Important Instructions to examiners:

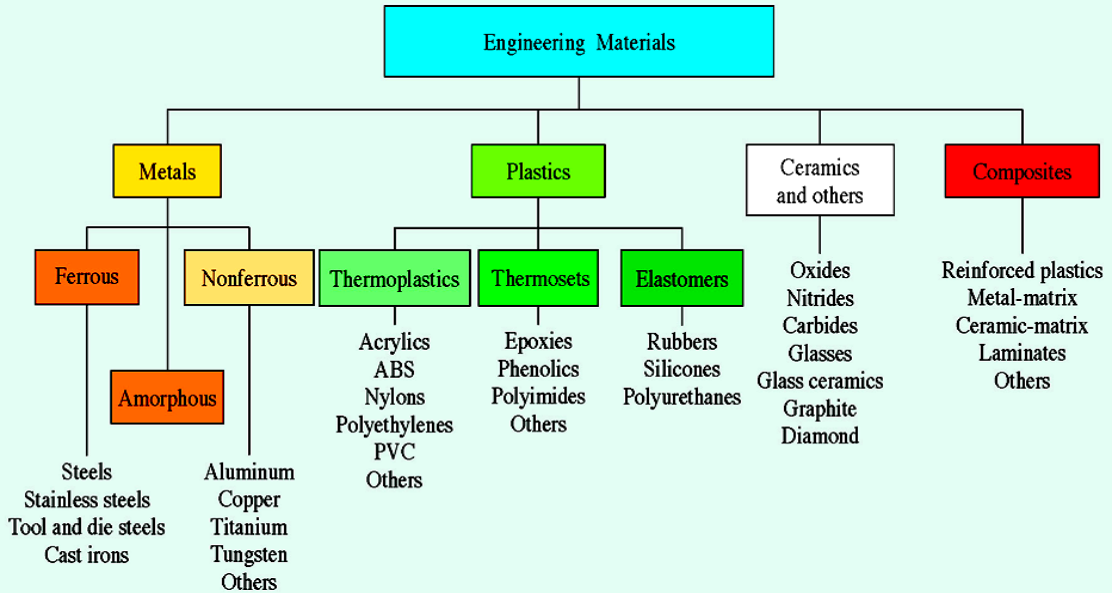
1) The answers should be examined by key words and not as word-to-word as given in the model answer scheme.
2) The model answer and the answer written by candidate may vary but the examiner may try to assess the understanding level of the candidate.
3) The language errors such as grammatical, spelling errors should not be given more Importance (Not applicable for subject English and Communication Skills).
4) While assessing figures, examiner may give credit for principal components indicated in the figure. The figures drawn by candidate and model answer may vary. The examiner may give credit for any equivalent figure drawn.
5) Credits may be given step wise for numerical problems. In some cases, the assumed constant values may vary and there may be some difference in the candidate's answers and model answer.
6) In case of some questions credit may be given by judgment on part of examiner of relevant answer based on candidate's understanding.
7) For programming language papers, credit may be given to any other program based on equivalent concept.

Model Answer	Marks
Q. 1. (A) Attempt any SIX of the following:	**12**
i) What is ferrous metal? Give any two examples of it.	**2**
Ans: Ferrous metal: (Definition 1 Mark) It contains iron as the main constituent. It has magnetic properties, good machinability, good mechanical properties and easy availability. **Example: (Any two-½ marks each)** a) Cast Iron b) Wrought Iron c) Alloy steels d) Die steels	**1** **1**
ii) State the compositions of plain carbon steel and also state where it is used?	**2**
Ans:(Any One of the following - 1 Mark for Composition & 1 Mark for any two Applications) **Composition & Applications of Plain Carbon Steel:** • **Low Carbon steel:** **Composition:** 0.008% to 0.30% Carbon and remaining iron with impurities. **Applications: (Any two)** Wires, nails, rivets and screws, building bars, grills, beams, angles, channels, etc. • **Medium Carbon steel:** **Composition:** 0.30% to 0.60% Carbon and remaining iron with impurities. **Applications: (Any two)** Bolts, axles, lock washers, large forging dies, springs, wires, wheel spokes, hammers, rods, turbine rotors, crank pins, cylinder liners, railway rails and railway tyres etc.	 **1** **1**

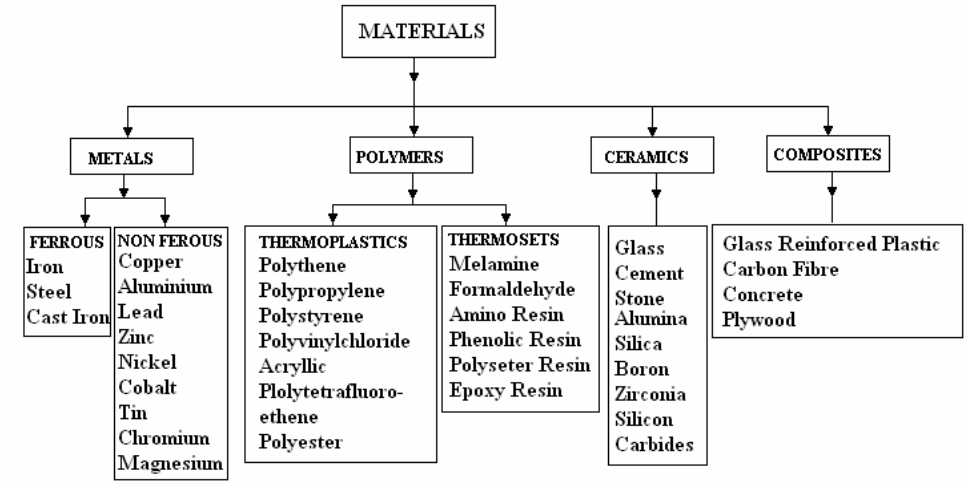
• **High Carbon steel:** **Composition:** 0.60% to 2.0% Carbon and remaining iron with impurities. **Applications: (Any two)** Forging dies, punches, hammers, chisels, vice jaws, shear blades, drills, knives, razor blades, balls and races for ball bearings, mandrels, cutters, files, wire drawing dies, reamers, and metal cutting saws etc.	
iii) What is 'Y' alloy? State its two uses.	**2**
Ans: (Y-alloy - 1 Mark & Application – 1 Mark) 'Y' alloy is called a copper Aluminium alloy. An alloy of aluminum with one or more elements like silicon, manganese, magnesium & Nickel etc. **Composition:** 92.5 % Al, 4%Cu, 2%Ni and 1.5%Mg. **Properties:** This alloy has the characteristic of retaining good strength at high temperatures. **Application: (Any Two – ½ Marks each)** i. Piston and other components of aero engines. ii. Piston, iii. cylinder head of IC engines, iv. dies casting, v. Pump rods etc. vi. It is also largely used in the form of sheets and strips etc.	**1** **1**
iv) State two engineering applications of gun metal and Babbitt metal.	**2**
Ans:(Any Two applications – ½ Marks Each) **Engineering Applications of Gun Metal** i. gun barrels, ii. ordnance parts, iii. Marine castings, iv. gears, v. bearings and vi. Steam pipe fittings vii. small valves **Engineering Applications of Babbitt Metal:** i. Fine Bearings for light & medium load rail road freight cars. ii. bush Bearings iii. bearings in railway iv. Locomotive slide valves. v. Aircraft industries vi. Turbine bushings	**1** **1**

v) What is rubber? State its types.	**2**
Ans: (Meaning of Rubber-1 Mark & Types – 1 Marks) **Rubber**: A rubber defined as an organic polymer, which elongates on stretching and regains its original shape after the removal of the stress. Major property of rubber is its high elasticity. **Following are the types of Rubber: (Any Two – ½ Marks Each)** 1. Natural rubber (NR) 2. Synthetic rubber, 3. Different types of synthetic rubbers are: i. Styrene-butadiene rubber (SBR) ii. Butyl rubber iii. Nitrile rubber. iv. Silicone (SIL) v. Neoprene (CR) vi. Butadine (NBR)	**1** **1**
vi) State any two properties & applications of ceramic material.	**2**
Ans: **Following are the properties of Ceramic Material: (Any Two- ½ Marks Each)** i. Ceramics are inorganic in nature & non metallic material. ii. Brittle material. iii. Insulation to flow of electric current iv. Withstand high temperature. v. Rock like appearance vi. Hardness vii. Corrosion resistance viii. Opaque to light **Following are the Application of Ceramic Material: (Any Two- ½ Marks Each)** i. Tiles, ii. sanitary ware, iii. insulators, iv. semiconductors, v. fuel elements in nuclear power plant, vi. cutting tools, vii. concrete and viii. Variety of glasses. ix. Nuclear engineering x. aerospace field xi. Electronic control devices xii. computers xiii. structures	**1** **1**

vii) What is thermoplastic? State its two properties.	**2**
Ans: **Thermoplastics: (1 Mark)** Plastics which can be easily softened again and again by heating. They can be reprocessed safely. They retain their plasticity at high temperature. They can be heated and reshaped by pressing many times. On cooling they become hard. They can be easily shaped into tubes, sheets, films and many other shapes as per the need. **Following are the properties of Thermoplastics: (Any Two-1/2 Marks each)** i. They are highly plastic ii. They are easily moulded or shaped. iii. They have low melting point iv. As they can be repeatedly used so they have good resale value. v. Soluble in some organic solvent vi. Softer and less strong	**1** **1**
viii) Define heat treatment. Give its two objectives.	**2**
Ans: **Heat Treatment: (1 Mark)** It is defined as an operation or combinations of operations involving heating and cooling of metals or alloys in its solid state with the purpose of changing the properties of the material. **OR** It is defined as an operation or combinations of operations involving heating and cooling of metals or alloys in its solid state to obtain desirable properties of the material. **Following are the objectives of Heat Treatment: (Any Two - 1/2 Marks each)** i. To improve machinability ii. To improve mechanical properties e.g. tensile strength, ductility, hardness, shock resistance, resistance to corrosion etc. iii. To relieve internal stresses induced during hot or cold working. iv. To change or refine grain size. v. To improve magnetic and electrical properties. vi. To improve heat resistance, wear resistance. vii. To improve weldability.	**1** **1**
Q. 1. (B) Attempt any TWO of the following:	**8**
i) How engineering materials are classified? Give example of each.	**4**
Ans: (Classification 2 Marks & Examples – 2 Marks) **Engineering materials are classified as below:**	**4**



