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PART - A

2 Marks Questions

1.
Sol. If the vertical faces of pattern are perpendicular to parting line, the edges of mould may be damaged when the pattern is removed from the sand. Hence the vertical faces are made taper for easy removal of pattern. This slight taper given on the vertical sides of pattern is called draft allowance.
2.
Sol. The various types of pattern allowances normally given are;
 1. Shrinkage allowance
 2. Machining or finish allowance
 3. Draft or taper allowance
 4. Distortion or camber allowance
 5. Rapping or shake allowance
3.
Sol. The main function of the riser is to supply excess molten metal to the solidifying casting; it allows the escape of air.
4.
Sol. Pattern is slightly larger in size as compared to the casting. Pattern may be in two or three pieces where as a casting is in one piece.
5.
Sol. **Destructive test:** Tensile, Impact, Hardness etc.
Non Destructive: Visual, sound, magnetic particles, dye penetration, ultrasonic etc.
6.
Sol. Solid or single piece pattern, match plate pattern, split pattern, sweep pattern, skeleton Pattern, segmental pattern, loose piece pattern, shell pattern.
7.
Sol. To provide a hollow surface or recess on the casting, the core is made.
8.
Sol. A core print is an extra projection on the pattern. It supports the core.
9.
Sol. Curing or heating the cores to obtain enough hardness is called as core setting.
10.
Sol. Permeability, refractoriness, strength collapsibility, stability.
11.
Sol. Give strength and hardness to core
Process cost is less
It saves time on heating
It can be stored for long use
12.
Sol. Green sand, Dry sand, Synthetic sand, Loam sand, Special sand, parting sand.
13.
Sol. **Green sand:** It contains 5 to 8% water and 15 to 20% clay.
Loam Sand: Loam sand is a mixture of fine sands, fine refractoriness, clay, graphite fiber and water. It contains more clay (50%)
14.
Sol. Shovel, Riddle, Rammer, Trowel, Slick, Strike off bar, lifter
15.
Sol. **Runner:**
It is used to make a sprue or a hole in the cope.
It receives the molten metal from the pouring basin and passes to the cavity.
Riser:



It supplies excess molten metal to the solidifying casting.
It allows the escape of air.

16.

Sol. Some times it is not possible to provide sufficient support for a core in the mould being poured, if the cores are bigger in size. In such cases the core is supported with rigid metal pieces called chaplets.

17.

Sol. Two difference between green sand mould and dry sand mould.

Green Sand Mould	Dry Sand Mould
Less time for making mould	More time consuming
Less surface finish	Better surface finish
Low strength	Stronger than green sand mould
Less permeability	More permeability

18.

Sol. The chills are used to provide directional solidification or to increase the rate of Solidification where the higher hardness required.

19.

Sol. Shifts - Two halves mismatching or casting
Hot tear Internal or external cracks
Fins - Thin projection of parting line
Inclusions - Foreign material present in casting

20.

Sol. Welding may be defined as the process of joining similar metals by th heat, with or without application of pressure and filler material.

21.

Sol.

1. It produces permanent joints.
2. The overall cost of the welding equipment is very low.
3. A Large number of metals can be welded.
4. A good weld is as strong as base metal.

22.

Sol. 1. Pressure welding 2. Non-pressure welding

23.

Sol. Spot welding, seam welding, lap and butt welding, projection welding.

24.

Sol. 1. Gas welding 2. Electric arc welding.

25.

Sol. The current is passes through the work pieces causes local heating and temperature rises to fusion point. Subsequent applications of pressure result in permanent joining of work pieces.

26.

Sol. Spot welding, seam welding, butt welding, projection welding.

27.

Sol. 1. Oxy acetylene welding 2. Oxy hydrogen welding 3. Oxy butane welding.

28.

Sol. 1. Neutral flame 2. Oxidizing flame 3. Reduction flame.

29.

Sol. Acetylene cylinder, gas cylinder, trolley, hose and hose fitting, pressure regulator, Welding torch.

30.

Sol. 1. Left ward welding. 2. Rightward welding.
3. Vertical welding 4. Overhead welding.

31.

Sol. 1. AC machine 2. DC machine
3. Transformer 4. Transformer with DC rectifier

32.

Sol. To avoid the formation of oxide and get strong perfect weld. It takes away from the impurities present in the surface of metal.

33.

Sol. Borex, sodium chloride.

34.

Sol. Electrode made of metallic wire called core wire, coated uniformly protective coating called flux.

35.

Sol. 1. Bare electrode 2. Dust coated electrode

36.

Sol. Low carbon steel rod, mild steel rod, vanadium steel rod.

37.

Sol. Direct, indirect, push pulls method.

38.

Sol. It is the resistance welding process. The heat is produced due to resistance against current. It is also called stitch welding.

39.

Sol. It is the welding process in which metal fused together by molten slag which melt the filler material and surface of the work to be welded.

40.

Sol.

1. The transformer maintenance cost is less.
2. Efficiency is very high.
3. The power available is very less.

41.

Sol. The arc is produced between the electrode and the work piece. The arc, end of electrode, the molten pool is submerged in the molten pool.

42.

Sol. It is used to avoid atmospheric contamination of the weld pool. The gases used in the welding process are argon helium hydrogen.

43.

Sol. There is no filler material used in the MIG welding instead OF filler material some inert gases are used.

44.

Sol. It is the welding process employing chemical energy is used to produce high temperature.

45.

Sol. 1. Crucible 2. Mould 3. Supporting structure.

46.

Sol. The heat is generated from the kinetic energy of intense beam of high velocity electron.

47.

Sol. 1. **Dimensional defects:** Warpage, incorrect joint preparation, size and profile.
2. **Structural defects:** porosity, non metallic inclusion, incomplete fusion, inadequate penetration.
3. **Defective properties:** low strength, toughness.

48.

Sol. It is a defect in the welding process in which failure to remove the slag after each layer in a multilayer in the welding operation lead to slag inclusion.

49.

Sol.

1. Hot cracking It occurs at high temperature just below freezing point. Excessive sulphur and carbon content in promotes the cracking.
2. Cold cracking - It occurs at room temperature. It occurs due to change in volume at weld cool.

50.

Sol. 1. Torch method 2. Furnace and hot plate method
3. Soldering iron method 4. Induction method.



51.

Sol. Soldering is the metal joining process with the help of the low melting point metal by the use of filler material and heat. The melting point of filler metal is below 427°C.

52.

Sol. Brazing may be defined as the technique of joining two similar or dissimilar materials by the addition of filler material whose melting point is above 427°C.

53.

Sol. **Different between soldering and brazing :**

Soldering	Brazing
✓ Joints require finishing ✓ Soldering joints are very weak and are used for electrical contact, fluid toughness, or sealing characteristics. ✓ Used for joining metal and alloy below 427°C ✓ It has very weak shearing strength	✓ Little finishing is required ✓ Joints are strong with good resistance to fatigue and corrosion. ✓ Used for joining metal and alloy above 427°C ✓ It has very high shearing strength

54.

Sol. Porosity in the materials largely eliminated
 Better mechanical properties
 Ability of forging to withstand unpredictable loads
 Rapid duplication of the components
 Wide range of forgeable metals is available

55.

Sol. Those processes, which are working below the recrystallisation temperature, are called cold working of metals.

56.

Sol. Those processes which are working above the recrystallisation temperature is called hot working of metals.

57.

Sol. Hot working requires less to get necessary deformation
 Brittle materials can also be hot worked.

58.

Sol. It is defined as the ratio of the cross sectional area of the billet to the cross section area of the product.

59.

Sol. The ratios of the difference in cross sectional area before and after drawing to the initial Cross sectional area.

$$RA = 1 - (D_o)^2 / (D_i)^2$$

60.

Sol. Extrusion, piercing

61.

Sol. % reduction = $D - d / D \times 100$

62.

Sol. Bloom fast break down of ingot into the size of 150mm x 150 mm to 250 mm x 300mm
 Billet a reduction of bloom of 50mm x 50mm to 125mm x 125mm by hot rolling.

63.

Sol. **Slab:** Obtained from bloom by rolling
Plate: The thickness, which is having minimum 6.35 mm
Sheet: Thin partner of plate -

Strip: A narrow sheet having maximum width of 6.00mm

64.

Sol. **Foil:** strip with maximum width of 300mm and maximum thickness of 1.5mm.

65.

Sol. It is the process of forming a very smooth, accurate polished shape on punch.

66.

Sol. Coining - pressing operation
Embossing forging operations

67.

Sol. During the bending operations, when the pressure on the metal release the bend angle may slightly change this is called spring back.

68.

Sol. The approximate minimum temperature at which complete recrystallisation of a cold worked metals take place within a specified time.

Recrystallization: Formation of new grain when the metal undergoes working.

69.

Sol. It is used to produce the seamless tube by using mandrel. It is used to produce the pierce at the center of the billet.

70.

Sol. 1. Two high rolling mills 2. Three high rolling mills
3. Three high rolling mills 4. Cluster rolling mills

71.

Sol. 1. Pitting 2. Cold shut and laps
3. Dents 4. Cracks

72.

Sol. 1. Direct or forward extrusions 2. Indirect or backward extrusion.

73.

Sol. Wire drawing is carried out by pulling a rod through the die which causes the reduction in cross section area of the rod.

74.

Sol. High intensity between the coils
Eddy current
Coil compression
Flux concentration

75.

Sol. Forming process occurs in
Small interval of time
Very high compact densities can be obtained
Mixtures of metal can be easily compacted

76.

Sol. It includes a number of process in which part are formed at a rapid rate by extremely high pressure. The energy needed for processing the material is released in a very short time. It is called high-energy rate forming process.

77.

Sol. It is used for compacting metal powder
It is used for forging and cold welding
It is also used for bending and extruding
Metal cutting process is also possible

78.

Sol. Explosive forming, Electro hydraulic forming, Electromagnetic forming, Dynapak high speed forming process.

79.

Sol. The commonly used die materials are concrete, wood, epoxy, plastics, plaster of paris and CI, steel etc.



80.

Sol. The basic principle is that discharging of a capacitor through coil over a period of micro seconds, the magnetic flux densities of the order of hundreds of kilogauss can be produced.

81.

Sol. A Flexible Manufacturing System [FMS] is a highly automated GT machine cell, consisting of a group of processing workstations, interconnected by an automated material handling and storage system, and controlled by a distributed computer system

82.

Sol. Flexible Manufacturing Systems [FMS] consists of the following four components.

1. Processing stations or workstations
2. Material handling and storage
3. Computer control system
4. Human labor

83.

Sol. The Objectives of FMS are

1. To provide flexible manufacturing facility for pan family components.
2. To provide the benefits of grouping the operation in single location.
3. To provide the flexibility in producing small and medium parts.
4. To maximize the utilization of facilities.
5. To have a good management control.

84.

Sol. FMS classified based on level of flexibility are

1. Production flexibility
2. Machine flexibility
3. Mix flexibility
4. Product flexibility

85.

Sol. The FMS is classified based on number of machines are

1. Single Machine Cell (SMC)
2. Flexible Manufacturing Cell (FMC)
3. Flexible Manufacturing System (FMS)

86.

Sol.

1. Increased machine utilization
2. Fewer machines required
3. Reduction in the amount of factory floor space required
4. Reduced inventory requirements
5. Lower manufacturing lead times
6. Greater responsiveness to change

87.

Sol. Metal cutting is "the process of removing unwanted material in the form of chips, from a block of metal, using cutting tool"

88.

Sol. The metal in front of the cutting tool rake face gets immediately compressed first elastically and then plastically. This zone is traditionally called as shear zone in view of the fact the material in the final form would be removed by shear from the parent metal.

89.

Sol. Machining is the manufacturing process by which parts can be produced to the desired dimensions and surface finish from a blank by gradual removal of the excess material in the form of chips with the help of a sharp cutting tool.

90.

Sol. Steel is an alloy of iron and carbon, which typically includes a mix of iron ore, coal, limestone and other elements. It is the most common steel utilized in metal fabrication, and has an almost endless list of uses from construction materials to machinery and weaponry.

91.

Sol. Cutting tools may be classified according to the number of major cutting edges (points) involved as follows:

- Single point: e.g., turning tools, shaping, planning and slotting tools and boring tools.
- Double (two) point: e.g., drills.
- Multipoint (more than two): e.g., milling cutters, broaching tools, hobs, gear shaping cutters etc.

92.

Ans. Angle of inclination of rake surface from reference plane.

93.

Ans. Angle of inclination of clearance or flank surface from the finished surface.

94.

Sol. It helps reduce cutting force and thus cutting power requirement.

95.

Sol. It is used to simplify design and manufacture of the form tools.

96.

Sol. It is used to increase edge-strength and life of the tool.

97.

Sol. The portion of the tool bit which is not ground to form cutting edges and is rectangular in cross section.

98.

Sol. The surface against which the chip slides upward.

99.

Sol. The surface which face the work piece. There are two flank surfaces in a single point cutting tool. One is principal flank and the other is auxiliary flank.

100.

Sol. The lowest portion of the side cutting edges.

101.

Sol. The conjunction of the side cutting edge and end cutting edge. It provides strengthening of the tool nose and better surface finish.

102.

Sol. The form of machined chips depends mainly upon:

1. Work material
2. Material and geometry of the cutting tool.
3. Levels of cutting velocity and feed and also to some extent on depth of cut.
4. Machining environment or cutting fluid that affects temperature and friction at the chip-tool and work-tool interfaces.

103.

Sol. The basic two mechanisms involved in chip formation are:

1. **Yielding:-** Generally for ductile materials.
2. **Brittle fracture:-** Generally for brittle materials.

104.

Sol. In machining ductile metals like steels with long chip-tool contact length, lot of stress and temperature develops in the secondary deformation zone at the chip-tool interface. Under such high stress and temperature in between two clean surfaces of metals, strong bonding may locally take place due to adhesion similar to welding. Such bonding will be encouraged and accelerated if the chip tool materials have mutual affinity or solubility.

105.

Sol. Built-up-edges are characterized by its shape, size and bond strength, which depend upon:

- Work tool materials.
- Stress and temperature, i.e., cutting velocity and feed.
- Cutting fluid application governing cooling and lubrication.

106.

Sol. **Advantages of Merchant's circle diagram are:**

- Easy, quick and reasonably accurate determination of several other forces from a few known forces involved in machining.
- Friction at chip tool interface and dynamic yield shear strength can be easily determined.
- Equations relating the different forces are easily developed.



107.

Sol. Limitations of Merchant's Circle Diagram:

- Merchant's circle diagram (MCD) is only valid for orthogonal cutting.
- By the ratio, F/N , the MCD gives apparent (not actual) coefficient of friction.
- It is based on single shear plane theory.

108.

Sol. Tool life generally indicates the amount of satisfactory performance or service rendered by a fresh tool or a cutting point till it is declared failed. Tool life is always assessed or expressed by

- Number of pieces of work machined.
- Total volume of material removed.
- Total length of cut.

109.

Sol. Wear and hence tool life of any tool for any work material is governed mainly by the level of the machining parameters i.e., cutting velocity (V_c), feed (f) and depth of cut (t).Taylor's Tool Life Equation = $V_c T^n = C$

Cutting velocity affects maximum and depth of cut minimum.

With the slope, n and intercept, c , Taylor derived the simple equation as,

110.

Sol. The life of the cutting tool is affected by the following factors:

- Cutting speed.
- Feed and depth of cut.
- Tool geometry.
- Tool material.
- Cutting fluid.
- Work piece material.
- Rigidity of work, tool and machine.

111.

Sol. A fixture may be described as a special chuck built for the purpose of holding, locating and machining a large number of identical pieces which cannot be easily held by conventional gripping devices. Fixtures also serve the purpose of accurately locating the machining surface.

112.

Sol. The main function of the shaper is to produce flat surfaces in different planes. In general the shaper can produce any surface composed of straight line elements. Modern shapers can generate contoured surface.

113.

Sol. The top and side of the table of a shaper have T-slots for clamping the work piece. The work piece may be supported on the shaper table by using any one of the following work holding devices depending upon the geometry of the work piece and nature of the operation to be performed.

1. Machine vise.
2. Clamping work on the table.
3. Angle plate.
4. V-blocks.
5. Shaper centre.

114.

Sol. It may be considered as an extension of the machine spindle on which milling cutters are securely mounted and rotated. The arbors are made with taper shanks for proper alignment with the machine spindles having taper holes at their nose. The arbor may be supported at the farthest end from the overhanging arm or may be of cantilever type which is called stub arbor.

115.

Sol.

1. Dimensional accuracy and good surface finish.
2. Good form and locational accuracy.
3. Applicable to both hardened and unhardened material.

116.

Sol. Dressing is the conditioning of the wheel surface which ensures that grit cutting edges are exposed from the bond and thus able to penetrate into the work piece material. Also, in dressing attempts are made to splinter the abrasive grains to make them sharp and free cutting and also to remove any residue left by material being ground.

117.

Sol. Abrasives may be classified into two types:

1. **Natural abrasives:-** Emery (50 - 60 % crystalline Al_2O_3 + Iron Oxide), Sandstone or Solid Quartz, Corundum (75-90 % crystalline Al_2O_3 + Iron Oxide) and Diamond.
2. **Artificial abrasives -** Aluminium Oxide (Al_2O_3), Silicon Carbide (SiC), Artificial diamond, Boron Carbide and Cubic Boron Nitride (CBN).

118.

Sol. Grinding processes are generally classified based on the type of surface produced.

They are:

1. Cylindrical grinding process.
2. Surface grinding process.
3. Centreless grinding process.

119.

Sol. Honing is a low abrading process which uses bonded abrasive sticks for removing stock from metallic and non-metallic surfaces. This process is used primarily to remove the grinding or the tool marks left on the surface by previous operations. However, it can be used for external cylindrical surfaces as well as flat surfaces. It is most commonly used for internal surfaces.

The advantages of honing are:

1. Correction of geometrical accuracy.
2. Dimensional accuracy.

120.

Sol. Lapping is a surface finishing process used on flat or cylindrical surfaces. Lapping is the abrading of a surface by means of a lap (which is made of a material softer than the material to be lapped), which has been charged with the fine abrasive particles.

- Geometrically true surface.
- Extreme accuracy of dimension.
- Correction of minor imperfections in shape.
- Refinement of the surface finish, and
- Close fit between mating surfaces.

121.

Sol. Broaching is a machining process for removal of a layer of material of desired width and depth usually in one stroke by a slender rod or bar type cutter having a series of cutting edges with gradually increased protrusion.

