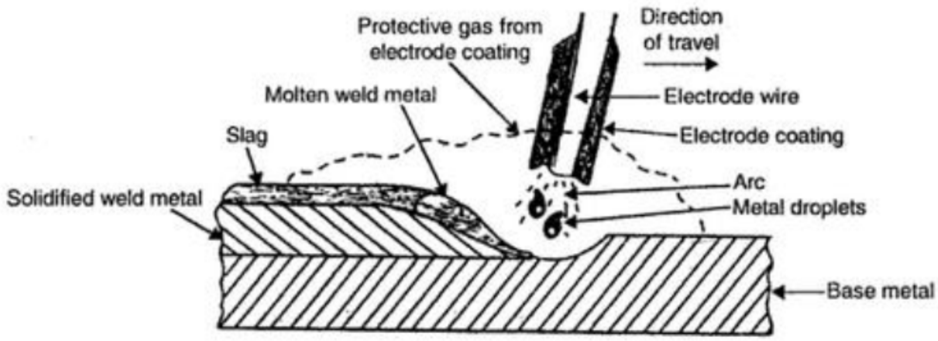


Fig. 21.6(*a*). *Principle of Flux Shielded Metal Arc Welding.*

13 function of coating on electrode:

1 atmospheric protection

2 heat treatment

3 Alloying.

All three were explained in the class.

1.What are the various manufacturing processes ? (2.5)

2.Define the **pattern.** Explain the various types of patterns. (2.5)

3.What do you understand by Die-casting? Explain hot chamber Die casting. (2.5)

4.Define welding and its classification with the help of hierarchical view. (2.5)

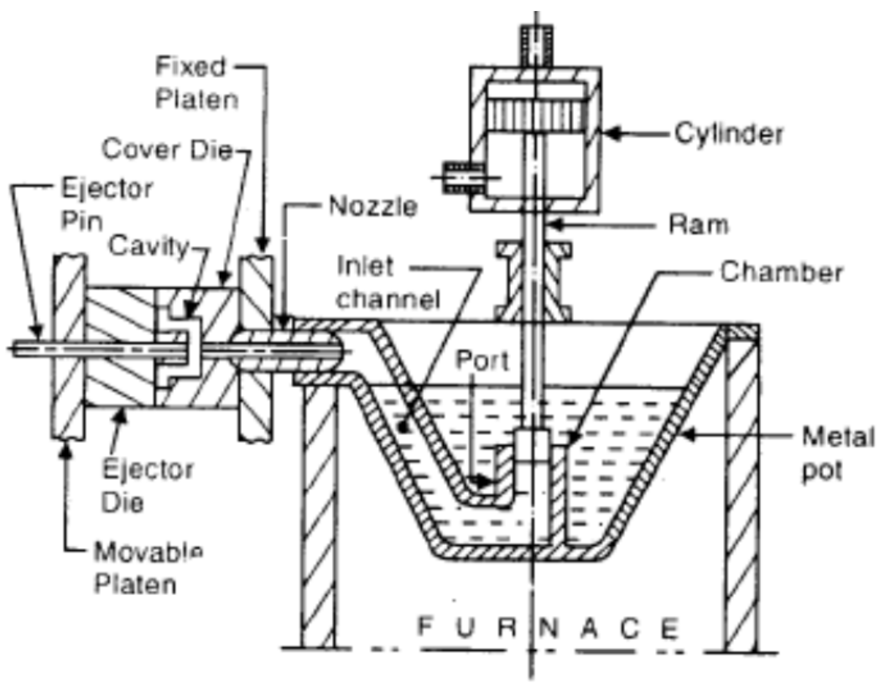
1 Already Explained

2 Already Explained

3 Die Casting: Molten metal is injected into closed metal dies under pressures ranging from 100 to 150 MPa. Pressure is maintained during solidification. After which the dies separate and the casting is ejected along with its attached sprues and runners. Cores must be simple and retractable and take the form of moving metal segments

Hot chamber Die Casting: primary features

- Good for low temperature (approx. 400°C)
- Faster than cold chamber machines
- Cycle times must be short to minimize metal contamination
- Metal starts in a heated cylinder
- A piston forces metal into the die
- The piston retracts, and draws metal in
- Metal: Lead, Tin, Zinc