OR



ii) What is aluminum? State its properties and applications. **4**

Ans:

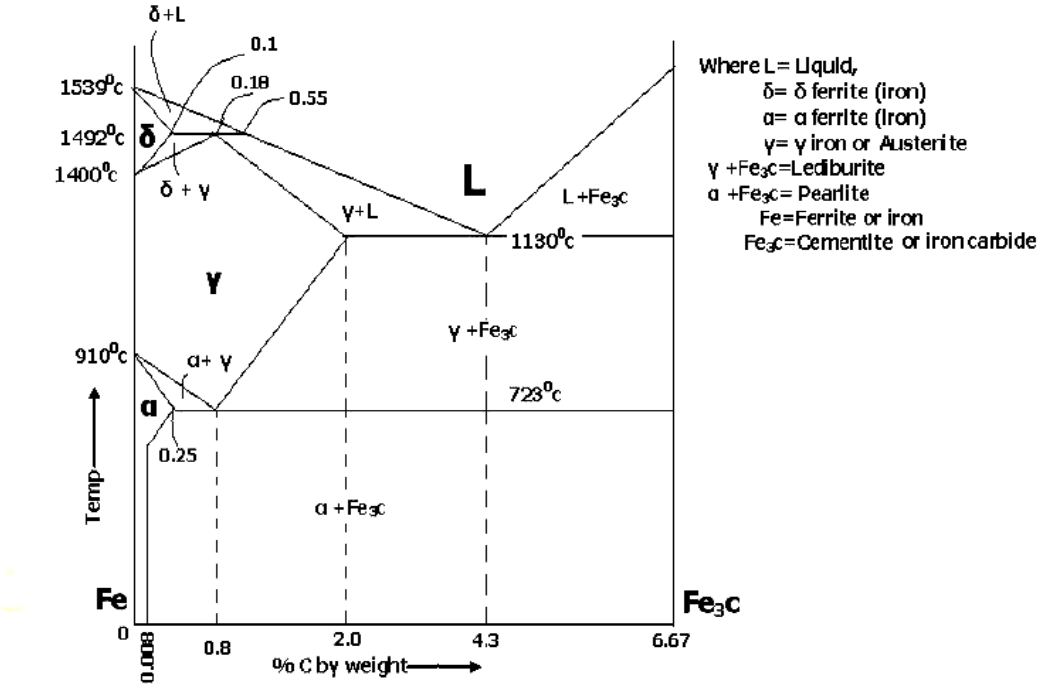
Aluminum: (1 Mark)

It is a white metal produced by electrical processes from its oxide (Alumina) which is prepared from a mineral called Bauxite. Bauxite is hydrated aluminium oxide ($Al_2O_3 2H_2O$). The chief impurities are oxide, silica, clay and titanium oxide. **1**

Following are the properties of Aluminum: (Any Three – ½ Marks Each) **1 ½**

i. It is light in weight (Specific gravity 2.7)
ii. It has very good thermal and electrical conductivity. On weight to weight basis, it carries more electricity than copper.
iii. It has excellent corrosion and oxidation resistance.
iv. It is ductile and malleable.

v. Its tensile strength varies from 95 to 157 MN/m^2. vi. It may be blanked, formed, drawn, turned, cast, forged and die cast. vii. In proportion to its weight it is quite strong. viii. Pure aluminium has silvery colour and luster. **Following are the Applications of Aluminum: (Any Three – ½ Marks Each)** i. Cooking utensils, ii. electrical conductors, iii. food containers, iv. ashtrays, v. bicycles, vi. motorcycle, vii. reflectors, viii. Mirrors. ix. telescopes x. trucks and buses, xi. aeroplanes and xii. Marine vessels.	**1 ½**
iii) Give any four properties of epoxy resins. State any four uses of it.	**4**
Ans: **Following are the properties of Epoxy resins: (Any Four – ½ Marks Each)** i. It is very tough, ii. chemical resistant and iii. Electrical resistant and iv. low shrinkage v. good adhesion to metal and glass vi. good resistance to wear and impact vii. Expensive viii. Transparent with creamy colour. **Following are the Applications of Epoxy resins: (Any Four – ½ Marks Each)** i. used in foundry and ii. in transformer as an insulating material iii. surface coating iv. adhesive for glass and metal, v. jigs and fixtures vi. Laminating materials used in electrical equipments.	**2** **2**
Q. 2. Attempt any FOUR of the following:	**16**
a) Draw iron-iron carbide, phase equilibrium diagram and label it.	**4**
Ans: (Credit should be given to suitable figure showing all details such as temperature percentage of carbon and state)	**4**



b) Compare between flame hardening and induction hardening. **4**

Ans: any four points – 1marks each **4**

Flame Hardening	Induction Hardening
Material is heated with oxyacetylene flame at a required temperature, and then it is followed by water spraying.	Material is heated by using high frequency induced current and then it is followed by water spraying.
Holding time is required.	Due to very fast heating, no holding time is required.
Oxidation & decarburization is minimum.	No scaling & decarburization.
Irregular shape parts can be flame hardened.	Irregular shape parts are not suitable for induction hardening.
Flame hardening requires more care in control of temperature.	Easy control of temperature by control of frequency of supply voltage.

c) What is normalizing? State its four objectives. **4**

Ans:

Normalizing: 2 marks

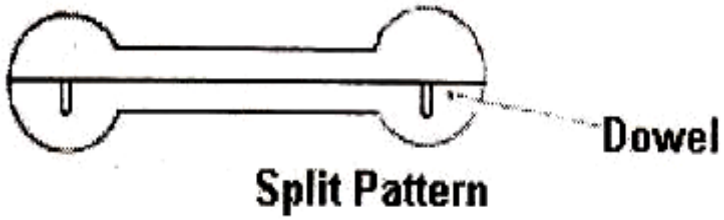
Normalizing is heating of steel to a point 40 to 50^{0}C above upper critical temperature, hold at that temperature for a short duration and subsequently cooling in still air at a room temperature. **2**

Following are the objectives of Normalising processes: (Any Four) (½ mark each)

i. Normalizing raises the yield point, ultimate tensile strength and impact strength values of steel.
ii. To eliminate coarse-grained structure. **2**
iii. To remove internal stresses that may have been caused by previous working processes.

iv. To improve the mechanical & electrical properties of the steel. v. To increase the strength of medium carbon steels to a certain extent (in comparison with annealed steels) vi. To improve the machinability of low carbon steels	
d) What is case carburizing? Give four applications of case carburizing.	**4**
Ans: Case Carburizing: (2 Marks) Carburizing is a method of depositing carbon on the surface layer of low carbon steel in order to produce a hard case. The machined parts of the low carbon steel are packed with carburizing mixture in a steel box as shown in Fig. The carburizing mixture contains 70% charcoal, 10% barium carbonate, 10% calcium carbonate and 10% sodium carbonate. A layer of the carburizing mixture of nearly 25 mm thickness is placed at the bottom. Then the components are so placed that no component touches one another or even the sides of the box. The box is covered and the lid tightly sealed with fireclay to avoid the entry or escape of gases. **Following are the application of case carburizing processes: (Any Four – ½ Marks each)** i. Gears ii. Ball Bearings iii. railway wheels iv. wear resistant bushings v. cam shafts	**2** **2**
e) State any two advantages and two disadvantages of foundry process.	**4**
Ans: **Following are the advantages of foundry process: (Any Two – 1 mark each)** i. It one of the most versatile manufacturing process. ii. Castings provide uniform directional properties. iii. Intricate shaped parts can be produced. iv. Very complicated parts can be cast in one piece. **Following are the disadvantages of foundry process: (Any Two – 1 mark each)** i. It is only economical for mass production. ii. Sand casting process cannot produce parts in accurate sizes. iii. Special casting processes are expensive. iv. In some casting process, skilled operators are required. v. Internal defects are not identified easily.	**2** **2**
f) What is pattern? State the different pattern materials.	**4**
Ans: **Pattern:** It is a true scale model of the desired product (casting), constructed in such a way that it can be used for forming an impression called mould (cavity) in damp sand. **OR** It is the model of anything which is so constructed that it may be used for forming an impression	**1**