PART - B

5 Marks Questions

122.

Sol. Different between orthogonal cutting and oblique cutting:

Orthogonal Cutting	Oblique Cutting
Cutting edge of the tool is perpendicular to the direction of tool travel	Cutting edge of the tool is inclined to the direction of tool travel
The direction of chip flow is perpendicular to the cutting edge	The direction of chip flow is angled to the cutting edge
The chip coils in a tight flat spiral	The chip flows sideways in a long
Produces sharp corners.	Produces chamfer at the end of cut.

123.

Sol. A machine tool may have a large number of various features and characteristics. But only some specific salient features are used for specifying a machine tool. All the manufacturers, traders and users must know how machine tools are specified.

The methods of specification of some basic machine tools are as follows:

Specification of Centre lathe machine tools:

- Maximum diameter and length of the jobs that can be accommodated.
- Power of the main drive (motor).
- Range of spindle speeds and range of feeds.
- Space occupied by the machine.

Specification of Shaper machine tools

Shaper

- Length, breadth and depth of the bed.
- Maximum axial travel of the bed and vertical travel of the bed/tool.
- Maximum length of the stroke (of the ram/tool).
- Range of number of strokes per minute.
- Range of table feed.
- Power of the main drive.
- Space occupied by the machine.

Specification of Drilling machine tools

Drilling machine (column type)

- Maximum drill size (diameter) that can be used.
- Size and taper of the hole in the spindle.
- Range of spindle speeds.
- Range of feeds.
- Power of the main drive.
- Range of the axial travel of the spindle/bed.
- Floor space occupied by the machine.

Specification of Milling machine tools

Milling machine (knee type and with arbor)

- Type; ordinary or swiveling bed type.
- Size of the work table.
- Range of travels of the table in X - Y - Z directions.
- Arbor size (diameter).
- Power of the main drive.
- Range of spindle speed.
- Range of table feeds in X - Y - Z directions.
- Floor space occupied.

124.

Sol. The metal cutting process is mainly classified into two types. They are:

1. **Orthogonal cutting process (Two-dimensional cutting)**

The cutting edge or face of the tool is 90° to the line of action or path of the tool or to the cutting velocity vector. This cutting involves only two forces and this makes the analysis simpler.

2. **Oblique cutting process (Three-dimensional cutting)**

The cutting edge or face of the tool is inclined at an angle less than 90° to the line of action or path of the tool or to the cutting velocity vector. Its analysis is more difficult of its three dimensions.

125.

Sol. Different types of chips of various shape, size, colour etc. are produced by machining are

Continuous chips without BUE

The following condition favors the formation of continuous chips without BUE chips:

- Work material - ductile.
- Cutting velocity - high.
- Feed - low.
- Rake angle - positive and large.

- Cutting fluid - both cooling and lubricating.

Discontinuous chips

This is also called as segmental chips.

The following condition favors the formation of discontinuous chips:

- Of irregular size and shape: - work material - brittle like grey cast iron.
- Of regular size and shape: - work material ductile but hard and work hardenable.
- Feed rate - large.
- Tool rake - negative.
- Cutting fluid - absent or inadequate.

Continuous chips with BUE

The following condition favors the formation of continuous chips with BUE chips:

- Work material - ductile.
- Cutting velocity - low (~ 0.5 m/s).
- Small or negative rake angles.
- Feed - medium or large.
- Cutting fluid - inadequate or absent.

126.

Sol. The cutting tool material of the day and future essentially require the following properties to resist or retard the phenomena leading to random or early tool failure:

- High mechanical strength, compressive, tensile, and TRA.
- Fracture toughness - high or at least adequate.
- High hardness for abrasion resistance.
- High hot hardness to resist plastic deformation and reduce wear rate at elevated temperature.
- Chemical stability or inertness against work material, atmospheric gases and cutting fluids.
- Resistance to adhesion and diffusion.
- Thermal conductivity - low at the surface to resist incoming of heat and high at the core to quickly dissipate the heat entered.
- High heat resistance and stiffness.
- Manufacturability, availability and low cost.

127.

Sol. 1. **High Speed Steel (HSS)**

The basic composition of HSS is 18% W, 4% Cr, 1% V, 0.7% C and rest Fe. Such HSS tool could machine (turn) mild steel jobs at speed only up to 20 ~ 30 m/min

2. **Stellite**

This is a cast alloy of Co (40 to 50%), Cr (27 to 32%), W (14 to 19%) and C (2%). Stellite is quite tough and more heat and wear resistive than the basic HSS (18 - 4 - 1) But such stellite as cutting tool material became obsolete for its poor grindability and especially after the arrival of cemented carbides.

3. **Sintered Tungsten carbides**

The advent of sintered carbides made another breakthrough in the history of cutting tool materials.

4. **Plain ceramics**

Inherently high compressive strength, chemical stability and hot hardness of the ceramics led to powder metallurgical production of indexable ceramic tool inserts

128.

Sol. Generally, surface finish of any product depends on the following factors:

- **Cutting speed**

Better surface finish can be obtained at higher cutting speeds. Rough cutting takes place at lower cutting speeds.

- **Feed**

Surface finish will not be good when coarse feed is applied. But better finish can be obtained in fine feeds.

- **Depth of cut**

Lighter cuts provide good surface finish to the work piece. If depth of cut increases during machining, the quality of surface finish will reduce.

Therefore, higher cutting speeds, fine feeds and low depth of cuts or applied to ensure good surface finish. Usually, it is done in finishing cuts. But, lower cutting speeds, coarse feeds and heavier depth of cuts are applied in rough cutting operations.

129.

Sol.

The machining operations generally carried out in centre lathe are:

Rough and finish turning:- The operation of producing cylindrical surface.

Facing:- Machining the end of the work piece to produce flat surface.

Centering:- The operation of producing conical holes on both ends of the work piece.

Chamfering:- The operation of beveling or turning a slope at the end of the work piece.

Shouldering:- The operation of turning the shoulders of the stepped diameter work piece.

Grooving:- The operation of reducing the diameter of the work piece over a narrow surface. It is also called as recessing, undercutting or necking.

Axial drilling and reaming by holding the cutting tool in the tailstock barrel.

Taper turning by

- Offsetting the tailstock.
- Swiveling the compound slide.
- Using form tool with taper over short length.
- Using taper turning attachment if available.
- Combining longitudinal feed and cross feed, if feasible.

Boring (internal turning) straight and taper:- The operation of enlarging the diameter of a hole.

Forming; external and internal.

Cutting helical threads; external and internal.

Parting off:- The operation of cutting the work piece into two halves.

Knurling:- The operation of producing a diamond shaped pattern or impression on the surface.

130.

Ans.

S.No.	Capstan Lathe	Turret Lathe
1.	Turret head is mounted on a ram which slides over the saddle.	Turret head is directly mounted on saddle. But it slides on the bed
2.	The turret movement is limited.	The turret moves on the entire length of the bed without any restriction.
3.	Hence shorter work piece can be machined.	Longer work piece can be machined.
4.	Its construction does not provide rigidity due to overhanging of ram beyond the bed.	It provides rigidity and strong.
5.	It is suitable for light duty applications.	It is suitable for heavy duty applications.

131.

Ans.

S.No.	Shaper	Planer
1.	The tool reciprocates and the work is stationary.	The work reciprocates and the tool is stationary.
2.	Feed is given to the work during the idle stroke of the ram.	Feed is given to the tool during the idle stroke of the work table.
3.	It gives more accuracy as the tool is rigidly supported during cutting.	Less accuracy due to the overhanging of the ram.
4.	Suitable for machining small work pieces.	Suitable for machining large work pieces.
5.	Only light cuts can be applied.	Heavy cuts can be applied.

132.

Sol. The standard marking system for conventional abrasive wheel can be as follows:

51 A 60 K 5 V 05

where

- The number '51' is manufacturer's identification number indicating exact kind of abrasive used.
- The letter 'A' denotes that the type of abrasive is Aluminium Oxide (Al_2O_3). In case of Silicon Carbide (SiC) the letter 'C' is used.
- The number '60' specifies the average grit size in inch mesh. For a very large size grit this number may be as small as 6 where as for a very fine grit the number may be as high as 600.
- The letter 'K' denotes the hardness of the wheel. The letter symbol can range between 'A' and 'Z', 'A' denoting the softest grade and 'Z' denoting the hardest one.
- The number '5' denotes the structure or porosity of the wheel. This number can assume any value between 1 to 20, '1' indicating high porosity and '20' indicating low porosity.
- The letter code 'V' means that the bond material used is vitrified.
- The number '05' is a wheel manufacturer's identifier.

133.

Sol. It is an adhesive substance which holds the abrasive grains together to form the grinding wheel.

Types of bonds

Bonds are classified into two types:

1. **Organic:-** Resinoid, Rubber, Shellac & Oxychloride.
2. **Non-Organic:-** Metallic, Vitrified & Silicate.

Vitrified bond (V)

Vitrified bond is suitable for high stock removal even at dry condition. It can also be safely used in wet grinding. It can not be used where mechanical impact or thermal variations are like to occur. This bond is also not recommended for very under centrifugal force.

Rubber bond (R)

Its principal use is in thin wheels for wet cut-off operation. Rubber bond was once popular for finish grinding on bearings and cutting tools.



Silicate bond (S)

Silicate wheels are made by mixing abrasive grains with silicate of soda. The mixture is moulded in a mould and dried for several hours. After drying, the moulded material is kept in a furnace at about 200 to 260°C for 20 to 80 hours. Silicate bonded wheels are light grey in colour. These wheels are having a fairly high tensile strength.

Metal bond (M)

Metal bond is extensively used with super abrasive wheels. Extremely high toughness of metal bonded wheels makes these very effective in those applications where form accuracy as well as large stock removal is desired.

Shellac bond (E)

Shellac bonded grinding wheels are relatively strong but not rigid. At one time this bond was used for flexible cut off wheels. At present use of shellac bond is limited to grinding wheels engaged in fine finish of rolls.

Oxychloride bond (O)

It is less common type bond, but still can be used in disc grinding operation. It is used under dry condition. It is produced by mixing abrasive grains with oxide and chloride of magnesium.

Resinoid bond (B)

Conventional abrasive resin bonded wheels are widely used for heavy duty grinding because of their ability to withstand shock load. This bond is also known for its vibration absorbing characteristics and finds its use with diamond and CBN in grinding of cemented carbide and steel respectively.

Resin bond is not recommended with alkaline grinding fluid for a possible chemical attack leading to bond weakening. Fiberglass reinforced resin bond is used with cut off wheels which requires added strength under high speed operation.

Electroplated bond

This bond allows large (30-40%) crystal exposure above the bond without need of any truing or dressing. This bond is specially used for making small diameter wheel, form wheel and thin super abrasive wheels. Presently it is the only bond for making wheels for abrasive milling and ultra high speed grinding.

Brazed bond

This is relatively a recent development, allows crystal exposure as high 60-80%. In addition grit spacing can be precisely controlled. This bond is particularly suitable for very high material removal either with diamond or CBN wheel. The bond strength is much greater than provided by electroplated bond. This bond is expected to replace electroplated bond in many applications.

134.

Sol. Given that,

$$T_1 = 20 \text{ min at } N_1 = 200 \text{ rpm,}$$

$$T_2 = 5 \text{ min at } N_2 = 400 \text{ rpm}$$

But Taylor's tool life equation for drilling

$$N_1 T_1^n = N_2 T_2^n = \text{constant}$$

$$\therefore 200(20)^n = 400(5)^n$$

$$40^n = 2$$

$$n = 0.5$$

$$\therefore \text{Tool life at } N_3 = 300 \text{ rpm}$$

$$\therefore N_1 T_1^n = N_3 T_3^n$$

$$\therefore 200(20)^{0.5} = 300 T_3^{0.5}$$

$$T_3 = 20 \left(\frac{200}{300} \right)^2 = 8.89 \text{ min.}$$

135.

Sol. The process by which external screw threads can be produced are:

1. Casting:

(i) Sand casting (ii) Die casting (iii) Permanent mould casting (iv) Plastic moulding (v) Shell moulding (vi) Low-wax casting

2. Rolling



3. Chasing:
 - (i) Single-point tool (ii) Multiple-point tool
4. Die and tap cut
5. Milling
6. Grinding

136.

Sol.

Given that,

Cutting speed (V) = 200 m/min, $\alpha = 10^\circ$, $b = 2$ mm, $t = 0.2$ mm, $\mu = 0.5$, $\tau_s = 400$ N/mm²Friction angle, $\beta = \tan^{-1}(\mu) = \tan^{-1}(0.5)$ $\beta = 26.57^\circ$

- (i) Using merchant's first solution to find out shear plane angle

$$2\phi + \beta - \alpha = 90^\circ$$

$$\phi = \frac{90 + 10 - 26.57}{2} = 36.7^\circ$$

Shear force,

$$F_s = \frac{\tau_s \cdot b \cdot t}{\sin \phi} = \frac{400 \times 2 \times 0.2}{\sin(36.7)} = 267.72 \text{ N}$$

$$\therefore F_s = R \cos(\phi + \beta - \alpha)$$

$$\therefore R = \frac{267.72}{\cos(36.7 + 26.6 - 10)} = 447.983 \text{ N}$$

Where R = resultant force of

- (i) Cutting force and thrust force or

- (ii) Normal and friction force at tool chip interface.

 $\therefore$ Cutting force

$$F_c = R \cos(\beta - \alpha) = 447.983 \times \cos(26.57 - 10) = 429.379 \text{ N}$$

Thrust force,

$$F_T = R \sin(\beta - \alpha) = 447.989 \sin(26.57 - 10) = 127.75 \text{ N}$$

137.

Sol.

Given that,

when

$$V_1 = 30 \text{ m/min}, T_1 = 1 \text{ hr} = 60 \text{ min},$$

when

$$V_2 = 2V_1 = 60 \text{ m/min}, T_2 = 2 \text{ min},$$

we can write

$$VT^n = C$$

$$V_1 T_1^n = V_2 T_2^n$$

Taking log on both sides we get,

$$\log V_1 + n \log T_1 = \log V_2 + n \log T_2$$

$$n = \frac{\log\left(\frac{V_2}{V_1}\right)}{\log\left(\frac{T_1}{T_2}\right)} = \frac{\log(2)}{\log(60/2)} = 0.2$$

 $\therefore$

Now for

given diameter

$$C = VT^n = 30 \times (60)^{0.2} = 68$$

$$T = 30 \text{ min}, V = ?, N = ?$$

$$d = 300 \text{ mm} = 0.3 \text{ m}$$

$$VT^n = C$$

$$V(30)^{0.2} = 68$$



and

$$V = 34.44 \text{ m/min}$$

$$V = \pi DN \Rightarrow 34.44 = \pi \times 0.3 \times N$$

$$N = 36.54 \text{ rpm.}$$

138.

Sol.

Given that,

The constants in the tool life equation are 60, 0.2

$$\therefore VT^{0.2} = 60$$

$$\text{Tool change time} = 3 \text{ min}$$

$$\text{Tool regrind time} = 3 \text{ min}$$

$$\text{Machine running cost} = \text{Rs. } 0.5/\text{min}$$

$$\text{Depreciation of tool regrind} = \text{Rs. } 5.0$$

$$\text{Direct running cost, } C_T = \text{Regrind time} \times \text{running cost/unit time} = 3 \text{ min} \times 0.5/\text{min} = \text{Rs. } 1.5$$

$$\text{Tool changing time, } T_c = 3 \text{ min}$$

$$\text{Depreciation cost, } C_m = \text{Rs. } 5.0$$

Optimum speed, V_0 for minimum cost,

$$= \frac{C}{\left[\left(\frac{1}{n} - 1 \right) \left(T_c + \frac{C_t}{C_m} \right) \right]^n} = \frac{60}{\left[\left(\frac{1}{0.2} - 1 \right) \left(3 + \frac{5}{1.5} \right) \right]^{0.2}} = 31.43 \text{ m/min.}$$

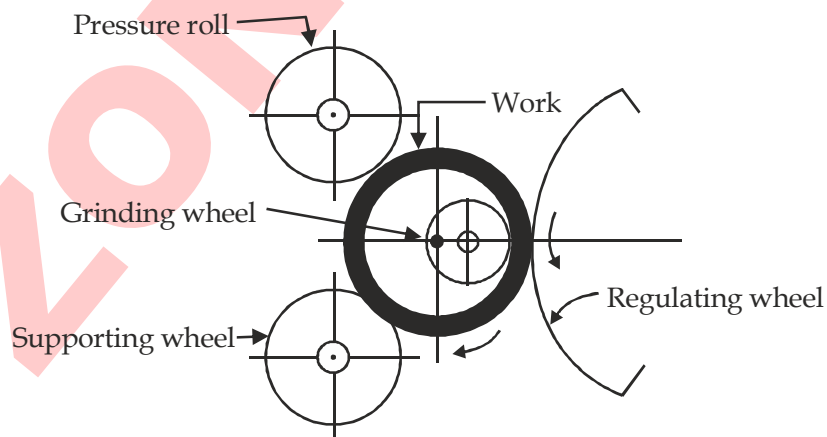
Optimum cutting speed, V_0 for maximum production

$$= \frac{C}{\left[\left(\frac{1}{n} - 1 \right) T_c \right]^n} = \frac{60}{\left[\left(\frac{1}{0.2} - 1 \right) 3 \right]^{0.2}} = 36.5 \text{ m/min.}$$

139.

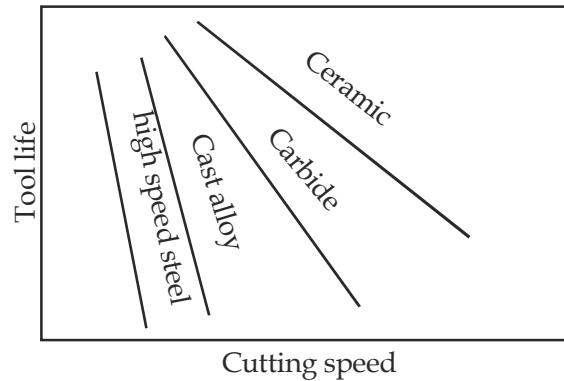
Sol.

Centreless grinding: In internal centreless grinding, the work is supported by three rolls. One is the regulating rolls, and the other is a pressure roll to hold the workpiece firmly against the support and regulating rolls. This is illustrated in fig. The grinding wheel contacts the inside diameter of the workpiece directly opposite the regulating roll, thus assuring a part of absolutely uniform thickness and concentricity. The pressure roll is mounted to swing aside to permit loading and unloading.