4 Already Explained

Q1a). Explain, Hot Chamber Die Casting with a neat sketch. (3.5)
Q1b). Write down the basic steps in casting process. (3.5)
Q2a). Define pattern. Write any five types of pattern. (3.5)
Q2b). Define term chills, chaplets, and core in casting. (3.5)
Q3a). What is the principle of Resistance welding? Write down types of Resistance welding. (5)
Q3b). Write different types of flames used in Gas welding. (2)
Q4a). What are different operations performed on Lathe Machine? (3)
Q4b). Explain briefly, the drilling and milling operation. (4)
Q5a). Explain, with the neat sketch, process of centrifugal casting? (5)
Q5b). Write the principle of Arc welding. (2)
Q6. Write short notes on any ***three:*** (7)
i) Pattern allowance, ii) Casting defect, iii) shaper and planer, iv)Vernier calliper, v)Edge preparation in welding, vi)Micrometer and its working

1 (a) Already Explained

1 (b) Already Explained

2 (a) Already Explained

2 (b) Already Explained

3 (a) Resistance Welding: Both heat and pressure are used. Heat is generated by the electrical resistance of the work pieces and the interface between them. Pressure is supplied externally and is varied throughout the weld cycle. Due to pressure, a lower temperature needed than oxy-fuel or arc welding. They are not officially classified as solid-state welding by the American Welding Society. Very rapid and economical. Extremely well suited to automated manufacturing. No filler metal, no flux, no shielding gases.

Type of resistance welding:

1. Resistance spot welding
2. Resistance seam welding
3. Projection welding
4. Upset welding

5. Flash welding

6. Percussion welding

3(b) Already Explained

4 (a) Already Explained

4 (b) Already Explained

5 (a) Already Explained

5 (b) Already Explained

6 Vernier Caliper: (diagram from book)

- A vernier scale is an auxiliary scale that slides along the main scale.
- The vernier scale is that a certain number n of divisions on the vernier scale is equal in length to a different number (usually one less) of main-scale divisions.

$$nV = (n - 1)S$$

where n = number of divisions on the vernier scale

V = The length of one division on the vernier scale

and S = Length of the smallest main-scale division

- Least count is applied to the smallest value that can be read directly by use of a vernier scale.
- Least count = S − V = 1/n (s)

Edge Preparation: edge preparation is done for removal of oxide layer present on the workpiece, 100 % joint efficiency, high strength of welding joint and Good penetration.

Factor influencing edge preparations are:

Thickness of material

Material

Welding process

Extent of penetration required

Welding distortion

Part B

1. Describe in detail shielded metal Arc welding . (5)
2. What are the different types of defects in casting and their remedies. (5)
3. Explain the classification of plain carbon steel. (5)
4. What are the operations performed on Lathe machine. Explain in detail. (5)
5. Name the different types of Vernier Callipers. Explain any one with neat sketch. (5)
6. What are the allowances provided on Pattern, Explain them (5)
7. Write short notes on :
   (a) Slip Gauges. (2)
   (b) Micrometer (3)

1 Already Explained

2 Already Explained

3 Low-carbon steel: (less than 0.3%C)

- Good formability and weld ability but lack hardenability
- Used in hot-forming, cold-forming etc.

Medium carbon steel or Mild steel (0.3% to 0.8 % carbon)

- high toughness & ductility
- Most widely used steel
- Heat treatable (austenitizing, quenching and tempering).
- Hardenability is increased by adding Ni, Cr, Mo.
- Used in various tempered conditions.
- Typical applications: gears, railway tracks, machine parts.

High carbon steel (more the 0.8 %C)

- Hardness & wear resistance are high but Toughness & formability is very low

  Note⇒ purest form of Iron i.e. wrought iron has least carbon content.

4 Already Explained

5 Already Explained

6 Already Explained

7 Slip Gauges or Gauge blocks

- These are small blocks of alloy steel.
- Used in the manufacturing shops as length standards.
- Not to be used for regular and continuous measurement.
- Rectangular blocks with thickness representing the dimension of the block. The cross-section of the block is usually 32 mm x 9 mm.
- Are hardened and finished to size. The measuring surfaces of the gauge blocks are finished to a very high degree of finish, flatness and accuracy.
- Come in sets with different number of pieces in a given set to suit the requirements of measurements.
- A typical set consisting of 88 pieces for metric units is shown in.
- To build any given dimension, it is necessary to identify a set of blocks, which are to be put together.
- Number of blocks used should always be the smallest.
- Generally the top and bottom Slip Gauges in the pile are 2 mm wear gauges. This is so that they will be the only ones that will wear down, and it is much cheaper to replace two gauges than a whole set.