or cavity in the damp sand or other suitable material. Pattern is principle tool during the casting process. **Various Materials used for making Patterns: (Any Three - 1 Mark each)** The wide variety of pattern materials in use may be classified as wood and wood products; metals and alloys; plasters; plastics and rubbers; and waxes. **i. Wood :** Generally wood used are teak, sal, shisam, pine and deodar. **Advantages:** 1. It is readily available. It can be easily cut and formed in a desired shape by gluing. 2. By applying preservatives like shellac, varnish etc., it can be preserved for a long time. It is light in weight. **Disadvantages**: 1. It is affected by moisture when it comes in contact with damp moulding sand. Because of sand abrasion, it wears out quickly. 2. Its life is short. Therefore the wood used for forming patterns should be well seasoned, straight grained, free from knots, strong and of reasonable cost. **ii. Metal :** Metal patterns are used for mass production work. Commonly metals used for patterns are cast iron, brass, aluminium alloy, magnesium alloy and white metal. **Advantages:** 1. Long life as compared to wooden pattern. No change in shape with moist sand. 2. When stored no warping occurs. Resistance to wear and very strong. 3. Better surface finish with dimensional accuracy. **Disadvantages**: 1. Costlier than wooden pattern. Machining is required which adds to cost. 2. Heavier than wood & inconvenient to handle during moulding. Alterations in the pattern cannot be easily made. **iii. Plastic:** Plastic as a pattern material has following advantages: 1. It is strong and dimensionally stable. It does not absorb moisture. 2. It is light in weight & durable. It has high resistance to wear. **iv. Waxes**: 1. The wax patterns are excellent for investment casting process. The waxes used are paraffin, shellac, bees wax and cerasin wax. 2. Normally wax patterns are formed by injecting liquid or semi-liquid wax into a split die (water cooled) after cooling the die parts are separated and wax pattern is taken out.	**3**
Q. 3. Attempt any FOUR of the following:	**16**
a) State the different types of pattern. Explain split piece pattern with neat sketch.	**4**
Ans: any 4 types – 2 marks 1. Single piece pattern 2. Split pattern 3. Match plate pattern 4. Cope and drag pattern 5. Gated pattern	**2**

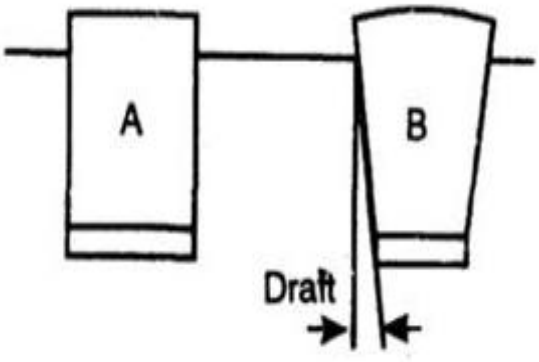
6. Sweep pattern 7. Loose piece 8. Follow board pattern Skeleton pattern 9. Segmental pattern 10. Shell pattern 11. Built-up pattern 12. Box-up pattern 13. Lagged-up pattern 14. Left & right hand	
Split Piece Pattern: sketch & explanation – 1 mark each Many times the design of casting offers difficulty in mould making and withdrawal of pattern, if a solid pattern is used. For such castings, split or two piece pattern are employed. They are made in two parts which are joined at the parting line by means of dowels. While moulding, one part of the pattern is contained by the drag and the other by the cope. An example of a split pattern is shown in fig.	**1**
 **Split Pattern**	**1**
b) What are different pattern allowances? Explain any two in detail.	**4**
Ans: : (List any 2 types – ½ Marks and explanation – 1 ½ marks each) • **Following are the types of allowances provided on pattern:** i. Shrinkage allowance ii. Draft allowance iii. Machining allowance iv. Distortion or camber allowance v. Shake allowance / rapping allowance	**1**
• **(Suitable explanation and sketch should be considered)** • **Shrinkage allowance:** As metal solidifies and cools, it shrinks and contracts in size. To compensate for this, a pattern is made larger than the finished casting by means of a shrinkage or contraction allowance. To provide an allowance, a patternmaker uses shrink or contraction rule which is slightly longer than the ordinary rule of the same length. Different metals have different shrinkages; therefore, there is a shrink rule for each type of metal used in a casting. ➢ It is also called as contraction allowance ➢ When liquid metal starts to cool shrinkage is possible ➢ Gets shrink & reduces size of the component ➢ To reduce above problem, allowance are provided on the pattern ➢ Patterns are made larger than actual size ➢ Different metal have different shrinkage ➢ It has three forms :	**1 ½**

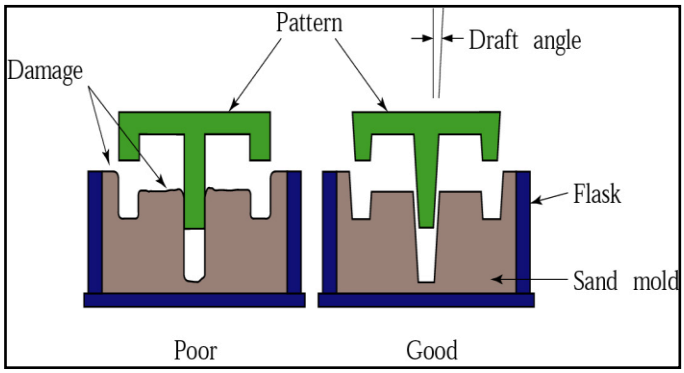
- ✓ Liquid Contraction
- ✓ Solidifying Contraction
- ✓ Solid Contraction

➢ First two are reduced by gets & risers

- ✓ Solid contraction can be reduced by providing more allowance on pattern
- ✓ Following points causes shrinkage :
- ✓ Pouring Temperature Of Molten Metal Is Low
- ✓ Type Of Mould Materials
- ✓ Design & Dimensions Of Castings
- ✓ Type Of Molten Metal

- **Draft allowance provided on pattern:**





1 ½

When a pattern is drawn from a mould, there is always some possibility of injuring the edges of the mould. This danger is greatly decreased if the vertical surfaces of a pattern are tapered-inward slightly.

This slight taper inward on the vertical surfaces of a pattern is known as the draft. Draft may be expressed in millimeter per meter on a side, or in degrees, and the amount needed in each case depends upon

1) length of the vertical side
2) Intricacy of the pattern, and
3) The method of moulding.

- **Machining allowance:**

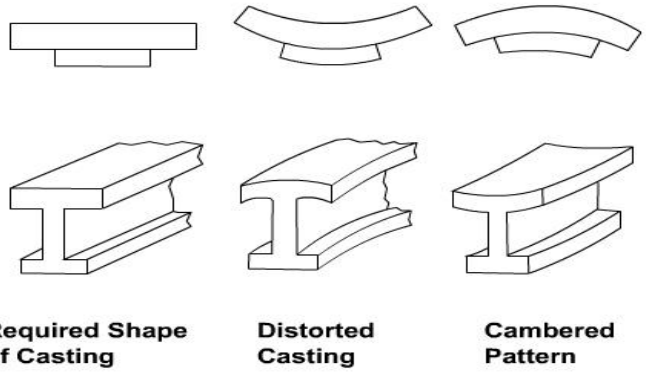
Rough surfaces of castings that have to be machined are made to dimensions somewhat over those indicated on the finished working drawings. The extra amount of metal provided on the surfaces to be machined is called machine finish allowance and the edges of these surfaces are indicated by a finish mark V, or F.

The amount that is to be added to the pattern depends upon
(1) the kind of metal to be used
(2) the size and shape of the casting and
(3) Method of moulding.

- **Distortion or camber allowance:**

Some castings, because of their size, shape and type of metal, tend to warp or distort during the cooling period. This is a result of uneven shrinkage and is due to uneven metal thickness or to one surface being more exposed than another, causing it to cool more rapidly. The shape of the pattern is thus bent in the opposite direction to overcome this distortion. This

feature is called distortion or camber allowance.



c) State any four types of moulding sand and list their properties. **4**

Ans: (any 2 type – 1 Marks each and list any 4 properties – ½ marks each) **2**

According to composition:

Natural or Green sand: It is obtained from river bed, dug from pits, crushing & milling of rocks etc. The requirements of these sands are satisfied by IS: 3343-1965, which has classified them into three grades A, B and C according to their clay content and sintering temperature.

Clay %	Grade A	Grade B	Grade C
	5-10	10-15	15-20
Sintering Temp. in ^{0}C	1350-1450	1200-1350	1100-1200

Synthetic or high silica sand:

It is obtained from crushing quartzite sandstone and then washing to get requisite shape and grain distribution. It is also obtained from sedimentary origin. Bentonite and water can be added to get desired strength and bonding properties.

Special sand:

Zircon, Olivine, Chromite and Chrome-magnesite are often used as special sands. Zircon sands are suitable for cores of brass and bronze casting. Olivine sands are suitable for non- ferrous castings of an intricate shape. Chamotte is suitable for heavy steel casting.

According to use:

Green sand:

It is a mixture of silica sand with 18 to 30 per cent clay, having a total water of from 6 to 8 per cent. The clay and water furnish the bond for green sand. Moulds prepared in this sand are known as green sand moulds.

Dry sand:

Green sand that has been dried or baked after the mould is made is called dry sand. They are suitable for larger castings. Moulds prepared in this sand are known as dry sand moulds.

Loam sand:

Loam sand is high in clay, as much as 50 per cent or so, and dries hard. This is particularly employed for loam moulding usually for large castings.