Internal Centreless grinding

Tool life curves:



140.

Sol. Tools are coated to provide certain desirable properties to the tool like wear resistance, hot hardness, better thermal characteristic.

Common Coating Material:

(i) **High speed steel:** This type of material significantly improve the cutting speeds 3 to 5 times carbon tool steels.

(ii) **Cast cobalt alloys:** This type of material has the property to retain hardness even at elevated temperatures better than HSS and also used at 25 percent higher cutting speed than HSS.

(iii) **Ceramic coating:** The ceramic coating provides good abrasion resistance. They have excellent high temperature properties such as high resistance to diffusion wear, and high hot hardness.

141.

Sol. The advantage of climb milling are:

1. Job is forced against table which results in elimination of vibrations.
2. Chips are deposited behind the cutter and out of its way.
3. Cutter do not touch the worked surface, better surface finish.
4. Low power consumption.
5. Thin sheet can be easily machined.

Disadvantages of climb milling:

1. More impact load on cutter on starting each cut.

Grinding ratio is defined as

Volume removed from workpiece GR = Volume removed from grinding wheel

142.

Sol. **FMS:** A flexible manufacturing system integrates all major elements of manufacturing into a highly automated system. FMS consists of a number of manufacturing cells, each containing an industrial robot (service several CNC machines) and an automated material handling system, all interacted with a central computer. This system is highly automated and is capable of optimizing each step of the total manufacturing operation. Flexible manufacturing system represents the highest level of efficiency, sophistication and productivity that has been achieved in manufacturing plants. The flexibility of FMS is such that it can handle a variety of part configurations and produce them in any order.

In FMS, the time required for change over to a different part is very short. The quick response to product and market demand variations is a major attribute of FMS.

FMC: In view of rapid changes in market demand and of the need for more product variety in smaller quantities flexibility of manufacturing operations is highly desirable. Manufacturing cells can be made flexible by using CNC machines and machining centres and by means of industrial robots or other mechanized systems for handling materials.

Flexible manufacturing cells are usually intended, so their design and operation are more exiting than those for other cells. The selection of machines and robots, including the types and capacities of end effectors and their control.

As with other flexible manufacturing systems the cost of flexible cells is high. Cellular manufacturing generally requires more machine tools and this increases manufacturing cost; however, this disadvantage is out-weighted by increased speed of manufacture, flexibility and controllability. Proper maintenance of the tools and the machinery is essential, as is the implementation of two or three shift operations of the cells.

Disadvantages:

- High cost
- Not suited for mass production
- Skilled manpower needed

143.

Sol. Factors are:

1. Helix angle
2. Chisel angle
3. Point angle
4. Feed rate

$$MRR = \frac{\pi}{4} D^2 f \left(\frac{N}{60} \right) = \frac{\pi}{4} \times (10)^2 \times 0.25 \times \frac{850}{60} = 278 \frac{\text{mm}^3}{\text{s}} \text{ Ans.}$$

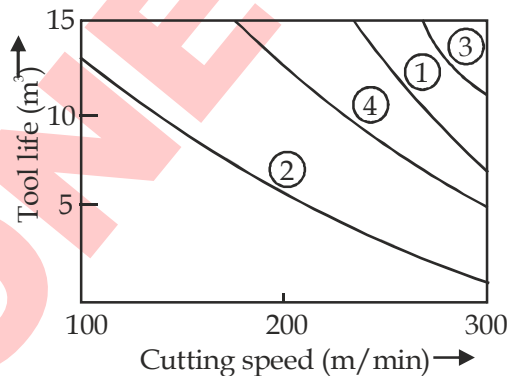
144.

Sol. Causes of poor machinability:

- Low thermal conductivity which does not allow heat generation during machining to dissipate from the tool edge, causing high tool tip temperature and excessive plastic deformation wear.
- High work hardening tendency leading to high cutting force.
- High chemical reactivity of titanium alloys causes chip to weld to the tool
- Low elastic modulus

General Characteristics of Coating for cutting tools and dies:

- It should have good abrasion resistance
- It should prevent built-up edge formation
- It should be stable at very high temperature
- It should possess property of red hardness



Variation of tool life with cutting speed for various micro-structure

145.

Sol. Length of uncut chip, $l = \frac{\pi(70+68)}{2} = 216.769 \text{ mm}$

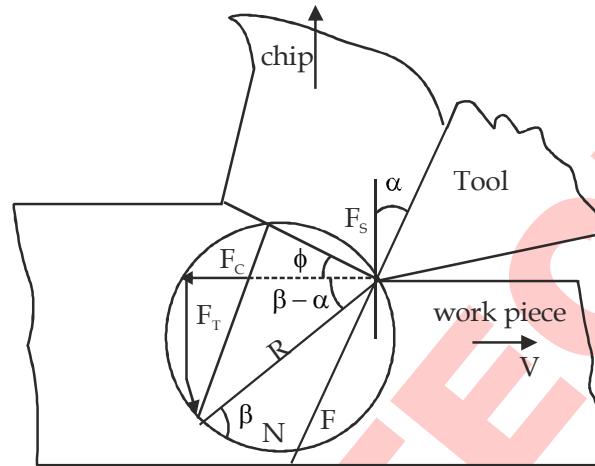
$$\text{Cutting ratio} = \frac{t}{t_c} = \frac{L_c (\text{Length of chip})}{L (\text{Uncut length})} = \frac{68.9}{216.769} = 0.318$$

$$\tan \phi = \frac{r \cos(\alpha)}{1 - r \sin \alpha} = \frac{0.318 \times \cos 10^\circ}{1 - 0.318 \times \sin 10^\circ} = 0.33147$$

$$\phi = 18.34^\circ$$

146.

Sol.

 F_T = Thrust force F_C = Cutting force F_N = Force normal to shear plane F_s = Force along the shear plane N = Force normal to rake face F = Force along rake face

Since the resultants of F_c , F_T and F_N , F_s are the same and those of F and N are the same in magnitude; the tips of all these force vectors must lie on an imaginary circle of diameter R as shown above.

$$F_C = F_s \cos \phi + F_N \sin \phi$$

$$F_T = F_N \cos \phi - F_s \sin \phi$$

$$F = F_C \sin \alpha + F_T \cos \alpha$$

$$N = F_C \cos \alpha - F_T \sin \alpha$$

$$F_s = F_C \cos \phi - F_T \sin \phi$$

$$F_N = F_C \sin \phi + F_T \cos \phi$$

If τ_s is ultimate shear stress of the work material, then the shear force F_s along the shear plane can be written as

$$F_s = \frac{bt\tau_s}{\sin \phi}$$

where b is the width of the workpiece under cutting and t is the uncut thickness

$$F_C = \frac{F_s \cos(\beta - \alpha)}{\cos(\phi + \beta - \alpha)}$$

Assumptions are:

- (i) Tool edge is sharp.
- (ii) The work material suffers deformation across a thin shear plane.
- (iii) There is no side spread (or the deformation is two dimensional).
- (iv) There is uniform distribution of normal and shear stresses on the shear plane.
- (v) The work material is perfectly plastic and tool material is perfectly rigid.

147.

Sol.

Diameter of a circular hole to be pierced, $d = 20 \text{ mm} = 0.02 \text{ m}$

(in a mild steel plate)

Thickness of the plate, $t = 2 \text{ mm} = 0.002 \text{ m}$

The shear strength of the work material, $\tau = 350 \text{ MPa} = 350 \times 10^6 \text{ N/m}^2$

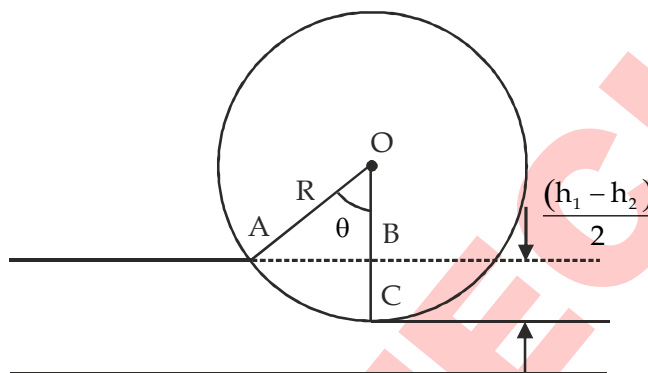
(mild steel)

Force required to pierce a circular hole, $F = (\pi d t) \tau$

$$= \pi \times 0.02 \times 0.002 \times 350 \times 10^6 = 0.04398 \times 10^6 \text{ N} = 43.98 \text{ kN}$$



Sol.

$$\begin{aligned} h_1 &= 60 \text{ mm;} \\ w &= 100 \text{ mm;} \\ D &= 40 \text{ mm;} \\ \mu &= 0.3; \\ \sigma_f &= 500 \text{ MPa} \end{aligned}$$
$$(\Delta h)_{\max} = \mu^2 R$$


$$\mu = \sqrt{\frac{(h_1 - h_2)}{R}}$$

$$0.3 = \sqrt{\frac{(60 - h_2)}{200}}$$

$h_2 = 60-18 \text{ } 42 \text{ mm}$, i.e. thickness after rolling

$\therefore$ Highest possible reduction = $h_1 - h_2 = 60 - 42 = 18 \text{ mm}$

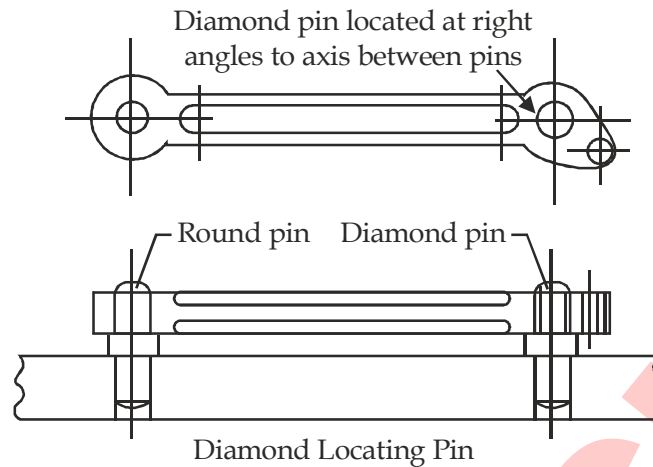
$$L_p = \sqrt{R\Delta h}$$

$$AC = L_p = \sqrt{200 \times 18} = 60 \text{ mm}$$

$$P = \sigma_f \times L_p \times w = 500 \times 60 \times 100 = 3000 \text{ kN}$$

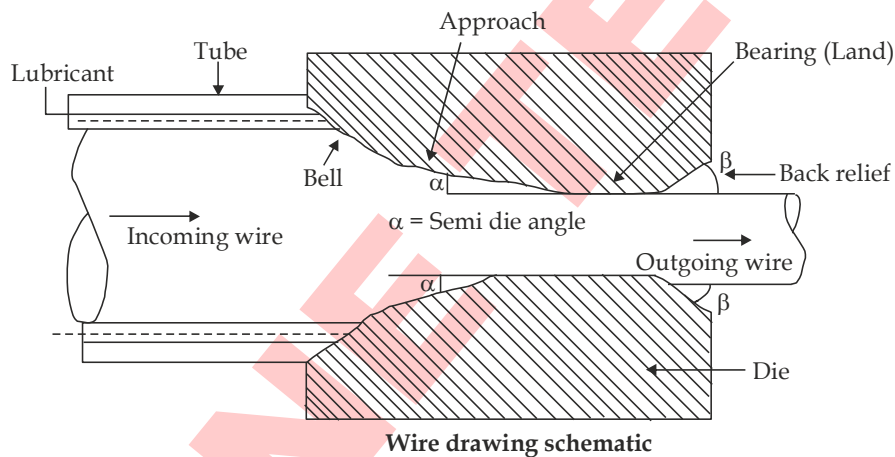
Sol.

If there are two already drilled holes, in one hole a conical pin is provided and in the other hole, a diamond pin is provided to accommodate the variation in the centre distance. Two sides of the diamond pin are relieved and the diamond pins are always kept in the larger hole. Purpose of diamond pin is to arrest the variation in centre to centre distance between holes.



150.

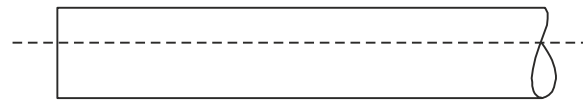
Sol. The various process variables in wire drawing are:



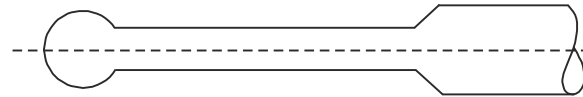
Edging: Edging is the process of flowing of metal from edges towards centre. it is done with the help of concave dies.

Fullering: It is the process of flowing of metal from a central area towards outside. it is done with the help of convex dies.

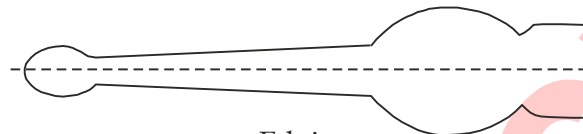




Forging stock



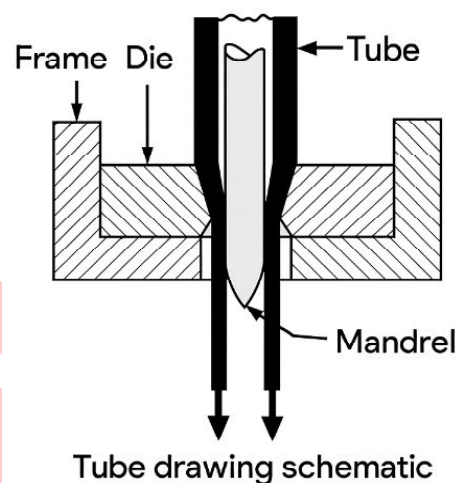
Fullering



Edging

Flash: In forging some of the material flows outside the dies in relief area. This metal is called flash and it has to be removed after forging process is complete.

Seamless tubes are produced by extrusion or tube sinking process. in tube sinking process a mandrel is there in the hole of the die. the thickness of tube is controlled with the relative gap between the mandrel and the die.



Tube drawing schematic

151.

Sol. Four methods by which high energy release rates are

1. Unconfined explosive forming
2. Confined or contact explosive forming
3. Electromagnetic forming
4. Electrohydraulic forming

Causes for springback:

- Due to minimum Heat Affected Zone (HAZ)
- Very high strain rate for small duration

152.

Sol. Machine tools are

(i) Gear Hobbing, (ii) Gear Shaping, (iii) Gear Planning

(i) Gear hobbing: The motions of the blank and the hob are like those of a worm and worm wheel. The gear ratio is such that during one revolution of the hob, the blank turns through as many teeth as there are starts or threads on the hob. Hob motion is rotary as well as translatory.

(ii) **Gear shaping:** The gear is driven by a gear train connected to the cutter drive. The cutters can be imparted translatory feed motion. The gear blanks are fixed on indexing spindle while the shaper tool oscillates as well as rotates as if in mesh with the work piece.

(iii) **Gear planning:** In this, a rack type cutter is employed. The cutter oscillates as well as moves linearly as if in mesh with the workpiece gear.

153.

Sol.

The dimensions of the slab = 30 cm × 30 cm × 6 cm

This can be considered as a long bar with a cross-section of (30 × 6) cm²

Modulus,
$$M_c = \frac{30 \times 30 \times 6}{2[30 \times 6 + 30 \times 6 + 30 \times 30]} = 2.14$$

The riser diameter,
$$\frac{D}{6} = 1.2 M_c$$

$$D = 6 \times 1.2 \times 2.14 = 15.408 \text{ cm} = H$$

The riser height, $H = D = 15.408 \text{ cm}$ ($\because$ given $D = H$)

and volume of the riser
$$= \frac{\pi}{4} D^2 \times H = \frac{\pi}{4} \times (15.408)^2 \times 15.408 = 2872.95 \text{ cm}^3$$

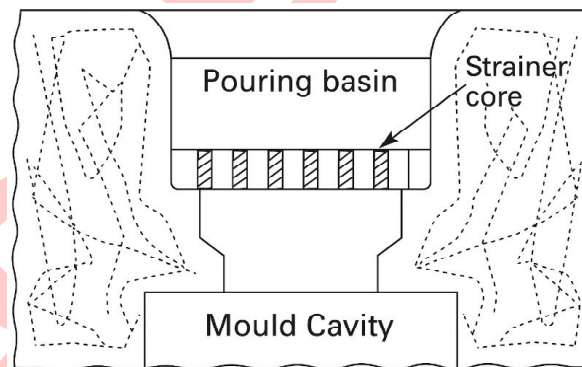
154.

Sol.

Various test which are performed on moulding sand to ensure its quality and its ability to meet the required level of accuracy and surface finish are

1. Moisture content test
2. Clay content test
3. Permeability test
4. Fitness test or sand grain size test
5. Strength test
6. Mould hardness test

Top gate: In this type of gating, the metal enters the mould cavity above the level of the parting line. Its main advantage is that it is gate conducive to a favourable temperature gradient. The pouring basin and gates themselves may serve as risers.



155.

Sol.

During solidification of metal, the density of the material changes due to cooling of the metal in both liquid and solid state as well as due to the solid to liquid phase transformation itself. Phase transformations in the solid state during solidification also cause volume change. During the cooling, the melt experiences thermal contraction due to lowered temperature. Hot tears and cold shut are the type of casting defects mainly due to improper solidification. Hot tears: A crack that develops in a casting due to high residual stresses is called hot tear. Cold shut: For a casting with gates at its two sides, the misrun may occur at the centre of the casting. When this happens, the defect is called cold shut.

156.

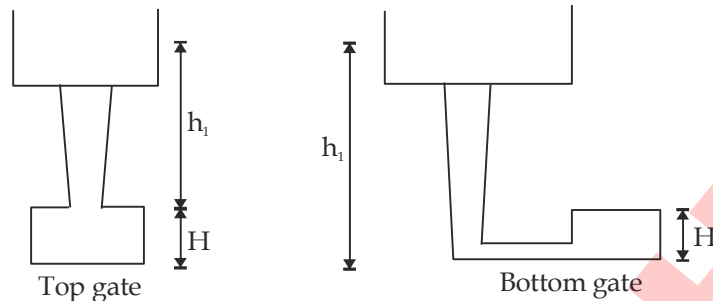
Sol.