Facing sand:

Facing sand forms the face of the mould. It is used directly next to the surface of the pattern and it comes into contact with the molten metal when the mould is poured. It is made of silica sand and clay, without the addition of used sand.

Backing sand:

Backing sand or floor sand is used to back up the facing sand and to fill the whole volume of the flask. Old, repeatedly used moulding sand is mainly employed for this purpose. The backing sand is sometimes called black sand because of the fact that old, repeatedly used moulding sand is black in colour due to the addition of coal dust and burning on coming m contact with molten metal.

System sand:

The used-sand is cleaned and reactivated by the addition of water, binders and special additives. This is known as system sand. Since the whole mould is made of this system sand the strength, permeability and refractoriness of the sand must be higher than those of backing sand.

Parting sand:

Parting sand is used to keep the green sand from sticking to the pattern and also to allow the sand on the parting surface of the cope and drag to separate without clinging. This is clean clay-free silica sand which serves the same purpose as parting dust.

Core sand:

Sand used for making cores is called core sand, sometimes called, oil sand. This is silica sand mixed with core oil which is composed of linseed oil, resin, light mineral oil and other binding materials. Pitch or flours and water may be used in large cores for the sake of economy.

Properties

1) Porosity/Permeability
2) Flow ability
3) Collapsibility
4) Adhesiveness
5) Cohesiveness or strength
6) Refractoriness

2

d) Explain with neat sketch any two moulding tools.	**4**

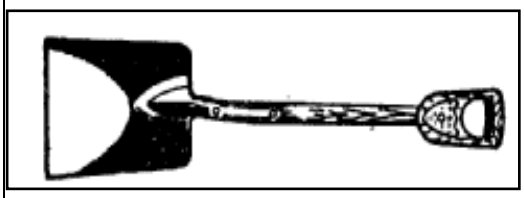
Ans: any 2 moulding tools – sketch– 2 marks (1mark each), explanation - 2 marks (1mark each)

Foundry tool & equipments may be classified into three groups namely, hand tools, flasks and mechanical tools.

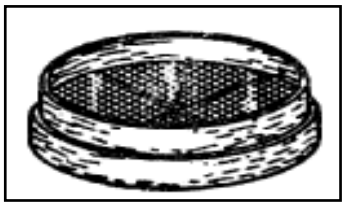
Hand Tools:

The hand tools a moulder uses are fairly numerous. A brief description of the most important tools is given here.

Shovel: A shovel (Fig.1) is used for mixing and tempering moulding sand and for moving the sand from the pile to the flask.



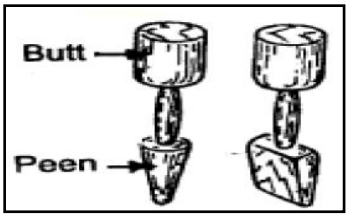
(Fig. 1)



(Fig. 2)

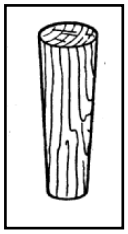
Riddle: A riddle, sometimes called a screen, consists of a circular or square wooden frame fitted with a standard wire mesh at the bottom as shown in Fig. 2. It is used for removing foreign materials such as nails, shot metal, splinters of wood, etc., from the moulding sand.

Rammer: A hand rammer (Fig.3) is a wooden tool used for packing or ramming the sand into the mould. One end, called the peen, is wedge shaped, and the opposite end, called the butt, has a flat surface.



(Fig. 3)

(Fig. 4)



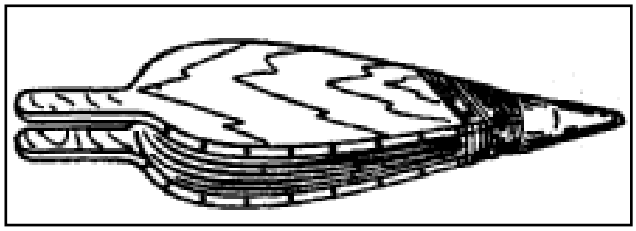
(Fig. 5)

Trowel: A trowel consists of a metal blade fitted with a wooden handle (Fig.4). Trowels are employed in order to smooth or sleek over the surfaces of moulds. A moulder also uses them in repairing the damaged portions of a mould.

Sprue pin: A sprue is a tapered peg (Fig.5) pushed through the cope to the joint of the mould. As the peg is withdrawn it removes the sand, leaving an opening for the metal. This opening is called the sprue through which the metal is poured. The sprue pin forms the riser pin.

Bellow: Bellows are used to blow loose particles of sand from the pattern and the mould cavity. A hand blower is shown in (Fig.6). Moulding machines are also provided with a compressed air

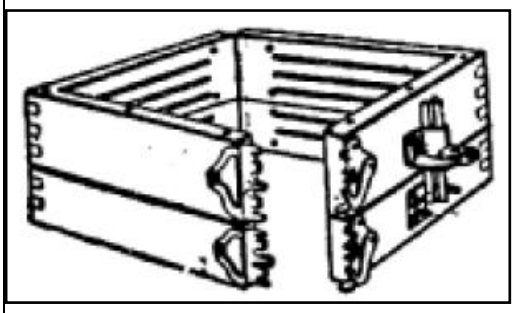
jet to perform this operation.



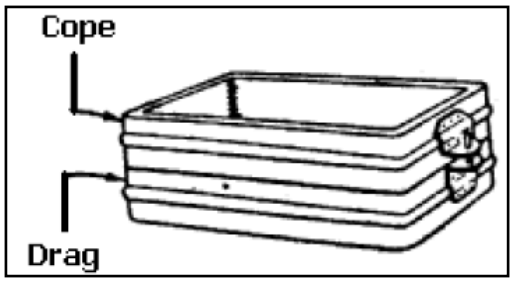
(Fig. 6)

Moulding boxes:

Sand moulds are prepared in specially constructed boxes called flasks. The purpose of the flask is to impart the necessary rigidity and strength to the sand in moulding. They are usually made in two parts, held in alignment by dowel pins. The top part is called the cope and the lower part the drag. If the flask is made in three sections, the centre is called the cheek. These flasks can be made of either wood or metals depending upon the size required. Two types of flasks are used in a foundry: (1) the snap flask, and (2) the tight or box flask. A snap flask (Fig.7) is made with the hinge on one corner and a lock on the opposite corner so that the flask may be removed from the mould before it is poured. The snap flask is of advantage in that many moulds can be made for the same pouring from a single flask.



(Fig. 8)



(Fig. 7)

A box flask shown in Fig. 8 must remain in the mould until the pouring operation is completed. These boxes are usually made of metal and are very suitable for small and medium sized moulding.

e) What is sand moulding process? Explain the general steps taken for it. **4**

Ans: 2 marks for sand moulding, 2 marks for any four steps

All metals may be cast in sand moulds and there is no limitation about the size of the casting which can be made. Sand casting is having wide application; sands are single purpose moulds as they are completely destroyed after the casting has been removed from the moulding box. **2**

Casting process involving the use of *sand* as a moulding medium is known as *sand moulding*.

The steps in sand moulding are :

Sand preparation→Pattern making→Core making→Moulding→Closing

The equipments needed in a sand moulding process are:

1. Pattern
2. Mould box
3. Moulding sand

4. Crucible **General steps:** 1) First of all a suitable flask is selected. 2) Drag part is placed upside down on the moulding board. 3) The pattern is placed on the board inside the flask. 4) If in two parts, lower part of pattern is placed in the drag. 5) If facing sand is used, it is placed all along the pattern surface to a suitable depth. 6) The drag is then filled with ordinary moulding sand and rammed properly. 7) The excesses sand is cut-off to bring it in level with the edges of flask. 8) A suitable amount of dray loose sand is sprinkle over the top surface and drag turned upside down, along with bottom board placed over it, after venting. 9) Cope is then placed over the drag and to part of pattern (it it is in two parts) assembled in position. 10) Dry, loose, parting sand is then sprinkled over the entire surface of the drag and pattern. 11) Runners and risers put in positions and supported vertically. 12) The facing sand, if used, is again put around the pattern surface to the usual depth. 13) Gaggers, if used, are then placed in position and the cope filled with ordinary moulding sand and rammed. 14) Excess sand is then cut-off, runners and riser pins are removed, venting performed, pouring basin form and dry sand sprinkled on the top surface. 15) Bottom board is placed over the cope and latter rolled over. 16) The pattern parts are removed from both drag and cope 17) Repairs, if any, are made and gates cut. 18) Dressing is then applied. 19) If it is dry sand mould, it is bake. 20) Dry sand cores, if any, are located in position and mould closed for pouring.	**2**
f) What is the purpose of gating and risers in sand casting? Explain with neat sketch.	**4**
Ans: any 4 purposes – ½ marks, sketch - 1 mark, explanation - 1 mark **Purpose of gating & risers in sand casting:** 1) The velocity of molten metal entering into the mould cavity should be as low as possible, so that there is no erosion of mould. 2) It should ensure the complete filling of the mould cavity. 3) It should prevent the molten metal from absorbing air or other gases while flowing through it. 4) It should prevent the formation of oxides. 5) It should prevent the entry of oxides, slag, and dross. 6) It's design should be practicable and economical 7) It is to feed the metal to the solidify casting so that shrinkage cavities are get rid of. 8) It permits the escape of air and mould gases as the mould cavity is being filled with the molten metal. 9) Full of molten metal indicates that the mould cavity has already been completely filled up with the same 10) A casting solidifying under the liquid metal pressure of the riser is comparatively sound. 11) It promotes directional solidification. 12) Fill the mold cavity completely before freezing.	**2**

13) Introduce the liquid metal into the mold cavity with low viscosity and little turbulence, so that mold erosion, metal oxidation and gas pick up is prevented
14) Help to promote temperature gradient favorable for proper directional solidification.
15) Incorporate traps for separation of non-metallic inclusions which are either introduced with the molten metal or are disclose in the gating system.
16) Regulate the rate at which liquid metal enters into the mold.
17) Be practicable and economical to make and consume least metal.