An equipment called muller is normally used in foundries to mix the sands. Mullers are essentially of two types, batch type and continuous. The purpose of muller is to activate the available bentonite within the sand for green sand control.

Distortion allowance is provided for casting of irregular shape which are distorted in the process of cooling as a result of metal shrinkage.

157.

Sol. There are two types of gates namely top gating and bottom gating system.



Mould size = $50 \text{ cm} \times 25 \text{ cm} \times 10 \text{ cm}$
 $h_t = 15 \text{ cm}$
 $A_g = 5 \text{ cm}^2$

$$\text{Filling time by top gate} = \frac{AH}{A_g \sqrt{2gh_t}} = \frac{50 \times 25 \times 10}{5 \times \sqrt{2 \times 981 \times 15}} = 14.57 \text{ s}$$

158.

Sol. (i) **Porosity:** Porosity in welding is caused by the presence of gases which get entrapped during the solidification process. The main gases that causes porosity are hydrogen, oxygen and nitrogen. Porosity if present in large would reduce the strength of the joint.

Remedies:

- Slowing the welding speed to allow time for the gases to escape.
- Proper cleaning and preventing the contaminants from entering the weld.
- Proper selection of electrodes and filler materials.

(ii) **Slag inclusion:** Slag is formed by the reaction with the fluxes and is generally lighter, so it will float on top of the weld pool and would be chipped off after solidification. However the stirring action of the high intensity arc would force the slag to go into the weld pool and if there is not enough time for it to float, it may get solidified inside the fusion zone and end up as slag inclusion. Also in multipass welding, the slag solidified in the previous pass is not cleaned before depositing the next lead, which may cause slag inclusion.

Remedies:

- Cleaning the weld bead surface before the next layer is deposited by using a hand or power wire brush.
- Redesigning the joint to permit sufficient space for proper manipulation of the puddle of molten weld metal.

(iii) **Incomplete fusion and penetration:** The main causes for this defect are improper penetration of the joint, wrong design of the joint or incorrect welding technique including the wrong choice of the welding parameters. The welding current if, is lower than required would not sufficiently heat all the faces of the joint to promote proper fusion. Also, the improper cleaning of the joint hinders the fusion of the metal in the joint.

Remedies:

- Increasing the heat input.
- Changing the joint design.
- Ensuring that the surfaces to be joined fit properly.
- Proper cleaning of the joint.

(iv) **Hot cracking:** This generally occurs at high temperature and the size can be very small to visible. The crack in most parts is intergranular and its magnitude depends upon the strains involved in

solidification. They are more likely to form during the root pass when the mass of the base metal is very large compared to the weld deposited.

Remedies:

- Preheating the bare metal, increasing the cross sectional area of the root bead, or by changing the contour or composition of the weld bead.

159.

Sol. Given that,

$$I = 30000 \text{ A,}$$

$$t = 0.005 \text{ second}$$

$$R = 100 \mu\Omega = 100 \times 10^{-6} \Omega$$

$$\text{Joint dimensions, } d = 5 \text{ mm, } h = 1.5 \text{ mm}$$

$$\text{Volume of the joint, } V = \frac{\pi}{4} d^2 h = \frac{\pi}{4} \times 5^2 \times 1.5 = 29.4524 \text{ mm}^3$$

$$\text{Heat needed for welding} = 10 \text{ J/mm}^3$$

$$\therefore \text{Energy required to melt joint} = 29.4524 \times 10 = 294.524 \text{ J}$$

$$\text{Energy liberated from the heat source} = I^2 R t$$

$$= (30000)^2 \times 100 \times 10^{-6} \times 0.005 = 450 \text{ J}$$

$$\text{Efficiency of the welding} = \frac{294.524}{450} = 0.654 = 65.4\%$$

160.

Sol. Spray Transfer: Spray transfer of metal occurs when the current setting is high. As the current is high, the magnetic pull on the molten metal increases and subsequently the molten metal is detached from the electrode tip by this pull, irrespective of the gravity force.

Gases Used in GMAW: The shielding gases most commonly used are argon, helium, carbon dioxide and mixtures of them.

Argon & helium are completely inert and therefore they provide a complete inert atmosphere around the puddle.

Carbon dioxide is the most economical of all the shielding gases.

161.

Sol. (i) Advantages of Flash Welding:

- A weld can be made over the whole joint area.
- A wide range of materials can be welded including steel, aluminium alloys, nickel alloys, titanium.
- A solid phase, forge weld is made and any molten metal and contaminants formed at the interface during heating are squeezed out into the upset.
- It is automatic or semiautomatic process.

Application: To join rail in railroad industry.

- It requires high ampere (100000 amp.) low voltage current.

Requirement of flashing: Flashing is required to create the arc to melt the ends of two pieces to be jointed.

162.

Sol. Too low a travel speed causes a large deposition of the filler metal whereas too high a speed does not give enough time for melting the base metal and consequently, results in less deposition. When welding speed is increased, the amount of heat input and corresponding, the filler metal per unit length of the joint decreases. so also the joint reinforcement. The opposite would be true when the welding speed is decreased.

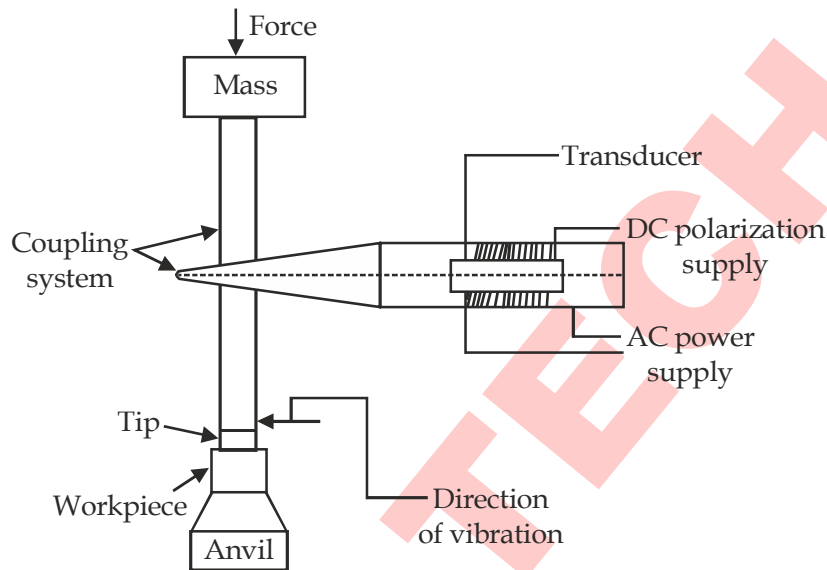
163.

Sol. Ultrasonic welding: In ultrasonic welding (USW), the mating surfaces of the two components are subjected to a static normal force and oscillating shearing (tangential) stresses. The shearing stresses are applied by the tip of a transducer similar to that used for ultrasonic machining. The frequency of oscillation is generally in the range of 10 kHz to 75 kHz. Proper coupling between the transducer and the tip is important for efficient operation.



The shearing stresses cause plastic deformation at the interface of the two components, breaking up oxide films and contaminants and thus allowing good contact and producing a strong-state bond. The temperature generated in the weld zone is usually in the range from one-third to one-half of the melting point of the metal joined, consequently neither melting nor fusion takes place.

The ultrasonic welding process is versatile and reliable. It can be used with a wide variety of metallic and non-metallic materials, including dissimilar metals. It is extensively used for the joining of plastics and for the lap welding of sheet, foil and thin wire.



164.

Sol. Functions of flux coating:

1. Flux coating material may act as deoxidizers.
2. Flux coating material by forming the slag, protect liquid metal from the atmospheric gases.
3. Flux coating material increases the strength of the joint by adding alloying element.
4. Flux coating material control the viscosity of liquid metal and heat transfer rate in the weld pool.
5. Flux coating material by reducing the arc blow increases the stability of the arc.
6. Flux coating material by reducing the heat transfer losses increases the heat concentration on the workpiece.

Flux coating materials:

- i. **De-oxidizing material:** Graphite, Alumina, Ferro silicon and Ferro manganese.
- ii. **Slag formation compounds:** Iron oxide, Silicon dioxide, Titanium oxide, Silica flour and Calcium fluoride.
- iii. **Arc stabilizer:** Sodium oxide, Calcium oxide, Potassium silicate.
- iv. **Alloying elements:** Chromium, Nickel, Cobalt and Vanadium.

165.

Sol. The main reasons for using the non-traditional machining processes are:

- **High strength alloys:** When the hardness of the work material is often higher than the cutting tool material or when it becomes necessary to use the machining process on hardened material in such cases, the Electro-chemical Processes (ECM) would be required.
- **Complex surfaces:** When very complex surfaces in three dimensions need to be produced, such as those in moulds and dies, where the workpiece surface being the hardened tool steel would be difficult to be processed by the conventional means, the non-traditional processes would be required.
- **Higher accuracies and surface finish:** The accuracy and surface finish desired in hard workpiece materials require the conventional machining to be done very slowly as well as adding a number of finishing processes, making the process very slow and uneconomical.

- **Difficult geometries:** In addition to the complex geometries, sometimes it is required to produce difficult geometries such as long holes with length-to-diameter ratio approaching that of 100, very small size holes such as those with less than 0.1 mm in diameter which are almost impossible to be produced by the conventional methods.

166.

Sol. Effect of inefficient dielectric and electrolyte circulation in inter-electrode gap in their process:
EDM:

- Due to inefficient dielectric fluid, system gets overheated due to improper cooling.
- Dielectric fluid act as a flushing medium also. Due to inefficient dielectric fluid, inadequate flushing occurs which results in decreased arc, the life of electrode and increased machining time.
- Not able to maintain the required properties like temperature variation.

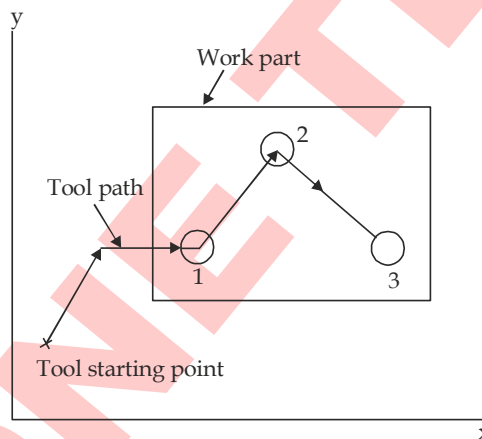
ECM:

- It is not able to carry away the heat generated during the operation.
- It is not able to carry away product of reaction from zone of machining.
- It is not able to provide desirable machining reactions to take place.
- It is not able to complete the electrical circuit between tool and workpiece.

167.

Sol. **Part Programming:** The part programming is a detailed step-by-step command or directions that direct the action of the processing equipment.

Point to Point Control: The point to point control system is also called a positioning system. In this system the cutting tool is moved at predefined point to point location in work envelope of machine tool.

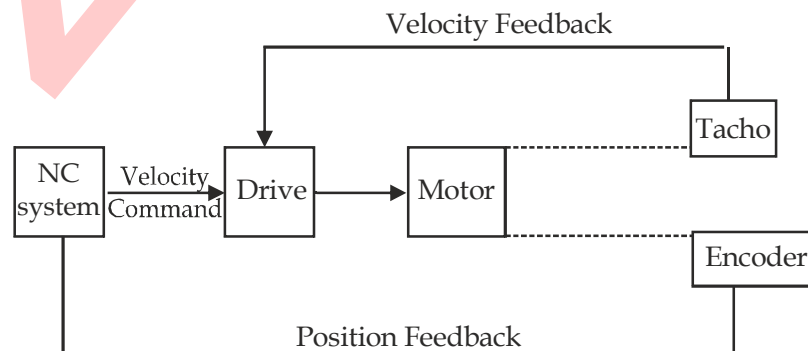


The path followed by the tool and speed is not important in this system once the cutting tool reaches the programmed point, the machining operation is performed at that point or position.

Example: CNC drilling machines; CNC spot welding machines.

168.

Sol.



Advantages of CNC over Conventional NC Systems:

- Flexibility offered is more.



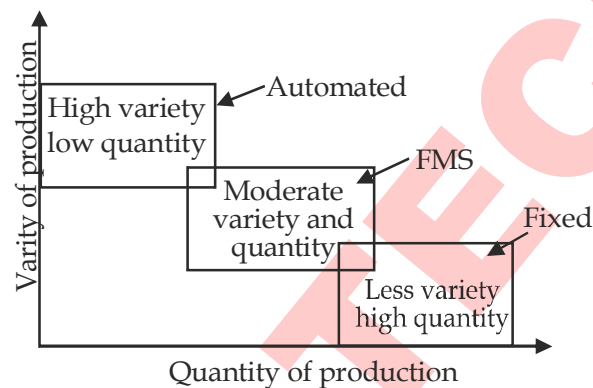
- Conversion of unit system can easily be incorporated
- Part program storage in minicomputer memory becomes useful in repetitive production
- Better system integration
- Machine language simplifies geometry change
- Minimizes production downtime.

169.

Sol. The important ingredients (elements) of an FMS are:

1. Work stations
2. Automated material handling and storage system
3. Computer control system

Flexible manufacturing systems are being designed with other type of processing and equipments including inspection stations, assembly works and sheet metal process. The FMS is most suited for the mid variety, mid value production range.



The advantages of FMS are

1. Adaptability to demand
2. Lower inventory levels
3. Less production time
4. Increased level of customer service and satisfaction

170.

Sol. **Tests of flexibility:** For a manufacturing system for becoming flexible there are several criteria. Four important test of flexibility in an automated manufacturing system are as follows:

1. **Part variety test:** It is to check the ability of a system to process different part styles in a non-batch mode. It is done for checking machine flexibility or production flexibility.
2. **Schedule change test:** It shows the ability of a system to accept to the changes in production schedule readily, these changes may be either part mix or in production quantity. It is used for mix flexibility, volume flexibility and expansion flexibility.
3. **Error recovery test:** It shows the ability of a system that how well it recover from equipment malfunctions and breakdowns, so that the production system is less disrupted. It is used for check routing flexibility.
4. **New part test:** It tells us that how easily a new part design can be introduced into the existing product mix. It tells us about product flexibility.

Application of FMS:

1. Metal cutting machining
2. Metal forming
3. Assembly
4. Joining-welding, gluing
5. Surface treatment
6. Inspection and testing

171.

Sol. List the manufacturing situations where FMS technology can be successfully employed. Also give at least four differences between dedicated and random-order FMS

Situations where FMS is employed:

- (i) To process different part styles in a non-batch mode.



- (ii) To accept changes in production schedule.
- (iii) To respond gracefully to equipment malfunctions and breakdowns in the system.
- (iv) To accommodate the introduction of new part designs.

Dedicated FMS:

- (i) A dedicated FMS is less flexible than random FMS.
- (ii) Instead of manufacturing a large variety of parts, it will only produce a limited mix but will do so continuously for long period of time.
- (iii) It has high production rate.
- (iv) Scheduling is less complex.

Random FMS:

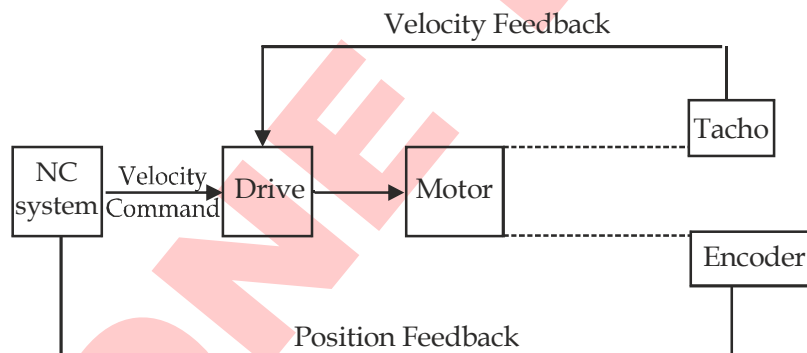
- (i) Manufactures random mix of parts with varied configurations at any given time.
- (ii) It uses machines that are able to handle a mix of product specifications.
- (iii) It can also progress through parts in random order.
- (iv) Scheduling is complex.

172.

Sol. Memory management is the act of managing computer memory. The essential requirement of memory management is to provide ways to dynamically allocate portions of memory to programs at their request, and freeing it for reuse when no longer needed. The task of fulfilling an allocation request consists of locating a block of unused memory of sufficient size. Memory requests are satisfied by allocating portions from a large pool of memory. One part of the memory management system finds a free spot for the new object, while another part garbage collects old objects to create more free space for new objects.

173.

Sol. **Advantages of CNC over Conventional NC Systems:**

**Advantages of CNC over Conventional NC Systems:**

- Flexibility offered is more.
- Conversion of unit system can easily be incorporated
- Part program storage in minicomputer memory becomes useful in repetitive production
- Better system integration
- Machine language simplifies geometry change
- Minimizes production downtime.

174.

Sol. **Basic components:**

- **Manipulators** - Mechanical unit called arm
- **Sensors** - transducers for sensing positions
- **Controllers** - brain of system
- **Power supply** - drive, hydraulic, electric, pneumatic

Welding Robot: It is a relatively new application of robotics. Welding robot is the use of mechanized programmable tools (robots) which completely automate a welding process by both performing the weld and handling the part. It is commonly used for resistance spot welding and arc welding in high production application, such as the automotive industry.



PART - C

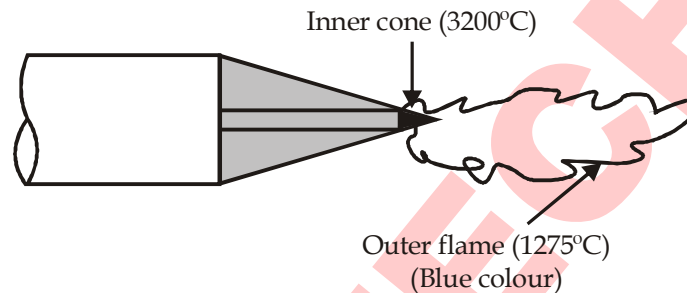
20 Marks Questions

175.

Sol. To achieve successful and efficient welding proper mixing of gases in appropriate proportion is important. According to the volume of oxygen and acetylene, flames can be classified as:

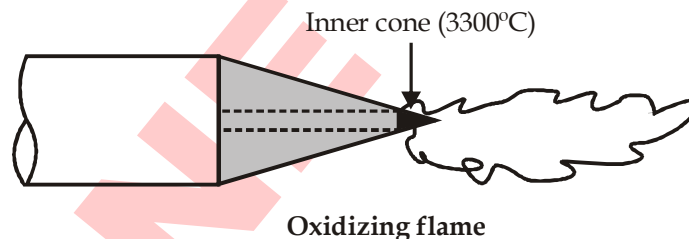
(i) Neutral flame:

It is produced when equal volume of oxygen and acetylene are mixed. Neutral flame does not create any chemical change in the molten metal and does not oxidize or carburize the metal. Flame is used for welding of cast iron, aluminium and stainless steel. It produces hissing sound.



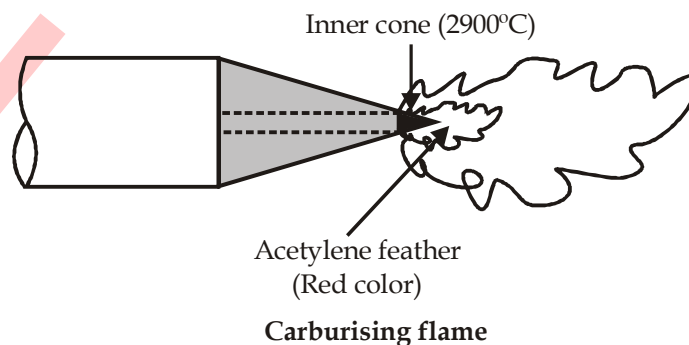
(ii) Oxidizing flame:

Oxidizing flame is obtained by increasing the supply of oxygen in mixture. It has small white cone that is shorter and more pointed than that of neutral flame. It is normally not used except in case of brass. It produces roaring sound.



(iii) Carburizing flame:

It is produced when supply of acetylene is higher than supply of oxygen and can create an approximate temperature of 3038°C. It can be identified by acetylene feather. It is used for welding of lead.



The advantages of Oxy Acetylene Welding are :

- It is simple in construction, no huge parts and equipment are used in its installation like Arc Welding.

- It is easy to operate and no need for highly skilled technicians to operate it.
- Not only for welding but also oxy acetylene is used to separate or cut the materials into pieces.
- This type of Welding is cheaper.
- As Oxy Acetylene uses the gases like oxygen and acetylene, it can be used to weld ferrous and even non-ferrous metals.
- The intensity of the flame can be adjusted to high and less by using the valve.
- It can be used for high melting metals and even for low melting metals.

The disadvantages of Oxy Acetylene Welding are :

- The temperature of the flame is less when compared to the arc welding.
- As like arc welding, the oxy acetylene does not have a high flux shield over the weld.
- It is suitable for thin materials and medium thin materials whereas it is not suitable for thick materials.

176.

Sol. Resistance Welding

- Resistance welding process is fusion welding process where heat and pressure are applied on the joint but no filler metal or flux is added.
- In resistance welding a low voltage and very high current is passed through the joint for very short time. This current heats the joint due to the contact resistance at the joint and melts it.

Resistance of the Joint composed of :

- Resistance of electrodes.
- Contact resistance between electrode and work piece.
- Contact resistance between two work place plates.
- Resistance of work piece plates.

Heat Produced in resistance welding :

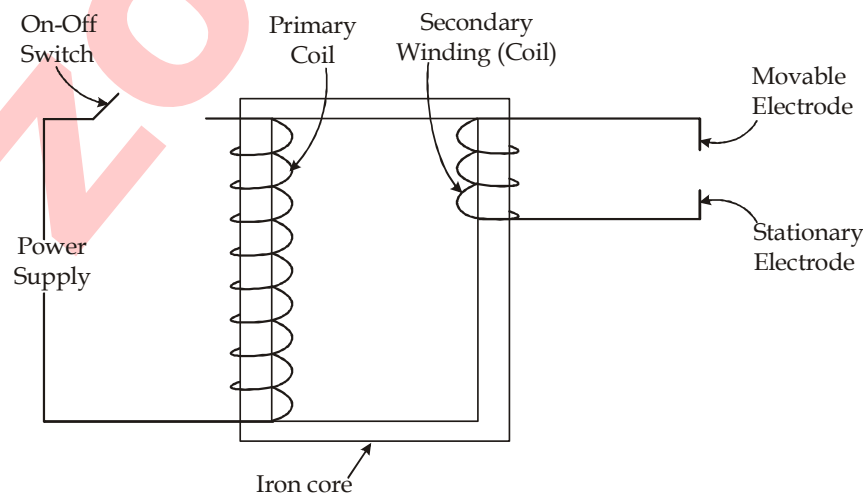
$$H = I^2RT$$

where, H is the heat generated indicated in joules.

I is the current in root mean square amperes.

R is the resistance in ohms

T is time of the current flow in seconds.



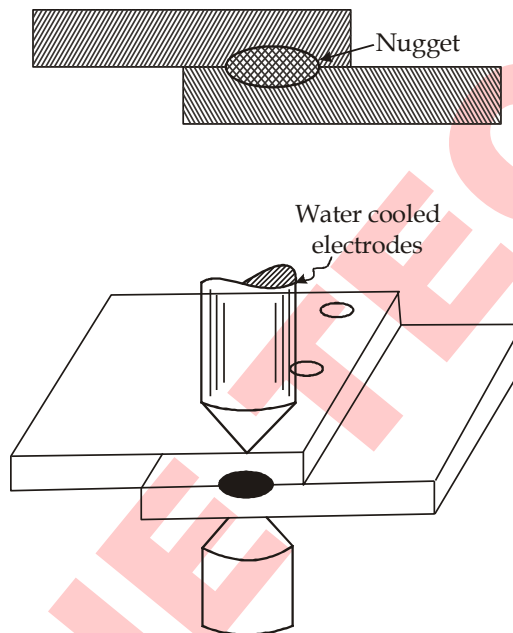
Typical Resistance Welder

Types of Resistance Welding :

- (i) Resistance spot welding
- (ii) Resistance seam welding
- (iii) Projection welding
- (iv) Upset welding

(i) Resistance Spot Welding :

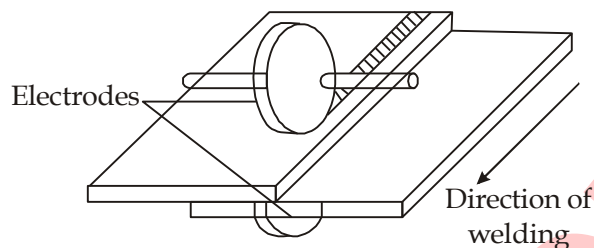
- It is simplest and most commonly used for making lap welds in thin sheets (up to maximum thickness 12.7 mm)
- In it secondary coil's one end is joined to movable electrode and other to fixed electrode and pass strong current at less voltage and applied mechanical pressure to form spot (Nugget) between interface of work place.



- Current $\rightarrow$ 3000 A to 40000 A
- Spot welding is widely used for fabricating sheet metal parts.
- **Squeeze Time :**
Time required for electrodes to align and clamp the work piece together under them and provide necessary electrical contact.
- **Weld Time :**
Time of current flow through the work place till they are heated to requirement temperature.
- **Hold Time :**
Time when pressure is maintained on the molten metal without electric current during this time piece are forged welded.
- **Off Time :**
After cooling of weld electrode pressure is released and metal piece removed for next cycle.
- Due to high current metal welded if proper pressure is not applied porosity and crack may develop at the centre of nugget.
- The metal under the electrode tip does not expand in direction of axis of electrode and after cooling the area of metal under tip reduced and takes concave shape.
- Surface indentation is also possible sometimes due to expulsion of molten metal from the weld 'zone' because of excessive heat generation by a smaller contact area. The depth of weld's penetration would normally vary from 3 to 8 times the thickness of the joining members.

(ii) Resistance Seam Welding

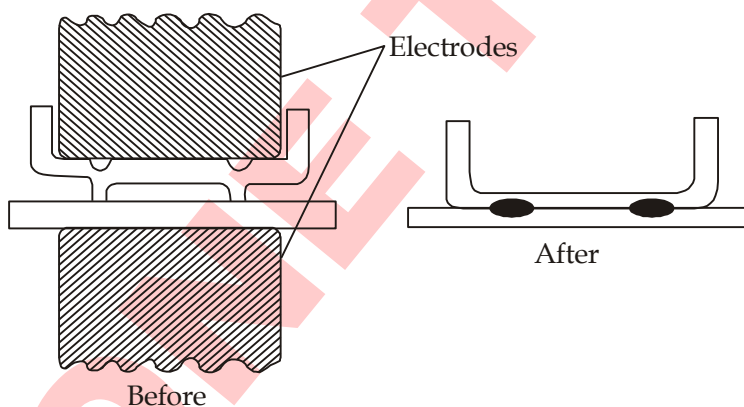
- It is modified form of spot, welding in it disc electrodes are used instead of cylindrical electrodes. They are continuously rotating so that work pieces get advanced underneath them and pressure also applied by them, current is applied through the electrodes in series of pulse.
- Pulses are so adjusted that pulses overlap each other and thus form a continuous seam joint. To achieve pressure tightness the seam welds should at least overlap 10 to 25% of each nugget.



- Using a continuous AC power supply. Also called roll spot welding. High frequency current (450 kHz) used for butt welded tubing.

(iii) Projection Welding

- It is another form of spot weld where one of sheets provided with a number of projections to help localize the current at predetermined spot projection is of order of 8 mm and obtained from embossing.

**Advantage**

- It is possible to weld more than one spot at a given time (the number of projection comes under the tip of electrode welded)
- The welds may be closer than possible in spot welding.
- Because of larger size of electrodes their life is much longer.
- The electrode can make to take the shape of assembly fixture, work places can be held in proper way during welding process.
- Proper heat balance may be made easily for obtained projection in thicker plates while welding of sheets of different thickness and for different metal projection provided on sheet of higher conductivity.
- Uniformity and appearance of weld is much better than compared to spot welding.

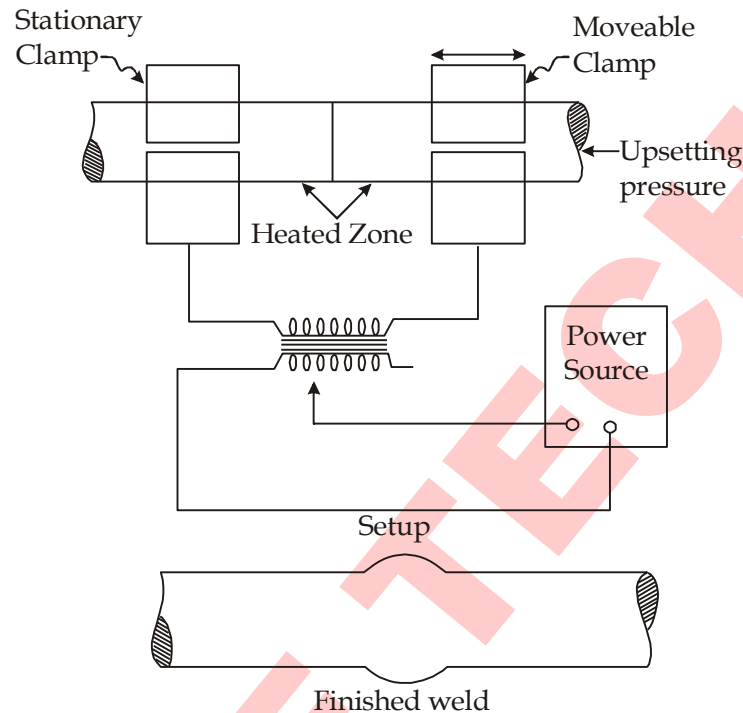
Disadvantage

- Prior operation embossing is required before welding.
- Electrodes are often to be made especially for a particular operations.
- Projections should have enough stiffness to withstand electrode force before current is passed.



(iv) Upset Welding

- The pieces to be joined brought together to match with each other in butt joint. After holding the pieces lightly current is passed. Joint being under pressure the ends of two pieces gets slightly upset and hence is name. It is useful for piping the two ends of rods or similar piece.



- This process is used to form electric welded pipes from a metal plate of suitable thickness the plates is first formed in to the shape of pipe with the help of three rolls. The ends of the plate of would be forming butt joint.

177.

Sol. Arc Welding

Principle of Arc

- An arc is generated between two conductor of electricity, cathode and anode (considering direct current, DC); when they are touched to establish the flow of current and then separated by a small distance.
 - An arc is a sustained electric discharge through the ionized gas column, called plasma, between the two electrodes. In order to produce the arc, potential difference between the two electrodes (voltage) should be sufficient to allow them to move across the air gap.
 - The larger air gap requires higher potential difference. If air gap becomes too large the arc may be extinguished. Duty cycle is the amount of time during which transformer, will be used for welding under normal loading conditions.
- While welding near the edges, since most of the magnetic lines will be concentrated in the material, arc will be deflected towards the workpiece. This phenomenon is called arc blow which result in spatter.

$$\text{Melting Efficiency} = (\eta)$$

$$\eta = \frac{\text{Heat required to melt the joint}}{\text{Net heat required}}$$

Heat require to melt the joint = Volume melted $\times$ Rated of melting.

Volume molted = Area of join $\times$ Welding speed.

Net heat supply = $\eta_{HT} \times V \times I$

I = Current

V = Voltage

η_{HT} = Heat transfer efficiency

Difference between soldering and Brazing

Soldering	Brazing
1. The melting point temperature of filler material is less than 430°C and it is also less than melting point temperature of base material.	1. The melting point temperature of filler material is less than 430°C but less than the melting point temperature of base material.
2. Filler material is an alloy of lead and tin it is known as solder.	2. Filler material is an alloy of copper, zinc, Cu and silver. This is known as Spelter.
3. The strength of joint is less when compared to brazing.	3. Strength is more
4. Used in electronic industry.	4. Used in pipe fitting where leak proof joints are required for initiate light weight component.
5. In soldering, the filler metal, called solder, and melts at a relatively low temperature.	5. Brazing is a joining process in which a filler metal is placed at or between the laying surface to be joined.
6. Solders must have high wetting capability and low surface tension.	6. The molten metal fills the closely fitting space by capillary action.
7. Heat sources for soldering are usually soldering irons, torches or ovens.	7. Upon cooling and solidification of the filler metal, a strong joint is obtained.

178.

Sol. (1) Porous Welds :

- These could occur due to short arc, insufficient puddling time impaired base metal or poor electrodes.
- In can be overcome by checking impurities in base metal, allowing sufficient puddling time, for gases to escape, use of proper current, weaving of weld to eliminate pinholes use of proper electrodes for the job, and adjusting arc length (lengthenng).

(2) Poor penetration

- It could occur due to fast speed, too large electrodes, too low current, or faulty penetration. It can be overcome by using enough current to get desired penetration, weld slowly, selecting proper electrode according to welding groove size, calculating electrode penetration properly, and leaving proper space at bottom of weld.

(3) Warping

- It could occur due to shrinkage of weld metal, faulty clamping of parts, faulty penetration or overheating at joint.
- It can be eliminated by peening joint edges before welding, welding rapidly, avoiding excessive space between parts, clamping parts properly, using high-speed and moderate penetration electrodes.

(4) Undercutting

- It could occur due to faulty electrode manipulation using faulty electrode and using too high



current. It can be taken care of by using a uniform weave in butt welding, avoiding excessive weaving, using moderate current and welding slowly, holding electrode at a safe distance from vertical plane in making horizontal fillet welds, and avoiding use of too large electrodes.

(5) Distortion

- It could occur due to uneven heat, improper sequence, or deposited metal shrinks. It can be taken care of by tacking or clamping parts properly, disposing off rolling or forming strains before welding, distributing welding to prevent uneven heating, and examining structure and using a proper sequence.

(6) Cracked Welds

- These could occur due to selection of wrong electrode, unbalanced weld and part sizes, faulty welds, faulty penetration, and rigid joints.
- These can be eliminated by heating parts before welding, eliminating rigid joints by proper design of structures, avoiding welds in string beads, keeping ends free to move as far as possible, making sound welds of good fusion, adjusting weld size to parts size, allowing a proper and uniform free space for joints, using low current.

(7) Poor appearance

- This could occur due to faulty selection of electrode, overhang, improper use of electrodes, or wrong arc and current voltage.
- It can be improved by using a uniform weave, avoiding high current, avoiding overheating and using proper welding technique.

(8) Poor Fusion

- It could be due to wrong speed, faulty preparation, high/low current, improper electrode size.
- It can be taken care of by adjusting electrode and V size sufficient weaving to melt sides of joints, using proper current for deposition and penetration of metal, and keeping weld metal from curling away from plates.

(9) Brittle Welds

- These could occur due to selection of wrong electrode, faulty preheating, or hardening of metal by air.
- It can be avoided by preheating at 150°C to 270°C in case of medium-carbon steel/alloy steels, making multiple-layer welds, annealing the joint after welding, using stainless or low hydrogen electrodes for increasing weld ductility.

(10) Spatter

- It may occur due to arc blow, too high current, lengthy arc, or use of faulty electrodes.
- It can be taken care of by adjusting current to suit requirement, adjusting arc length, lightening arc blow, and picking suitable electrode.

(11) Magnetic Blow :

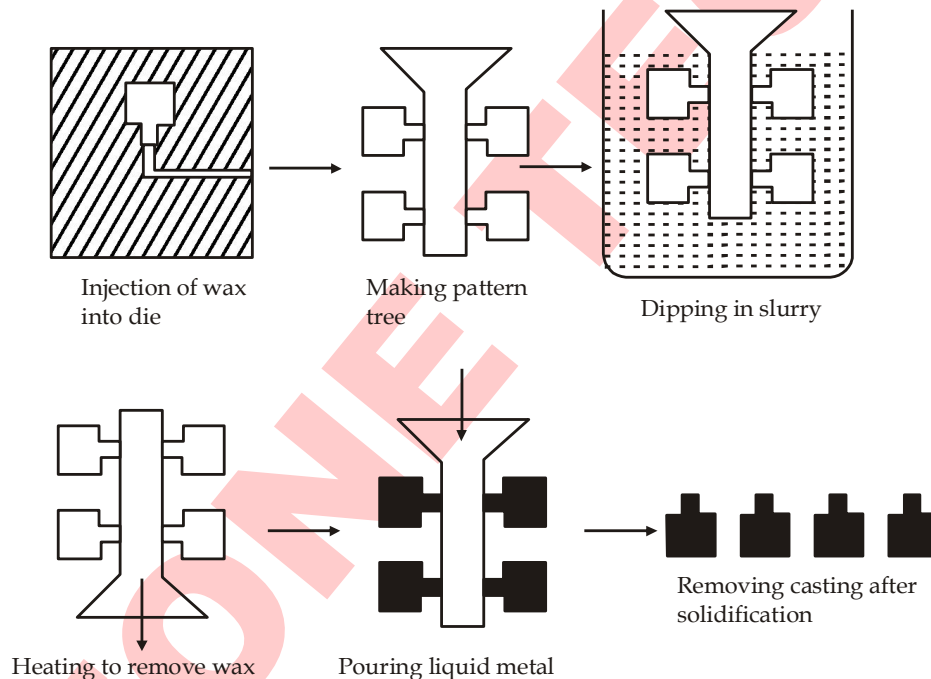
- It is caused by magnetic fields which deviate the arc from its intended course.
- It can be eliminated by using steel blocks to alter magnetic path around arc, dividing the ground into parts, using a short arc locating the ground properly on the works, using AC welding, and welding in the same direction in which arc blows.