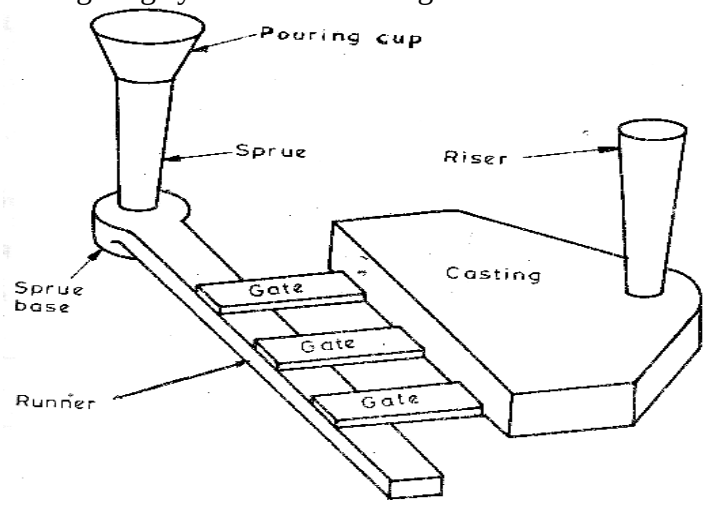
Gating system:

The term gating system refers to all passageways through which the molten metal passes to enter the mold cavity. **1**

The gating system is composed of

1) Pouring cups and basins
2) Sprue
3) Runner
4) Gates
5) Risers

Various components of gating systems shown in fig.



1

Since the way which liquid metal enters the mold has a decided influence upon the quality and soundness of a casting, the different passages for the molten metal are carefully designed and produced. A gating system should avoid sudden or right angle changes in direction. Sudden change in direction causes mold erosion, turbulence and gas pick up. If possible the gating system should from a part of the pattern. It

a) Avoids cutting a runner and gates
b) Permits sand to be rammed hard.
c) Helps prevent erosion and washing away of the sand as molten metal flows into the mold.

Pouring cups:

Makes it easier for the ladle or crucible operator to direct the flow of metal from crucible to sprue.

A pouring cup is a funnel shape cup which forms the top portion of the sprue.

Pouring basins:
Makes it easier to ladle operator to direct the flow of metal from crucible to sprue.
Helps maintaining the required rate of liquid metal flow.
Reduces turbulence and overtaxing at the sprue entrance.
Helps separating dross, slag etc. from metal before it (i.e. metal) enters the sprue hole.

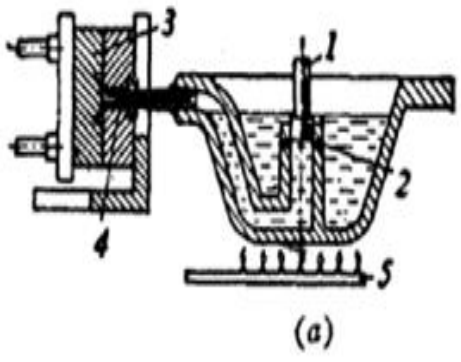
Sprue:
A sprue feeds metal to the runner which in turn reaches the casting through the gate.
A sprue is tapered with its bigger end at the top to receive the liquid metal. The smaller end is connected to the runner.

Gates:
A gate is a channel which connect a runner with the mold cavity and through which molten metal flows to fill the mold cavity.
A gate should feed liquid metal to the casting at the rate consistent with the rate of solidification.
The size of the gate depends upon the rate of solidification.
A small gate is used for a casting which solidifies slowly and vice versa.

Types of gates:
Top gate / drop gate
Bottom gate
Parting line side gate

Risers:
Risers are reservoirs of molten material. They feed this material to sections of the mold to compensate for shrinkage as the casting solidifies. There are different classifications for risers.
Top Risers: Risers that feed the metal casting from the top.
Side Risers: Risers that feed the metal casting from the side.
Blind Risers: Risers that are completely contained within the mold.
Open Risers: Risers that are open at the top to the outside environment.

Q. 4. Attempt any FOUR of the following:	**16**
a) Explain with neat sketch hot chamber pressure die casting.	**4**
Ans: sketch 2 marks, explanation 2 marks **Hot Chamber Die Casting:**	**2**



(a)

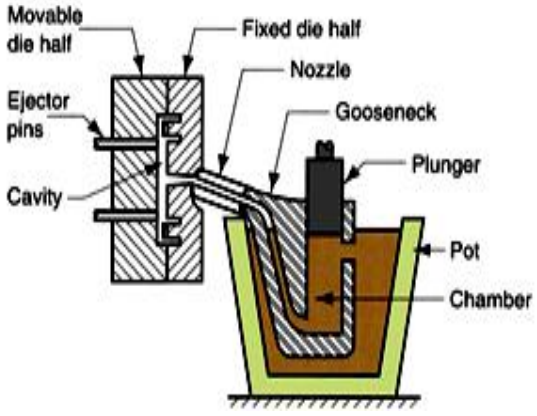


Fig. Hot chamber Pressures die casting

This process is particularly suitable for lead, magnesium, tin, and zinc alloys. The advantages of die casting practice lie in the possibility of obtaining castings of sufficient exactness and in the facility for casting thinner sections that cannot be produced by any other casting method. Cycle in hot chamber casting: (1) with die closed and plunger withdrawn, molten metal flows into the chamber (2) plunger forces metal in chamber to flow into die, maintaining pressure during cooling and solidification. In a hot chamber submerged plunger-type machine, the plunger operates in one end of a gooseneck casting which is submerged in the molten metal. With the plunger in the upper position, metal flow by gravity into this casting through holes 2 just below the plunger and the entrapped liquid metal is forced into the die 3 through the gooseneck channel and in-gate 4. As the plunger retracts, the channel is again filled with the right amount of molten metal. The plunger made of refractory material may be actuated manually or mechanically and hydraulically, that is by means of air pressure below 150 kgf/cm2 (about 15 MN/m2). Heating 5 is continued throughout the operation to keep the molten metal sufficiently liquid. The range of alloys that can be handled is limited by the pump material.	**2**
b) State any four casting defects and remedies to avoid them.	**4**
Ans:(Any four – 1/2 Marks each for defects & remedies) **1.Shifts :** This is an external defect in a casting. **Cause**: Due to core misplacement or mismatching of top and bottom parts of the casting usually at a parting line. Misalignment of flasks is another likely cause of shift. **Remedy:** By ensuring proper alignment of the pattern or die part, moulding boxes, correct mounting of patterns on pattern plates, and checking of flasks, locating pins, etc. before use. **2.Warpage :** Warpage is unintentional and undesirable deformation in a casting that occurs during or after solidification. **Cause:** Due to different rates of solidification different sections of a casting, stresses are set up in adjoining walls resulting in warpage in these areas. Large and flat sections or intersecting sections such as ribs are particularly prone to warpage. **Remedy:** Is to produce large areas with wavy, corrugated construction, or add sufficient ribs or rib-like shapes, to provide equal cooling rates in all areas; a proper casting design can go a long way in reducing the warpage of the casting. **3.Swell:** A swell is an enlargement of the mould cavity by metal pressure, resulting in localised or overall enlargement of the casting. **Cause:** This is caused by improper or defective ramming of the mould. **Remedy:** To avoid swells, the sand should be rammed properly and evenly.	**4**

4. Blowholes: Blow holes are smooth, round holes appearing in the form of a cluster of a large number of small holes below the surface of a casting. These are entrapped bubbles of gases with smooth walls.

Cause:

Excessive moisture in the sand, or when permeability of sand is low, sand grains are too fine, sand is rammed too hard, or when venting is insufficient.

Remedy:

To prevent blowholes, the moisture content in sand must be well adjusted, sand of proper grain size should be used, ramming should not be too hard and venting should be adequate.

5. Drop: A drop occurs when the upper surface of the mould cracks, and pieces of sand fail into the molten metal.

Cause:

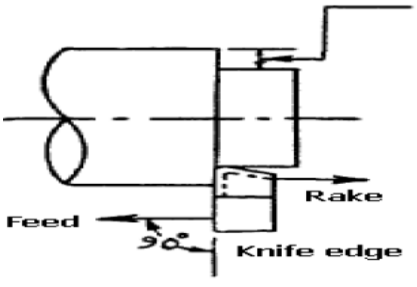
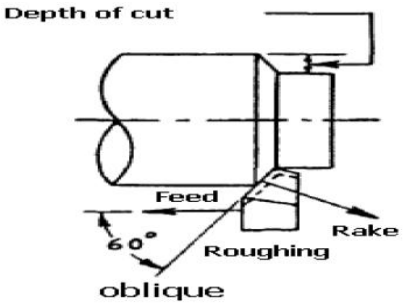
This is caused by low strength and soft ramming of the sand, insufficient fluxing of molten metal and insufficient reinforcement of sand projections in the cope.

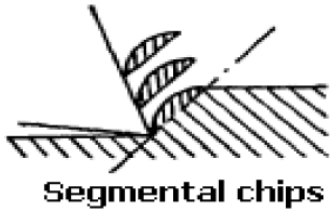
Remedy:

The above factors are eliminated to avoid drop.

c) Difference between orthogonal cutting and oblique cutting. **4**

Ans: any 4 points – 1 mark each **4**

Orthogonal Cutting	Oblique Cutting
The cutting edge of the tool is **perpendicular** to the cutting velocity factor	The cutting edge is **inclined** at an angle 'i' with the normal to the cutting velocity factor
The cutting edge **clears** the width of the workpiece on either ends.	The cutting edge **may not clear** the width of the workpiece on either ends.
The chip flows **over the** tool face.	The chip flows **on the** tool face.
Only **two** components of the cutting forces are acting on the tool.	Only **three** components of the cutting forces are acting on the tool.
Tool is **perfectly** sharp.	Tool is **not perfectly** sharp.
Tool **contacts** the chip on rake face only.	The toll **may not** generate a surface parallel to workface.
The maximum chip thickness **occurs** at the middle.	The maximum chip thickness **may not occur** at the middle.
Only one cutting edge in action.	**More than one** cutting edges are in action
 orthogonal	 oblique

d) What are the different types of chips? Explain with sketch chip formed during machining cast iron.	**4**
Ans: 3 types – ½ mark each , discontinuous chips sketch – 1 ½ marks, explanation -1 mark 1. The discontinuous or segmental form. 2. The continuous or ribbon type. 3. The continuous with built-up edge. **Discontinuous or segmental chips** Machining of brittle materials **like cast iron** produce these types of chips. Small fragments are produced because of lack in ductility of material. Friction between tool and chip reduces, resulting in better surface finish.  **Fig. Segmental chips / discontinuous chips**	**1 ½** **1** **1 ½**
e) What is tool signature? Explain it with example.	**4**
Ans: tool signature – 2 marks, 2 marks - example The term tool signature or tool designation is used to denote a standardized system of specifying the principle tool angles of single point cutting tool. Tool signature (designation) under ASA (American Standards Association) System is given in the order α_b-α_s-θ_e-θ_s-C_e-C_s-R Where, α_b = Back rake angle; α_s = Side rake angle; θ_e = End relief angle; θ_s = Side relief angle; C_e = End cutting edge angle; C_s = Side cutting edge angle; +*R = Nose radius **Example** **e.g.: – 0 – 7 – 7 – 7 – 15 – 15 – 0.8** It means that back rake angle 0°, side rake angle 7°, end relief angle 7°, side relief angle 7°, end cutting edge angle 15°, side cutting edge angle 15°, nose radius 0.8 mm	**2** **2**
f) What are different types of tool material? State their properties.	**4**
Ans: (list any 4 types – ½ marks, any 2 properties – 1 marks each) The principal cutting materials are: 1. High-speed steels. 2. Stellites. 3. Cemented carbides. 4. Diamonds. 5. Abrasive 6. Carbon steel	**2**

7. Medium alloy steel 8. ceramics 9. cubic boron nitride (CBN) **The characteristics/ properties of the ideal material are:** **1. Hot hardness:** The material must remain harder than the work material at elevated operating temperatures. **2. Wear resistance:** The material must withstand excessive wear even though the relative hardness of the tool-work materials changes. **3. Toughness:** The material must have sufficient toughness to withstand shocks and vibrations and to prevent breakage. **4. Cost and easiness in fabrication:** The cost and easiness of fabrication should have within reasonable limits.	**2**
Q. 5. Attempt any FOUR of the following:	**16**
a) Why cutting fluids are used in machining of metal? State the different types of cutting fluids used.	**4**
Ans: Purpose of cutting fluid -2 marks(any 4) ,Types of cutting fluid -2 marks(any 4) **Cutting fluids are used in machining**:-(Any four ½ mark each) 1) To cool the tool 2) To cool the work piece. 3) To lubricate & reduce friction. 4) To improve surface finish. 5) To protect the finished surface from corrosion. 6) To cause chips break up into small parts. 7) To wash the chips away from the tool. **Types of Cutting fluids used in machining are:-(Any four ½ mark each)** **1) Water**: Water, plain or containing an alkali, salt or water-soluble additive but little or no oil or soap are sometimes used only as a coolant. **2) Soluble oils**: Soluble oils are emulsions composed of around 80 per cent or more water, soap and mineral oil. **3) Straight oils**: The straight oils may be (a) straight mineral (petroleum) oils, kerosene, low-viscosity petroleum fractions, such as mineral seal, or higher-viscosity mineral oils, (b) straight fixed or fatty oils consisting animal, vegetable, or synthetic equivalent, lard oil, etc. **4) Chemical compounds**: These compounds consist mainly of a rust inhibitor, such as sodium nitrate, mixed with a high percentage of water. **5) Solid lubricants**: Stick waxes and bar soaps are sometimes used as a convenient means of applying lubrication to the cutting tool. **6) Chemical additive oil**: Straight oil or mixed oil is mixed up with sulphur or chlorine. It is used for machining tough, stringy, low carbon steel.	**2** **2**

b) How lathe machines are classified?	**4**
Ans: Lathe machines are classified as :- (Any four 1 mark each) Lathes are classified according to 1) Speed lathe. i. Wood working ii. Centering iii. Polishing iv. Spinning 2) Engine or centre lathe. i. Belt drive ii. Individual motor drive iii. Gear head lathe 3) Bench lathe. 4) Tool room lathe. 5) Capstan and turret lathe. 6) Automatic lathes. 7) Special purpose lathes. i. Gap bed lathe ii. Wheel lathe iii. Duplicating lathe iv. T – lathe	**4**
c) State the different operations that can be performed on lathe machine. Explain how taper turning operation is performed.	**4**
Ans: **Any two operations (½ mark each),** **Taper turning operation (sketch-2 mark, & Explanation -1 mark)** **Operations performed on lathe machine** 1. Facing, 2. Plain turning, 3. Step turning, 4. Taper turning, 5. Drilling, 6. Reaming, 7. Boring, 8. Undercutting, 9. Threading, 10. Knurling. **Taper turning operation :-(any one of the following)** **Different Methods of Taper turning** i. By a broad nose from tool ii. By swiveling the compound rest iii. By setting over the tailstock centre iv. By a taper turning attachment v. By combining longitudinal and cross feed	**1**

1)**By broad nose from tool :-**

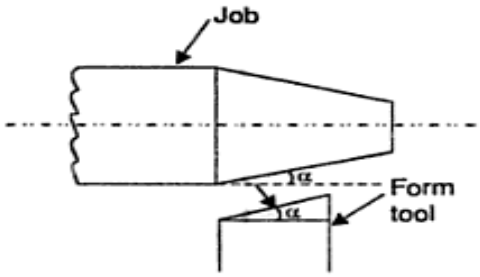


Fig. Taper turning by a form tool.

2

I

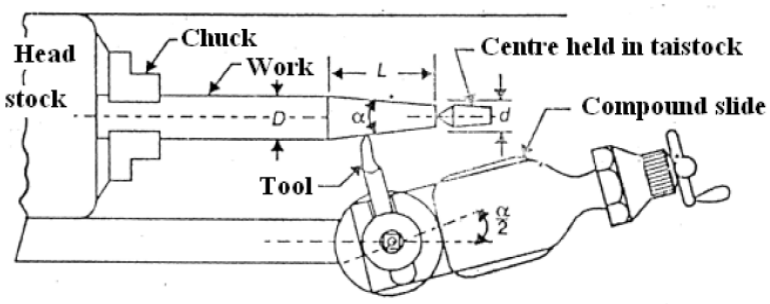
It is a method of taper turning shown in fig. a broad nose tool having straight cutting edge is set on to the work at half taper angle and is fed straight into the work to generate a tapered surface.

1

With this method, tapers of short length only can be turned. This form tool taper turning method not adversely used. It is limited to short external tapers. The edge tool must be exactly straight for accurate work

2***)* By swiveling the compound rest:-**

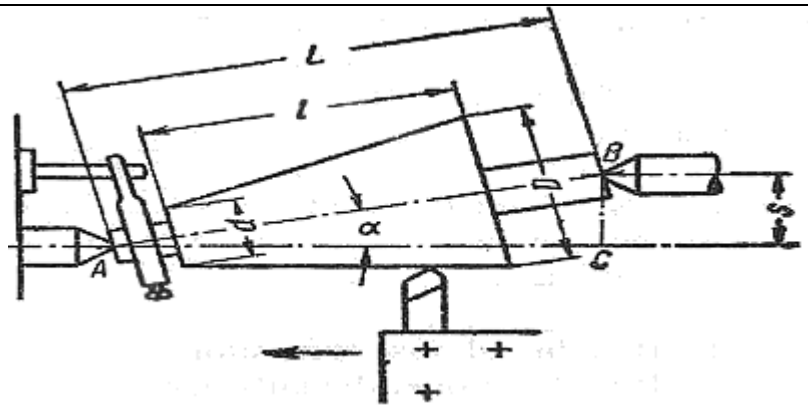
This method employs the principle of turning taper by rotating the work piece on the lathe axis and feeding the tool at an angle to the axis of rotation of the work piece. The tool mounted on the compound rest is attached on a circular base (Swivel plate), graduated in degree, which may be swiveled and clamped at any desired angle. Once the compound rest is set at the desired angle half the taper angle, rotation of the compound slide screw will cause the tool to be fed at the angle and generate a corresponding taper. The movement of tool is controlled by hand.