179.

Sol. Investment Casting

- The investment casting process, also called the lost wax process.
- The pattern is made of wax or of plastic (such as polystyrene) by molding or rapid prototyping techniques.
- The sequences involved in investment casting are shown in figure.
- The pattern is made by injecting molten wax or plastic into a metal die in the shape of the pattern.
- The pattern is then dipped into a slurry of refractory material such as very fine silica and binders including water, ethyl silicate and acids.
- After this initial coating has dried, the pattern is coated repeatedly to increase its thickness.

- The term investment derives from the fact that the pattern is inverted with the refractory material wax pattern requires careful handling because they are not strong enough to withstand the forces involved during mold making.
- However, unlike plastic pattern, wax can be recovered and reused.
- Although the labor and material involved make the lost wax process costly, it is suitable for casting high melting point alloys with good surface finish and close dimensional tolerances.
- Therefore, few or no finishing operation, which would otherwise add significantly to the total cost of the casting are required.
- Typical parts made are components for office equipment as well as mechanical component such as **gears, cams, valves and ratchets**.
- In this, mould is prepared around an expendable pattern. It is used for making intricate shapes which are not symmetrical.
- Investment casting produces better tolerances. Compared to shell moulding.
- It is used for making jewellery surgical equipment and blade for gas turbine, bolt and triggers for fire arm.
- The pattern is made of either wax or mercury



Application

- Complex shapes which are difficult to produce by any other method are possible since the pattern is with drawn by melting it.
- Very fine details and thin section can be produced by this process.
- Very close tolerances and surface finish can be produced.
- It can produce jet engine parts, turbine blades, dentures medical in plan's surgical instrument gold ornaments etc.

180.

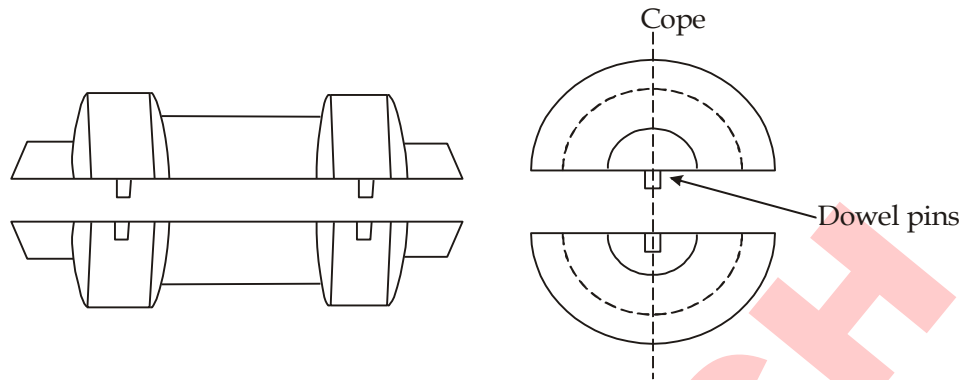
Sol. (i) **Single Piece Pattern :**

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

(ii) **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.

(iii) Split Pattern or Two Piece Pattern :

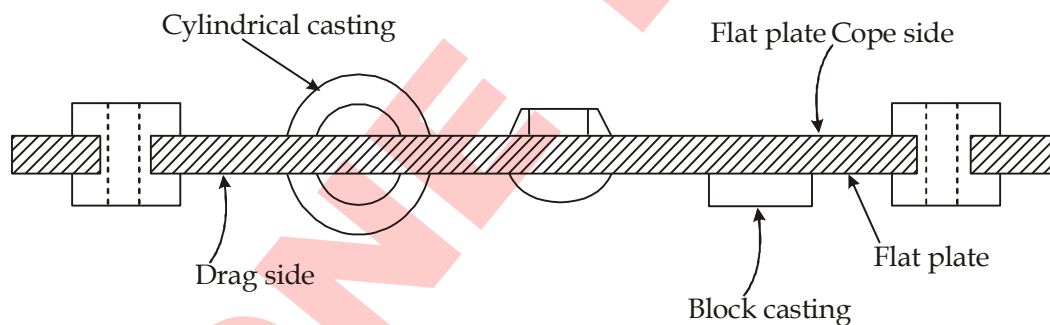


This is the most widely used type of pattern for intricate castings. When the contour of the casting makes its withdrawal from the mould difficult, or when the depth of the casting too high, then the pattern is split into two parts so that one part is in the drag and the other in the cope.

(iv) Cope and Drag Pattern :

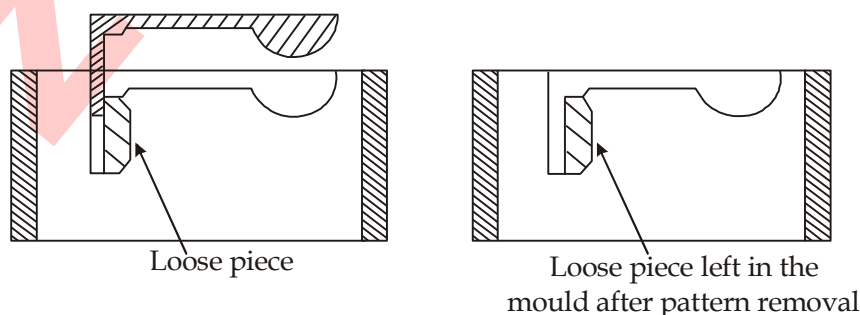
These are similar to split patterns. In addition to splitting the pattern, the cope and drag halves of the pattern along with the gating and riser systems are attached separately to the metal or wooden plates along with the alignment pins. They are called cope and drag patterns.

(v) Match Plate Pattern :



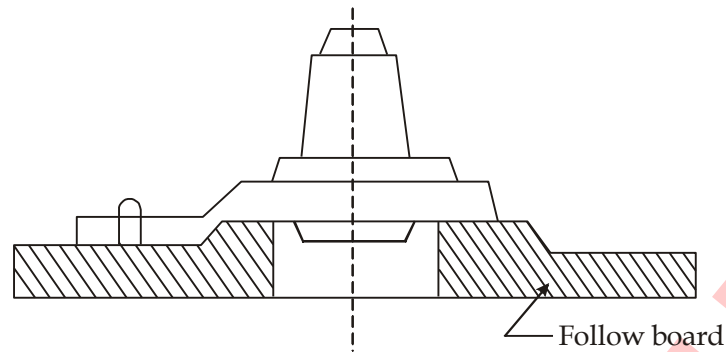
The cope and drag patterns along with the gating and the risering are mounted on a single matching metal or wooden plate on either side.

(vi) 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.

(vii) Follow Board Pattern :



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

(viii) Sweep Pattern :

It is used to sweep the complete casting by means of a plane sweep. these are used for generating large shapes, which are axi-symmetrical or prismatic in nature such as bell-shaped or cylindrical.

(ix) Skeleton Pattern :

This type of pattern is useful generally for very large casting, required in small quantities, where large expense on complete wooden pattern is not justified.

181.

Sol. The following are the major casting defects, which are likely to occur in sand casting :

- (i) Gas defects
- (ii) Shrinkage cavities
- (iii) Molding Material defects
- (iv) Pouring Material defects
- (v) Mold Shift

(i) Gas defects

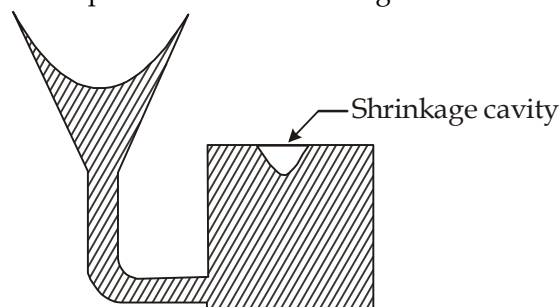
A condition existing in a casting caused by the trapping of gas in the molten metal or by mold gases evolved during the pouring of the casting.

The defects in this category can be classified into blowholes and pinholes porosity. Blow holes are spherical or elongated cavities present in the casting on the surface or inside the casting. Pin hole porosity occurs due to dissolution of hydrogen gas, which gets entrapped during heating or molten metal.

(ii) Shrinkage Cavities

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.

Sprue may be too thin, too long or not attached in the proper location, causing shrinkage cavities. It is recommended to use thick sprues to avoid shrinkage cavities.



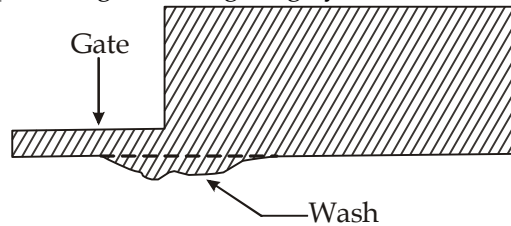
(iii) Molding Material Defects :

(a) 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 moulding sand not having enough strength and the molten metal flowing at higher velocity.

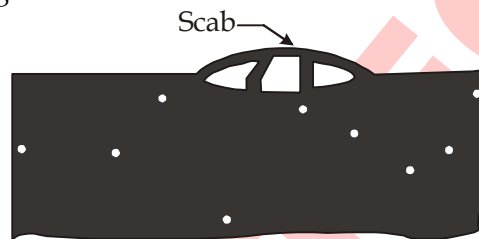
The former can be taken care of by the proper choice of molding sand and the latter can be overcome by the proper design of the gating system.



(b) 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.

The reason can be too fine sand, low permeability of sand, high moisture content of sand and uneven mould ramming.

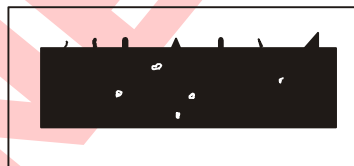


(c) Metal Penetration :

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.

Other molding materials defects are fusion, swell, inclusions etc.



Metal Penetration

(iv) Pouring Material Defects

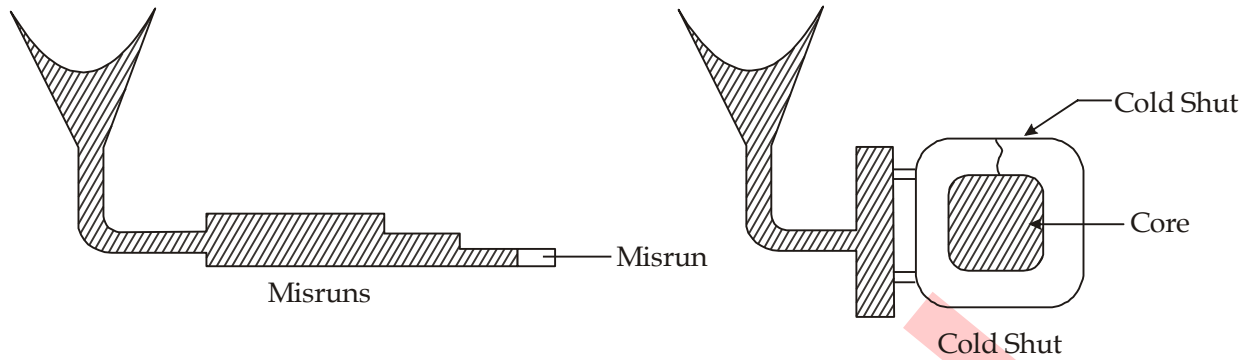
(a) Mis run

(b) Cold shut

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

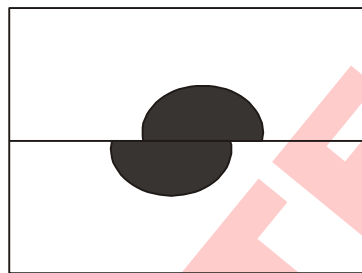
A **cold shut** is caused when two streams while meeting in the mold cavity, do not fuse together properly, forming a discontinuity in the casting.

The mis run and cold shut defects are caused either by a lower fluidity of the mold or when the section thickness of the casting is very small fluidity can be improved by changing the composition of metal and by increasing the pouring temperature of the metal.



(v) **Mold Shift :**

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



Mold Shift

182.

Sol. TYPE OF MOULDING SAND

(i) **Green Sand :**

It is a mixture of silica and upto 30% clay with about 8% water. If contains sufficient moisture. Clay and water act as bonding material it is used simple and rough casting.

(ii) **Dry sand:**

When the moisture is removed from green sand it is known as dry sand. The mould produced by dry sand has greater strength rigidity and thermal stability. This sand is used for large and heavy castings

(iii) **Loam sand:**

It is a mixture of 50% sand and 50% clay water is added in sufficient amount. It is used for axisymmetry object mould like turbine parts hoppers and bells.

(iv) **Facing sand:**

A sand used for facing of the mould is known as facing sand. It is consist of silica sand and clay without adding used sand. It is directly used next to the surface of the pattern for easy removal

(v) **Parting sand :**

A pure silica sand employing on the faces of the patterns before moulding is known as parting sand when the pattern is with drawn from the mould to avoid sticking of moulding sand with pattern it is used.

(vi) **Core sand:**

A sand used for making cores is known as core sand. It is silica sand mixed with core oil (linseed oil, resin, mineral oil) and other binding materials (corn flour, sodium silicate). If has good compressive strength.

PROPERTIES OF MOULDING SAND

(1) **Porosity:**

It is the ability of moulding sand to allow gases to pass through

(2) **Cohesiveness:**



It is the property of sand to hold its particles together. It may be defined as the strength of the moulding sand. This property plays a vital role in retaining intricate shapes of mould. Insufficient strength may lead to collapse the mould

(3) **Adhesiveness:**

It is the property of sand due to which the sand particles sticks to the sides of the moulding box.

(4) **Plasticity:**

It is the property of sand by virtue of which it flows to corners around the mould when rammed.

(5) **Flow ability:**

It is the ability of moulding sand to free flow and fill the recesses and fine detail in the pattern it varies with moisture content.

(6) **Collapsibility:**

It is the property of sand due to which sand mould collapse automatically after the solidification of the casting.

(7) **Refractoriness:**

It is the property of sand to withstand high temperature of molten metal without fusion or soften. Usually it should be able to withstand temperature upto 1650°C.

183.

Sol. FORGING :

It is a manufacturing process involving the shaping of metal using localized compressive forces. The forces are delivered using hammering, pressing or rolling

TYPICAL FORGING METHODS:

(i) **Drop Forging :**

In this method a heavy weight hammer is dropped onto the metal to mold it into the shape of die. The dies are flat in shape with some having distinctively shaped surface for specialized operations.

There are two types of drop forging

(a) **Open die forging (Smith Forging) :**

In this type of forging a hammer strikes and deforms a metal on a stationary anvil. The metal allows to flow for the areas where it is in contact with dies.

Open die forging is suitable for simple large parts as well as customized metal components

(b) **Closed die Forging (Impression die Forging):-**

In this process metal is placed in a die and attached to anvil. The hammer is dropped onto the metal, causing it to flow and fill the die cavities. The hammer is in contact with metal for very short time. Excess material that remains outside the die is called flash

(ii) **Roll forging:**

It consists of two cylindrical or semi-cylindrical horizontal rolls that deform a round or flat bar stock. This works to reduce its thickness and increase its length. This heated bar is inserted and passed between the two rolls

(iii) **Press-Forging**

Press forging uses a slow, continuous pressure or force instead of the impact used in drop hammer forging. The slower ram travel means that the deformation reaches deeper so that the entire volume of the metal is uniformly affected

(iv) **Upset forging**

Upset forging is a manufacturing process that increases the diameter of the metal by compressing its length. Crank presses are used in upset forging.

184.

Sol. Defects and their remedies in rolling process

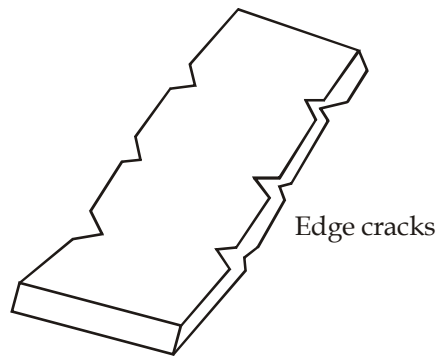
(i) **Edge cracks:**

During both hot and cold rolling, the metal might show some crack on the edges. This phenomenon occurs from secondary tensile stress induced at the workpiece surfaces. These cracks result from factors such as uneven heating, uneven rolling or excess quenching

• **Remedies:**



A trimming operation can remove edge cracks. Also stretch and roller levelling under tension might remove edge cracks



(ii) Alligator cracks:

During rolling, layers of metal stock might separate, leading to opening of slabs resembling alligator cracks.

- **Remedies :**

Cambering of rolls

(iii) Wavy edges :

One of the most common rolling defects in the occurrence of fibers at the edge. This occurs when concave rolls end leading to elastic deformation

- **Remedies :**

Use small diameter rolls

(iv) Centre Buckling:

Fibers at centre of the metal piece are longer than those at the edges

- **Remedies:**

Use crown roll to overcome centre of deformation of material.

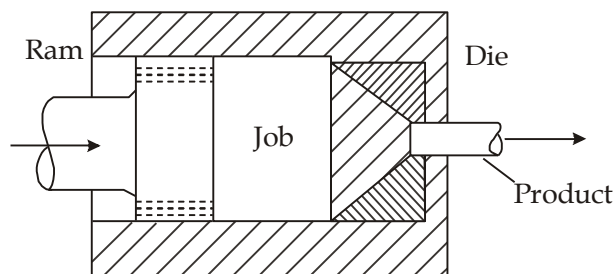
185.

Sol. Various type of extrusion process:

- (i) Direct extrusion
- (ii) Indirect extrusion
- (iii) Impact extrusion
- (iv) Hydrostatic extrusion

(i) Direct (Forward) Extrusion :

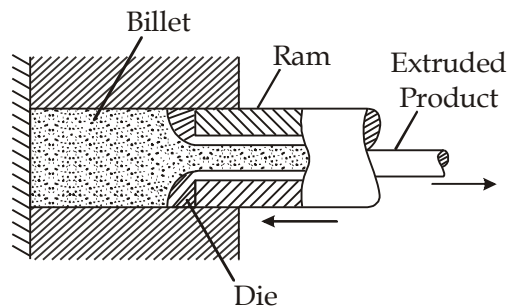
The process in which direction of flow of metal is in forward direction i.e. same as that of ram. In the forward extrusion the problem of friction is prevalent because of relative motion between cylinder walls and heated metal billet specially in case of steel due to high temperature, at lower temperature oil or lubricants are used but at higher temperature molten glasses used. This stays in liquid form at operating temperature. To avoid die wear, die may be preheated.



(ii) Indirect (Backward) Extrusion :

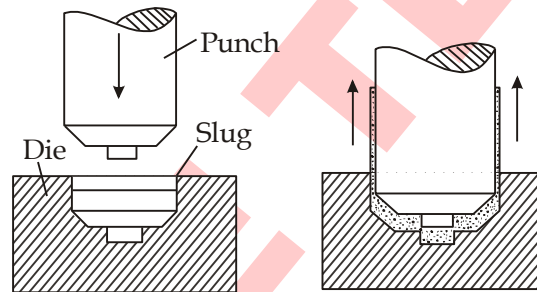


In order to completely overcome the friction heated metal billet confined in cylinder plunger is used to compress the metal billet against the container forcing it to flow backward through the die in hollow plunger. This extrusion process is not commonly used because of problem of handling extruded metal coming out through the moving ram.



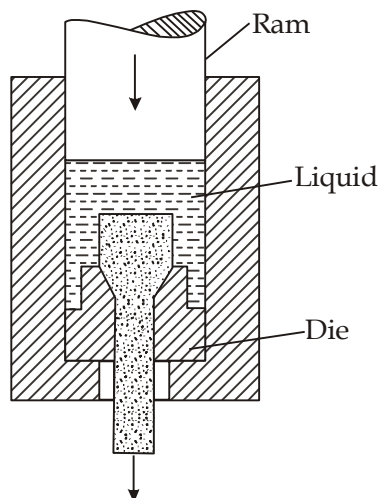
(iii) Impact extrusion

This is a cold extrusion process used for making short tubes of soft alloys such as tooth paste container. Punch is forced into a blind die containing a small slug of metal with clearance between punch and die so arranged that the metal flows up and around the punch and forms a deep, thin walled cup.



(iv) Hydrostatic Extrusion

Instead of applying the load on the billet directly by the ram a fluid medium can be used. This process is known as hydrostatic extrusion, here the frictional loss at the billet container interface is eliminated. A slight variation of this process offers a possibility of extruding a relatively brittle material.



186.

Sol. (i) Cutting Speed :

Cutting speed is defined as the speed at which the work moves with respect to the tool.

For a workpiece say a circular bar of diameter D rotating at N rpm.

$$S = \frac{\pi DN}{1000} \text{ m/min}$$

$$v = \text{Cutting speed} = \text{Peripheral speed} = S$$

$$v = \frac{\pi DN}{1000}$$

(ii) Feed (f) :

The term feed (f) implies the distance that the tool advance for each revolution of the work. Feed is expressed in mm/revolution.

For example if the feed is specified as 2 mm/revolution it implies that the tool moves a distance of 2 mm for every revolution of the job.

(iii) Depth of Cut (d)

The depth of cut ' d ' is the perpendicular distance measured from the Machined surface to the uncut (or previous cut) surface of the work piece.

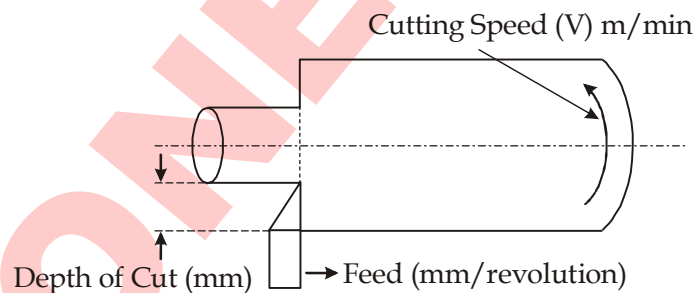
For the turning operation, the depth of cut is expressed as

$$\text{Depth of cut 'd'} = \frac{D_1 - D_2}{2} \text{ mm}$$

where

D_1 = Original diameter of the workpiece in mm

D_2 = Final diameter of the workpiece in mm



187.

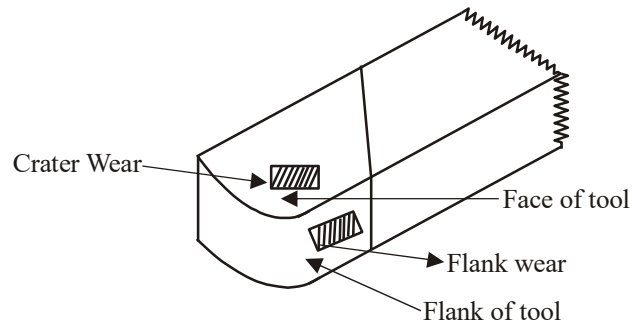
Sol. Flank wear:

- It is due to abrasive action of discontinuities like debris from built up edge etc.
- It wears outside and end flank of the tool.
- It is occur at tool work piece interface.
- This wear is predominates at low speed

Crater wear:

- Crater wear generally occur in machining ductile material due to abrasion and diffusion of metal at face of the tool.
- It is occur at face at a short distance from cutting edge.
- This wear is predominates at high speed.
- Tool wear can be reduce by proper cooling and lubricate because the major cause of tool wear is friction and temperature rise due to friction.
- It can also reduced by using high hardness and abrasion resistance tool and high resistance to adhesion and diffusion.





Tool life criteria

- (1) Complete failure of the tool
- (2) Visual observation of flank or crater wear
- (3) Finger nail test to feel flank wear
- (4) Sound of the tool
- (5) Chip disposal problems
- (6) Degradation of finish
- (7) Power increase
- (8) Workpiece count
- (9) Length of cutting time for the tool

188.

Sol. Given data in a cutting operation is

$$t_1 = 0.127 \text{ mm}$$

$$w = 6.35 \text{ mm}$$

$$V = 2 \text{ m/s}$$

$$\alpha = 10^\circ$$

$$F_C = 567 \text{ N}$$

$$F_T = 227 \text{ N}$$

$$t_2 = 0.228 \text{ mm}$$

(i) Shear plane angle (ϕ)

$$\tan \phi = \frac{\cos \alpha}{\frac{t_2}{t_1} - \sin \alpha}$$

$$\tan \phi = \frac{\cos 10}{\frac{0.228}{0.127} - \sin 10} = 0.6073$$

$$\phi = 31.27^\circ$$

(ii) Friction angle (β)

$$\tan \beta = \frac{\frac{F_T}{F_C} + \tan \alpha}{1 - \frac{F_T}{F_C} \tan \alpha}$$

$$\tan \beta = \frac{\frac{227}{567} + \tan 10}{1 - \frac{227}{567} \tan 10}$$

$$\tan \beta = 0.62$$

$$\beta = 31.82^\circ$$

(iii) Shear stress along shear plane

$$\frac{F_s}{\left(\frac{w \cdot t_1}{\sin \phi} \right)} = \tau_s$$

$$F_s = F_c \cos \phi - F_t \sin \phi$$

$$F_s = 567 \cos 31.27 - 227 \sin 31.27$$

$$F_s = 366.8 \text{ N}$$

$$\tau_s = \frac{366.8 \times \sin 31.27}{(0.127 \times 6.35)}$$

$$\tau_s = 236.1 \text{ Mpa}$$

(iv) Power for cutting operations

$$P_c = F_c \cdot V$$

$$P_c = 2 \times 567 = 1134 \text{ Nm / s}$$

$$P_c = 1134 \text{ W}$$

(v) Chip velocity (V_c)

$$\frac{V_c}{\sin \phi} = \frac{V}{\sin(90^\circ - \phi + \alpha)}$$

$$V_c = \frac{2 \times \sin 31.27^\circ}{\sin(90^\circ - 31.27 + 10^\circ)}$$

$$V_c = 1.114 \text{ m / s}$$

(vi) Shear strain in chip

$$\gamma = \tan(\phi - \alpha) + \cot \phi$$

$$\gamma = \tan(31.27 - 10) + \cot 31.27$$

$$\gamma = 2.036$$

189.

Sol. Mainly chips are of three types :-

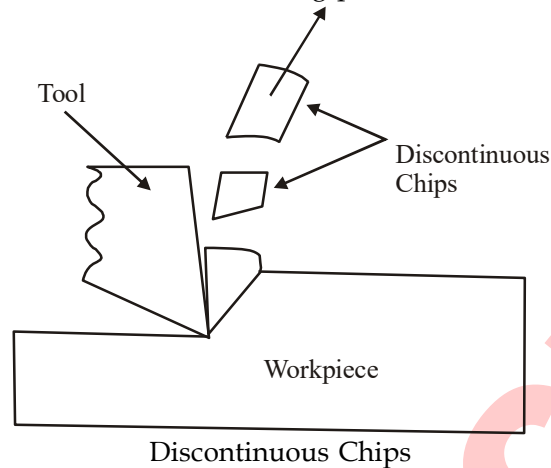
- (i) Discontinuous chips.
- (ii) Continuous chips.
- (iii) Continuous Chips with built up edges (**or BUE chips**)

These three types are elaborated below:

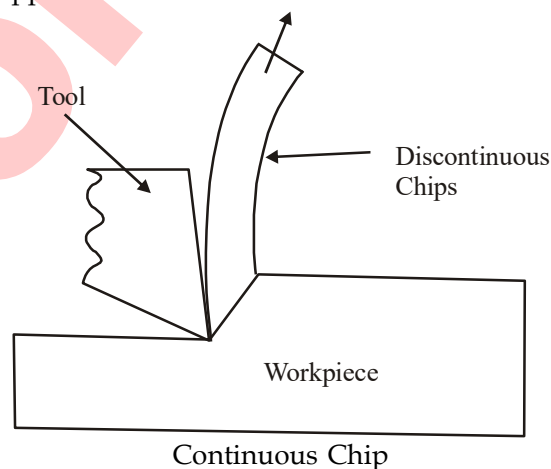
(i) Discontinuous Chips:

- If the chips during machining process is not continuous i.e. formed with breakage are called **discontinuous chips**.
- **Discontinuous chips** are formed when brittle or hard metals like brass, bronze and cast iron are used as workpiece in the machining process.

- **Discontinuous chips** are also formed in ductile material when the friction between tool and workpiece is high. Discontinuous chips is not a good sign for machining of ductile material as it gives poor surface finish and machining process becomes slow.



- **Factors responsible for formation of Discontinuous chips :**
 - (1) **Material of workpiece:** When the workpiece is made of brittle material such as cast iron and bronze.
 - (2) **Bevels:** Small bevels of cut tools.
 - (3) **Cutting Speed:** Cutting speed is low.
 - (4) **Feed:** When the feed is large and chip is thick.
 - (5) **Rake Angle:** Small rake angle.
 - (6) **Friction:** High friction forces at the chip tool interface.
 - (7) **Depth of cut:** Large value of depth of cut.
- (ii) **Continuous Chips:**
 - **Continuous chips** are the chips formed during machining without breakage or without segments.
 - These chips are formed by the continuous plastic deformation of metal without fracture in front of the cutting edge.
 - **Continuous Chips** are mainly formed during cutting of ductile material like mild steel, aluminum and copper.



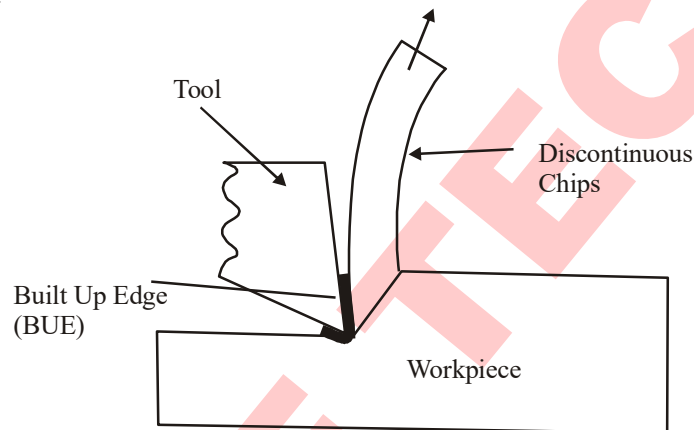
- **Factors responsible for formation of continuous chips :**
 - (1) **Material of Workpiece:** When ductile material is used as the workpiece.
 - (2) **Cutting Speed:** Cutting speed is high.
 - (3) **Chip thickness:** Thickness of chip is less.
 - (4) **Rake Angle:** Rake angle is large.



- (5) **Depth of cut:** Depth of cut should be small.
- (6) **Lubricants and Coolants:** Lubricants and coolants should be used efficiently.
- (7) **Coefficient of friction:** Coefficient of material of tool should be low.
- (8) **Friction:** Friction of chip on tool face should be minimum. This condition can be achieved by:
 - (a) Polishing tool face.
 - (b) Use of efficient cutting lubricants.
 - (c) Using tool made of low coefficient of friction.

(iii) **Continuous Chip With Built Up Edge :**

- This type of chip is similar to continuous chip and it has a built up edge adjacent to the tool face and also is not as smooth as continuous edge.
- Actually, Built Up Edge (BUE) is an accumulation of material against the rake face, that siezes to the tool tip, separating it from the chip.
- BUE is form during machining of ductile metal when excessive friction exists between tool and workpiece.



Continuous Chip with Built Up Edge (BUE)

Formation of Built Up Edge:

- Built Up Edges are formed mainly due to friction between the tool and interface of chip. Because of friction between the tool and the chip, very intense heat is generated near the nose of the tool. The compressed metal near the nose of the tool get welded due to high temperature near the nose. This compressed metal near welded to the nose is called built up edge.
- The chip flows through this built up edge and gets broken and get carried away by the chip and are called as built up edge chip.
- Rest of the built up edge stick to the surface of the workpiece and make it rough.
- As built up edge is formed near nose of tool, rake angle of the tool changes and so the cutting force also changes.
- **Factors responsible for formation of Built up Edge :**
 - (1) **Workpiece Material:** Metal used as workpiece is ductile.
 - (2) **Friction:** High friction exists near the face of the tool.
 - (3) **Coolant:** Insufficient coolant and lubricant.
 - (4) **Temperature:** High temperature near the tool face while cutting.
 - (5) **Feed Rate:** High value of feed rate.
 - (6) **Cutting Speed:** Low cutting speed.
 - (7) **Rake Angle:** Very small rake angle.

190.

Sol. Differences between up milling and down milling

S.No.	Up Milling	Down Milling
1.	In up milling, cutter rotates against the direction of table feed.	In down milling, cutter rotates along the direction of table feed.
2.	Chip load on teeth (or uncut chip thickness) increases gradually from zero at the point of engagement to maximum at the point of disengagement.	Chip load on teeth (or uncut chip thickness) decreases gradually from maximum at the point of engagement to zero at disengagement.
3.	Here tooth experience gradual loading as contact starts with zero chip load.	Here tooth experience impact loading as tooth engages suddenly with maximum chip load.
4.	With horizontal axis milling machine, cutting force in up milling mode is directed upward, and thus it tends to lift off the workpiece from the worktable. Accordingly, rigid and expensive fixture is required for firmly mounting the workpiece.	In down milling mode, the cutting force is directed downward, and thus it tends to press the workpiece rather than lift off. So cheaper fixture can be employed.
5.	Thin workpiece samples, if machined using up milling mode, may get distorted due to upward cutting force.	Chances of distortion of thin workpiece samples are less with down milling mode if proper support in bottom is provided.
6.	Due to gradual buildup of chip load in up milling, heat generation is also high. So there exists a tendency of chip welding with the teeth.	Tendency of chip welding is less in down milling but chip re-deposition on finished surface occurs frequently that may degrade quality of finished surface.
7.	Burr is formed only on unfinished surface ahead of the tool feed; however, majority of such burr is removed in the subsequent passes.	Burr is formed at finished surface in opposite side of the tool feed. Thus these burrs are not removed automatically. This leads to degraded cutting quality.
8.	At the beginning of engagement, teeth rub with lay or feed marks on the machined surface. This improves surface finish.	No such rubbing action takes place, and thus lay marks remains intact on the machined surface.
9.	Besides improving surface finish, rubbing during engagement may result in undesirable work hardening owing to significant heat generation.	Chance of work hardening is minimal with down milling.
10.	In up milling mode, no chipping action occurs on teeth of the cutting tool due to gradual contact. Accordingly, tool wear rate is relatively low.	Due to impact loading at engagement, chipping occurs and it may cause notch wear. Thus tool wear rate is high. There also exists a chance of catastrophic failure of the teeth.
11.	No backlash eliminator is required.	Backlash eliminator is required, especially if the milling machine is an older one.
12.	If the workpiece or cutter material is brittle (such as ceramic), up milling is always preferred.	Down milling is not a good choice if the workpiece material is brittle.

191.