Taper turning

3) By setting over the tailstock centre:-

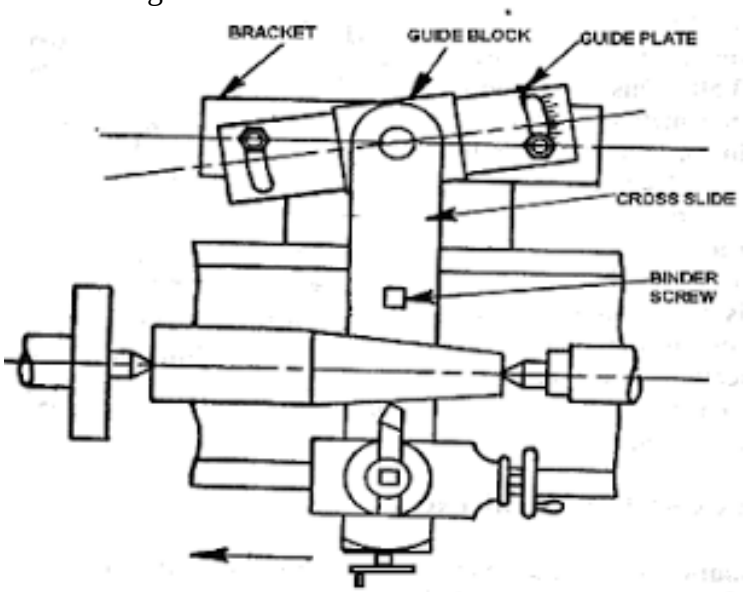
The principle of turning taper by this method is to shift the axis of rotation of the workpiece, at an angle to the lathe axis, and feeding the tool parallel to the lathe axis. The angle at which the axis of rotation is shifted is equal to half angle of taper. This is done when the body of tailstock is made to slide on its base towards or away from the operator by a set over screw. The amount of set over screw being limited, this method is suitable for turning small taper on long jobs.



4***) By a taper turning attachment:-***

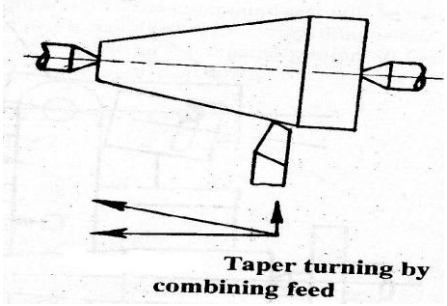
The principle of turning taper by a taper attachment is to guide the tool in a straight path set at an angle to the axis of rotation of the work piece, while the work is being revolved between centres or by a chuck aligned to the lathe axis. It consists of a bracket or frame which is attached to the rear end of the lathe bed and support guide bar pivoted at the centre. The bar having graduations in degrees may be swiveled on either side of zero graduations and is set at the desired angle with lathe axis.

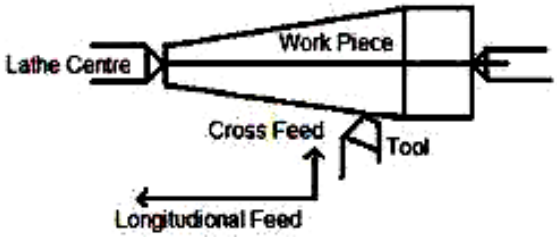
When taper turning attachment is used, the cross slide is first made free from lead screw. The rear end of cross slide is then tightened with the guide block by means of bolt. When longitudinal feed is engaged, the tool mounted on cross slide will follow the angular path, as the guide block will slide on the guide bar set at an angle to the lathe axis. The required depth of cut is given by the compound slide. The guide bar must be set at half taper angle and taper on the work must be converted in degrees.



5)By combining longitudinal and cross feed:-

This is a more specialized method of turning taper .In certain lathes both longitudinal and cross feeds may be engaged simultaneously causing the tool to follow a diagonal path which is the resultant of the magnitude of the two feeds. The direction of the resultant may be varying the rate of feeds by change gears provided inside the apron.



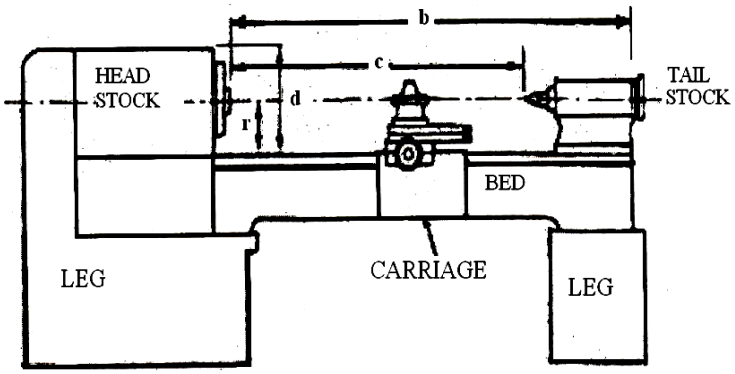


d) How lathe machines are specified? Enlist the major parts of centre lathe machine. **4**

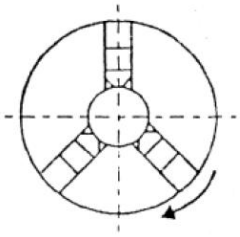
Ans: Lathe specification sketch -1 mark, explanation 2 mark,
enlisting any 2 parts of lathe ½ mark each

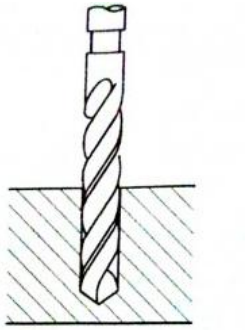
Lathe specification:-(3 mark)

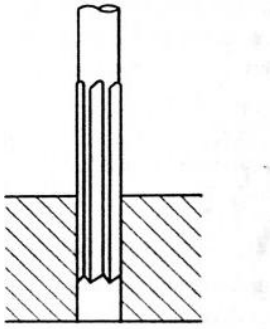
1. The height of the centers measured from the lathe bed.
2. The swing diameter over bed. This is the largest diameter of work that will revolve without touching the bed and is twice the height of the centre measured from the bed of the lathe. **2**
3. The length between centers. This is the maximum length of work that can be mounted between the lathe centers.
4. The swing diameter over carriage. This is the largest diameter of work that will revolve over the lathe saddle, and is always less than the swing diameter over bed.
5. The maximum bar diameter. This is the maximum diameter of bar stock that will pass through hole of the headstock spindle.
6. .The length of bed. This indicates the approximate floor space occupied by the lathe

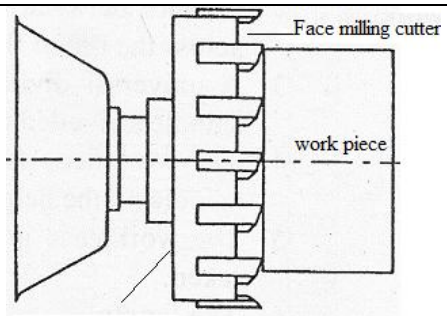


r- Centre height c- Length between centres
d- Swing diameter over bed b- Length of bed **1**

Major parts of centre lathe :-(any two ½ mark each) 1.Bed 2.Head stock 3.Tailstock 4.Carriage 5.Feed mechanisms 6.Screw cutting mechanism	**1**
e) State the four accessories used on lathe machine. Explain with neat sketch use of three jaw chuck.	**4**
Ans:-Listing any 4 accessories 2 mark (½ mark each), **sketch of three jaw chuck 1 mark, explanation 1 mark** **Accessories of lathe:-** i. Centre ii. Chuck iii. face plate iv. angle plate v. mandrel vi. rests vii. carriers viii. catch plates ix. collets	**2**
Three jaw chuck:- The three jaw universal chuck, as shown in Fig.5.7 (a) is also called self centering chuck..In this all the jaws may be made to slide simultaneously by equal amount within the slot provided on the body by rotating any one of the three pinions. When the disc is made to rotate by any one of the pinions, all the three jaws moves forward or backward by equal amount. This chuck is used for holding round and hexagonal and other similar shaped work piece and the job is centered automatically and quickly.	**1**
	**1**
f) How drilling machines are classified? List the major parts of bench drilling machine.	**4**
Ans: Classification of drilling machine 2 marks, parts of bench drilling machine 2 marks **Classification of drilling machine (any four)** 1. Portable drilling machine 2. Bench drilling machine 3. Sensitive drilling machine 4. Upright or column drilling machine 5. Radial drilling machine 6. Gang drilling machine	**2**

7. Multi-spindle drilling machine 8. Vertical drilling machine 9. Automatic drilling machine 10. Deep hole drilling machine **Major parts of bench drilling machine (any four)** i. Base ii. Spindle iii. Drill chuck iv. Head v. Adjustable Table vi. Column	**2**
Q. 6. Attempt any FOUR of the following:	**16**
a) Explain drilling and reaming operation with neat sketch.	**4**
Ans: **Drilling 2 mark ,Reaming 2 mark** **Drilling operation (Fig 1 mark ,explanation 1 mark)** It is an operation of producing a circular hole in a work piece by forcing a drill against it. It is the operation of producing a cylindrical hole by removing metal by the rotating edge of a cutting tool called the drill. Drilling hole not produce an accurate hole in a workpiece and the hole so generated by drilling become rough and the hole is always slightly oversize than the drill used due to the vibration of the spindle and the drill.  Drilling Operation **Reaming operation (Fig 1 mark ,explanation 1 mark)** It is accurate way of sizing and finishing a hole which has been previously drilled. The speed of the spindle is made half that of drilling and automatic feed may be employed .Reamer cannot originate the hole .It simply follows the path which has been previously drilled and removes a very small amount of metal. It is an operation of slightly enlarging a machined hole to proper size with a smooth finish..The material removed by this process is around 0.375mm and for accurate work this should not exceed 0.125 mm	**1** **1** **1**

 Reaming Operation	**1**
b) State the various milling operations and explain with sketch face milling operation.	**4**
Ans: Milling operation 2 marks, Face milling operation 2 marks **Milling operations (Any two 1mark each)** **1**.Plain milling :-For producing a plain ,flat, horizontal surface parallel to axis of rotation of plain milling cutter 2.Face milling:-To produce flat surface face milling cutter rotated about an axis perpendicular to work surface 3.Side milling:-Producing flat vertical surface on the side of the work piece 4.Straddle milling:-Producing flat vertical surfaces on both sides of a work piece by using two side milling cutters mounted on the same arbor 5. Angular milling:- Producing angular surface on the work piece other than at right angles to the axis of the milling machine spindle. 6. Gang milling:-Operation of machining several surfaces of a work piece simultaneously by feeding the table against a number of cutters having same or different diameters mounted on same arbor. 7.Form milling :-Operation of producing irregular contours by using form cutters. 8.Profile milling:-Operation of reproduction of an outline of a template or complex shape of a master die on a work piece. 9.End milling :- producing flat surface which may be vertical, horizontal or at an angle in reference to table surface. 10.Saw milling :-Producing narrow slots or grooves on the work piece. 11.Milling keyways ,Grooves ,slots:-Producing keyways ,Grooves ,slots in work piece 12.Gear cutting :-To produce gears 13.Helical milling :-Producing helical flutes or groves around the periphery of cylindrical or conical work piece. 14. Thread milling :-Producing threads by using a single or multiple thread milling cutter. **Face milling operation:- (Fig 1mark, Explanation 1 mark)** The face milling operation is performed by a face milling cutter rotated about an axis perpendicular to the work surface. The operation is carried in a plain milling machine, and the cutter is mounted on a stub arbor to produce a flat surface. The depth of cut is adjusted by rotating the cross feed screw of the table.	**2** **1**

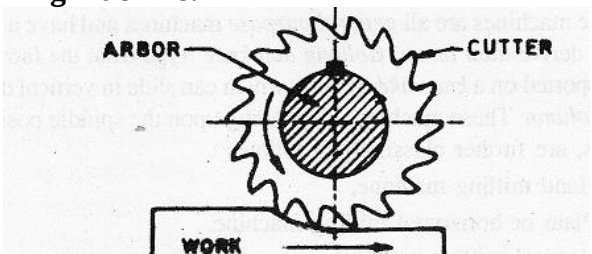


Face milling operation — **1**

c) What is working principle of milling? State the type of milling machine. — **4**

Ans: Working principle 1 mark, fig 1 mark , Types of milling machine 2 marks

Working principle of milling machine:-

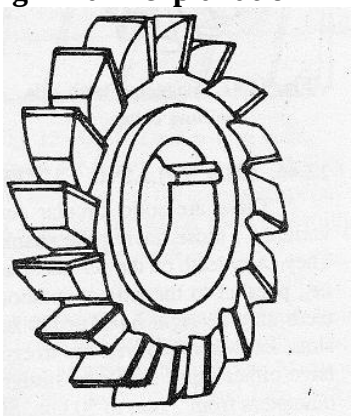
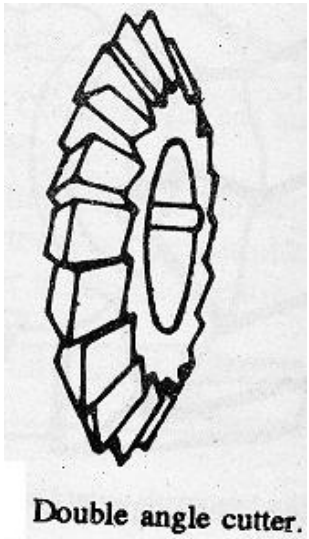
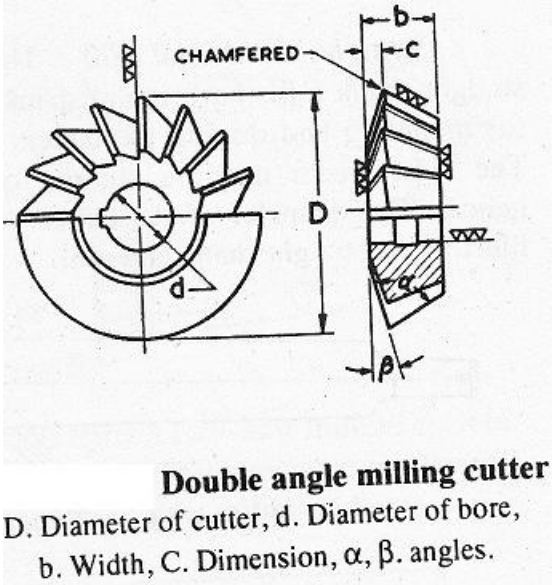


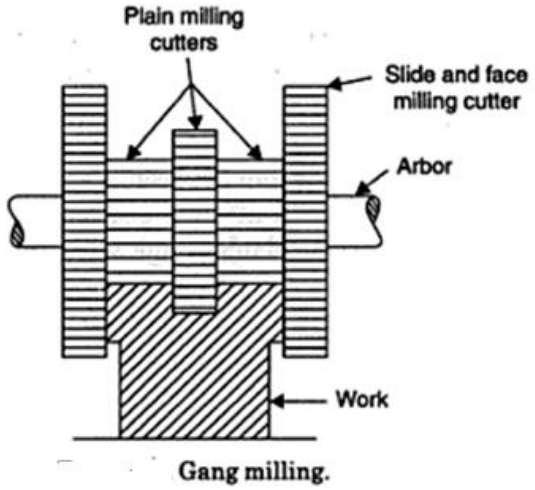
Working principle on a milling machine. — **2**

In this work is rigidly clamped on the table of the machine or between centers, and revolving multi teeth cutter mounted either on spindle or on arbor. The cutter revolves at high speed and the work fed slowly past the cutter. The work can be fed vertical, longitudinal or cross direction. As the work advances, the cutter-teeth remove the metal from the work surface to produce desired shape. — **1**

Types of milling machine:- (any four ½ mark each) — **2**

1) Column and knee type milling machine
   a. Plain or horizontal milling machine
   b. Hand milling machine
   c. Vertical milling machine
   d. Universal milling machine
   e. Omniversal milling machine
2) Manufacturing or fixed bed type milling machine
   a. Simplex milling machine
   b. duplex milling machine
   c. triplex milling machine
3) Planer type milling machine
4) Special purpose milling machine
   a. cam milling machine
   b. planetary milling machine

c. profile milling machine d. drum milling machine e. duplicating milling machine	
d) Explain with neat sketch plain side milling cutter and double angle milling cutter.	**4**
Ans :Plain side milling cutter:-(Fig 1 mark explanation 1 mark)  Standard or plain side milling cutter. The plain side milling cutters have straight circumferential teeth and have side teeth on both of its side. They are made to have cutting teeth on the periphery as well as on both sides. They are normally used for cutting slots or in face milling. Two or more such cutters may be mounted on the arbor and different faces of the work piece may be machined simultaneously. These cutters are available in different widths ranging from 5 mm to 25 mm and diameter upto 200mm. **Double angle milling cutter:-(Fig 1 mark explanation 1 mark)** The double angle milling cutter has V-shaped teeth with both conical surfaces at an angle to their end faces. The included angle of this 'V' is either 45°,60°or 90°.The angle of teeth may not be symmetrical with respect to a plain a right angle to the cutter axis. The double angle milling cutters are mainly used for cutting spiral grooves on a piece of blank.  Double angle cutter.  **Double angle milling cutter** D. Diameter of cutter, d. Diameter of bore, b. Width, C. Dimension, α, β. angles.	**1** **1** **1** **1**

e) What is gang milling? Explain gang milling operation with neat sketch.	**4**
Ans: Gang Milling :-Fig 2 mark, Explanation 2 marks Gang milling operation: It involves the use of a combination of more than two cutters, mounted on a common arbor, for milling a number of flat horizontal and vertical surfaces of a work piece simultaneously. This method saves much of machining time and is widely used in repetitive work. The cutting speed of a gang of cutters is calculated from the cutter of the largest diameter.  Gang milling.	**2** **2**
f) Suggest the type of cutter to be used for following operations on milling machine **i)Thin slot** **ii)Flat surface** **iii)Irregular contours** **iv)Key way**	**4**
Answer: 1 mark each **1) Thin slot :-**Metal slitting cutters **2) Flat surface :-** Plain milling cutter, face mill cutter, T- max cutter **3) Irregular contours :-** Form milling cutter **4) Key way:-** Staggered teeth side milling cutter, End mill cutter, key way cutter	 **1** **1** **1** **1**