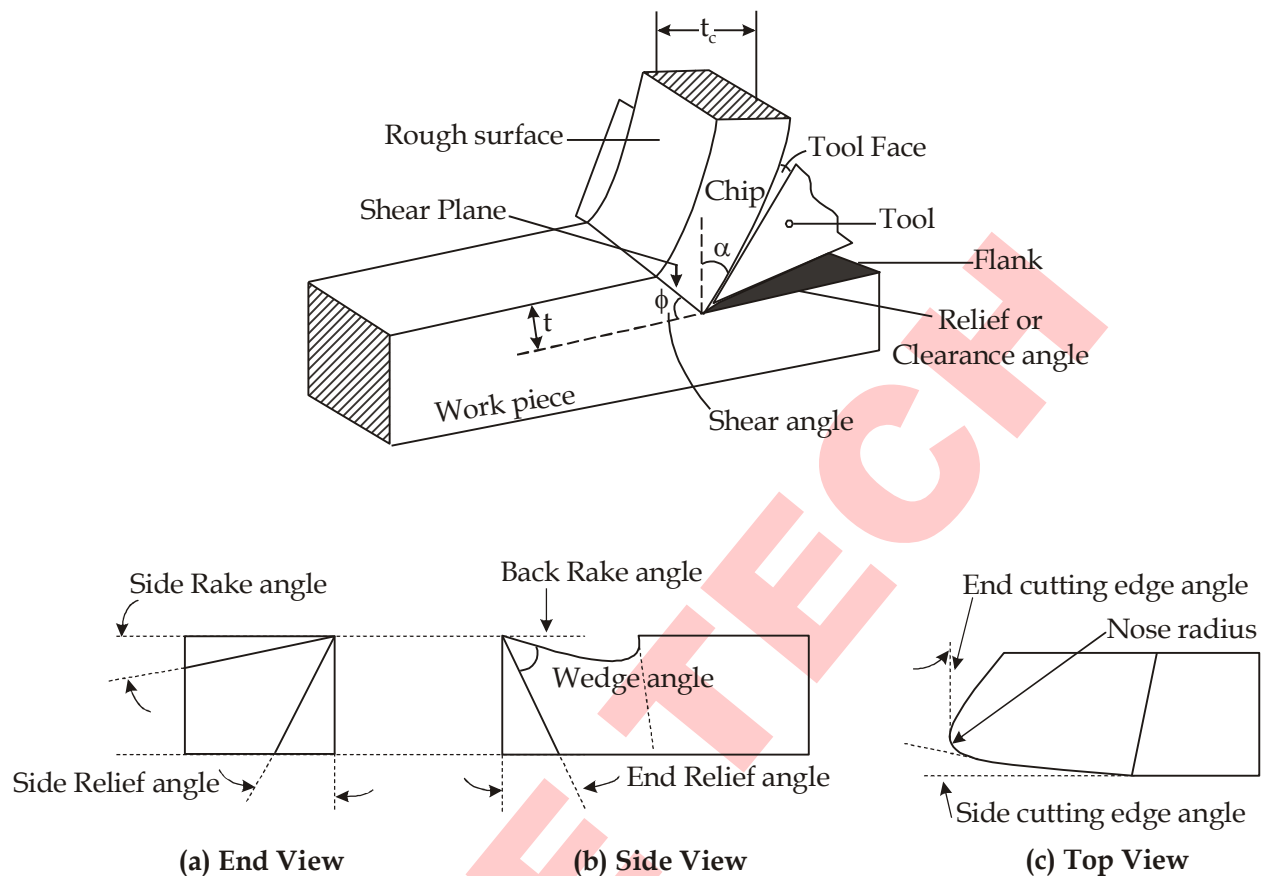
Sol.

S.No.	Single Point Cutting Tool	Multi Point Cutting Tool
1.	Single point cutting tools contain only one main cutting edge in the cutter body.	Multi point cutting tools contain more than one (even up to hundreds) cutting edges in the cutter body.
2.	While machining with single point cutting tool, only one main cutting edge continuously remains in contact with workpiece.	While machining with multi point cutting tool, more than one cutting edges simultaneously engage in material removal action in a pass.
3.	Chip load per tooth is usually high.	Due to presence of multiple cutting edges, effective chip load per tooth reduces.
4.	Since one cutting edge continuously remains in contact with the workpiece, so rate of heat generation and subsequent rise in tool temperature is high.	Due to successive engagement and disengagement, heat dissipates from the cutter when it is not in contact with workpiece. Consequently rate of rise in tool temperature is low.
5.	In case of unplanned breakage of cutting edge, entire process is required to pause until the broken tool is replaced by a new one.	If one cutting edge breaks, cutting action can be continued using other cutting edges without much problem.
6.	Design and fabrication of single point cutting tools are easier.	Design and fabrication of multi point cutting tools are quite difficult.
7.	Usually low feed rate and depth of cut is employed when machining is carried out with single point cutting tools. Accordingly, material removal rate (MRR) and productivity are low.	Higher feed rate can be employed when machining is carried out with multi point cutting tool. This increases MRR and productivity. Accordingly, machining operation becomes economic.
8.	Examples of single point cutters: • Turning tool • Shaping tool • Planing tool • Slotting tool • Boring tool • Fly milling cutter, etc.	Examples of multi-point cutters: • Milling cutters • Hobs • Broach • Grinding wheels • Reamer • Knurling tool, etc.

192.

Sol. Given that

 α = Rake angle ϕ = Shear angle Ψ = Lip angle/Wedge angle/Cutting angle t_c = Chip thickness t = Uncut chip thickness



Single Point Cutting Tool :

The cutting tool which is having single cutting edge, is known as single point cutting tool.

Ex: Turning tool, shaping, planing, parting tool etc.

According to American standard system, tool signature is

$$\alpha_b - \alpha_s - \gamma_e - \gamma_s - C_e - C_s - R$$

where,

α_b = Back Rake angle

α_s = Side Rake angle

γ_e = End Relief angle

γ_s = Side Relief angle

C_e = End cutting edge angle

C_s = Side cutting edge angle

R = Nose Radius

(i) Back Rake Angle (α_b)

It is the angle between the base of the tool and the base of the shank or holder and it is usually measured in a plane perpendicular to the base & parallel to length of the tool.

It affects the ability of the tool shear the work material and form the chip.

(ii) Side Rake Angle (α_s)

It is the angle between the base of the tool and the base of the shank or holder, it is usually measured in a plane perpendicular to the base and parallel to the width.

(iii) **End Relief angle (γ_e)**

It is the angle between the portion of end flank immediately below the end cutting edge and a line drawn through the cutting edge perpendicular to the base, it is usually measured in a plane perpendicular to the end flank.

(iv) **Side Relief Angle (γ_s)**

It is the angle between the portion of the side flank immediately below the side cutting edge and a line drawn through this cutting edge perpendicular to the base.

(v) **End cutting Edge angle (C_e)**

The end cutting angle is the amount that the end cutting edge slopes away from the nose of the tool, so that it will clear the finish surface on the work piece.

(vi) **Side Cutting Edge angle (C_s)**

It is the angle which prevents interference as the tool enters the work Materials (normally 15° to 30°), larger this angle the greater the component of force tending to separate the work and tool (may induce chatter)

(vii) **Nose Radius (R)**

It is the curvature of the tool take it strength the tool nose and provide between surface finish. If nose radius increase, cutting force and cutting power will also increase.

193.

Sol. Centreless Grinding :

- Centreless grinding makes it possible to grind both external and internal cylindrical surface without requiring the workpiece to be mounted between centers or in a chuck.
- This eliminates the requirement of centre hole in some workpieces and the necessity for mounting the workpiece, thereby reducing the cycle time. Two wheels are used. The larger one operates at regular grinding speeds and does the actual grinding. The smaller wheel is the regulating wheel. It is mounted at an angle to the plane of the grinding wheel.
- The regulating wheel controls the rotation and longitudinal motion of the workpiece and usually is a plastic or rubber bonded wheel with a fairly wide face. The work piece is held against the work-rest blade by the cutting forces exerted by a grinding wheel and rotates at approximately the same surface speed as that of regulating speed.

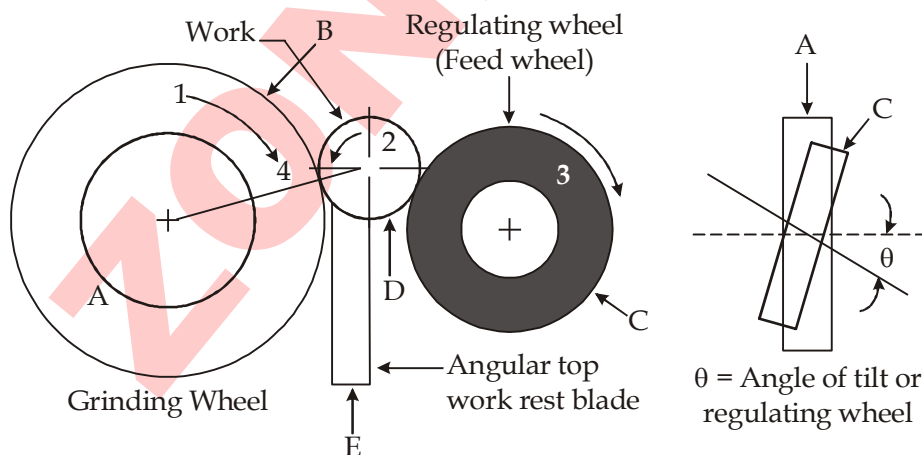


Fig. : External Centerless Grinding

A. Grinding wheel	B. Grinding face	C. Regulating wheel
D. Work piece	E. Work rest blade	
Movements :		
1. Grinding wheel	2. Work	3. Regulating wheel
		4. Infeed

(i) Through Feed :

In through feed grinding the workpiece is supported on a work-rest blade and is ground between two wheels. Grinding is done by the larger wheel, while the smaller wheel regulates the axial movement of the workpiece. The regulating wheel which is rubber bonded, is tilted and runs at a speed of only about 5% of that of the grinding wheel.

(ii) Infeed :

Part with variable diameters, such as bolts, valve tappets and distributor shafts can be ground by centreless grindings, called infeed grinding.

(iii) End Feed :

Taper pieces are centreless ground by end feed grinding.

194.

Sol. Since the second last value in the tool signature is very high and the side cutting edge angle as per ASA can not be so high. So, ORS tool signatures are given in the above problem. So approach angle $= 75^\circ$;

$$D = 160 \text{ mm}$$

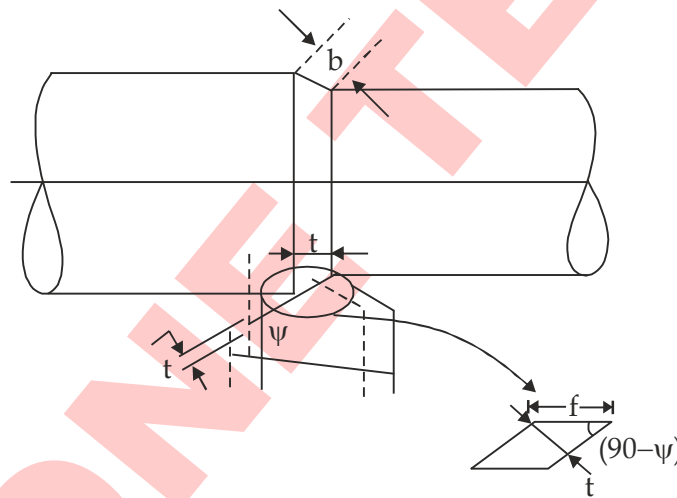
$$N = 400 \text{ rpm}$$

$$f = 0.32 \text{ mm/rev.}$$

$$F_C = 1200 \text{ N}$$

$$F_F = 800 \text{ N}$$

$$t_2 = t_c = 0.8 \text{ mm}$$



Find: (i) F , N (ii) τ_s (iii) P_c

$$\alpha = 0$$

$$v = \frac{\pi DN}{60} = \frac{\pi \times 400 \times 0.16}{60}$$

$$= 3.35 \text{ m/s}$$

$$F_R = F_T \sin \psi$$

$$F_F = F_T \cos \psi$$

$$\psi = 90^\circ - 75^\circ = 15^\circ$$

$$800 = F_T \cos 15^\circ$$

$$F_T = 828.22 \text{ N}$$

$$F = F_T \cos \alpha + F_C \sin \alpha = 828.22 \text{ N}$$

$$N = F_C \cos \alpha - F_T \sin \alpha = 1200 \text{ N}$$

$$2. \quad \frac{F_s}{\left(\frac{b \cdot t}{\sin \phi}\right)} - \tau_s : \tan \phi = \frac{\cos \alpha}{\frac{t_c}{t} - \sin \alpha}$$

$$\text{As } \alpha = 0 \text{ then } \phi = \frac{t}{t_c}$$

$$t = f \cos \psi = 0.31 \text{ mm} ; b = \frac{d}{\cos \psi} = 4.14 \text{ mm}$$

$$\tan \phi = \frac{0.31}{0.8}$$

$$\Rightarrow \phi = 21.18^\circ$$

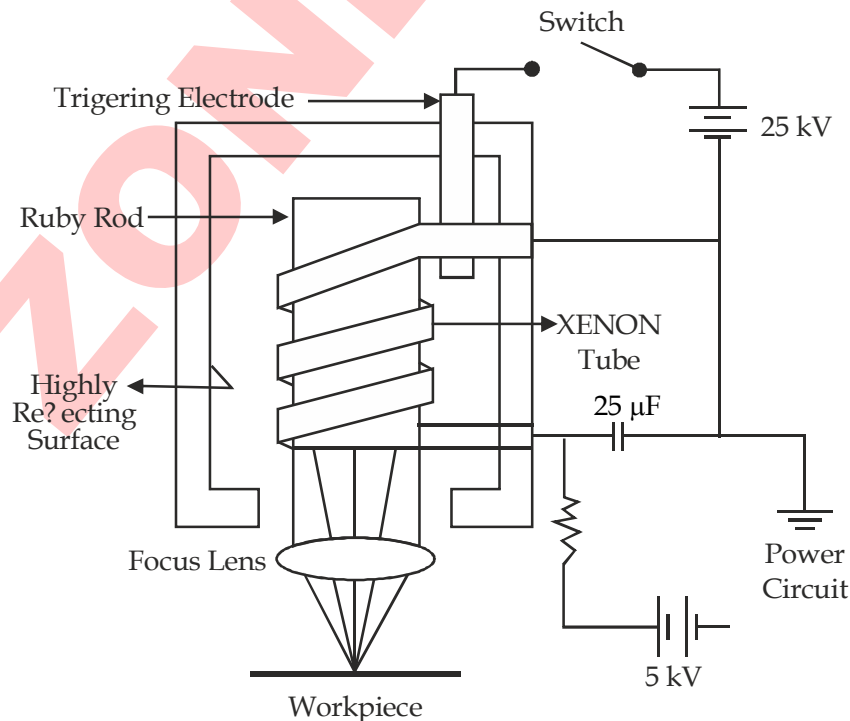
$$F_s = F_c \cos \phi - F_t \sin \phi = 1200 \cos 21.18^\circ - 828.22 \sin 21.18^\circ \\ = 819.7 \text{ N}$$

$$\tau_s = \frac{819.7 \sin 21.18^\circ}{0.31 \times 4.14} = 230.76 \text{ MPa}$$

$$3. \quad P = F_c V = 1200 \times 3.35 = 4020 \text{ W}$$

195.

Sol. Laser beam machining or more broadly laser material processing deals with machining and material processing energy of coherent photons or laser beam, which is mostly converted into thermal energy upon interaction with most of the materials laser beam can very easily be focussed using optical lenses as their wavelength ranges from half micron to around 70 microns. Focussed laser beam as indicated earlier can have power density in excess of 1 MW/mm².



Mechanics of LBM

- A coiled xenon flash tube is placed around the ruby rod and the voltage is supplied to the flash tube.
- Due to the photonic energy of xenon lamps, the atoms of the crystal get excited. As the electron return from the metastable state to the ground state, it releases a laser ray.
- The internal surface of the container is made highly reflective and one end of the container is made perfectly reflective and other end is made partially reflective. After a number of reflections, a coherent monochromatic beam of laser is obtained.
- The parallel beams are converged using an optical focusing lens.
- The converged beam is used to heat and melt the workpiece and machining is proceeded.

196.

Sol. **Automatic Guided Vehicle (AGV):** Automatic guided vehicles are battery operated, automatically steered vehicles that follow defined pathways in the floor. It is equipped with automatic guidance equipment, either electromagnetic or optical and they are used to move unit load between load and unload stations in the factory.

DNC: Direct numerical control (DNC) can be defined as a type of manufacturing system in which several NC or CNC machines are controlled remotely from a main frame computer in real time and time sharing mode. Today, the DNC system is considered as an essential for the efficient management of many CNC machine tools in the shop floor.

Chuckling reamer: These are machine reamers with short flutes. These may be either of the type known as rose reamers or fluted reamers.

Rose reamers do not cut on the circumference of the flutes but are beveled off and clearanced to cut on their ends. These are used for heavy roughing cuts, for example for clearing out cored holes.

Fluted reamers are used for reaming more accurate work while rose reamer can remove greater amount of metal than a fluted type.

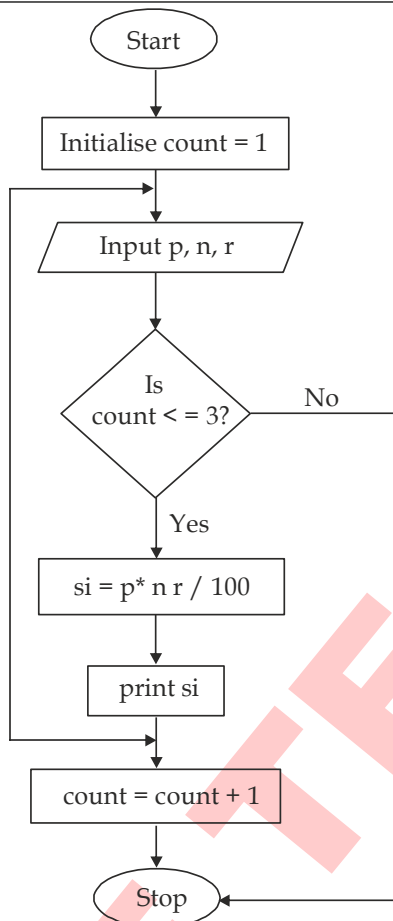
Helix Angle of Drill: The helix or rake angle is the angle formed by the leading edge of the land with a plane having the axis of the drill.

The higher value of helix angle improves the chip removal and less helix angle improves the strength of cutting angle.

197.

Sol.

```
(i)
#include <stdio.h>
#include <conio.h>
void main()
{
    int p, n, r, si;
    int count;
    for (count=1; count<= 3; count++)
    {
        printf("enter principal, time, and rate of interest");
        scanf("%d %d %d", &p &n &r);
        si = (p*n*r)/100;
        printf("The simple interest is %d", si);
    } getch ();
}
```



(ii)

```

#include <stdio.h>
#include <conio.h>
void main()
{
    int V, A, r;
    int pi = 3.142;
    printf("enter radius");
    scanf("%d", &r);
    V = (u*pi*r*r*r)/3;
    printf("The volume is %d", V);
    A = (u*pi*r*r);
    printf("The area is %d", A);
    getch();
}

```