MODEL ANSWER

WINTER– 18 EXAMINATION

Subject Title: Materials and Manufacturing Processes Subject Code: 22307

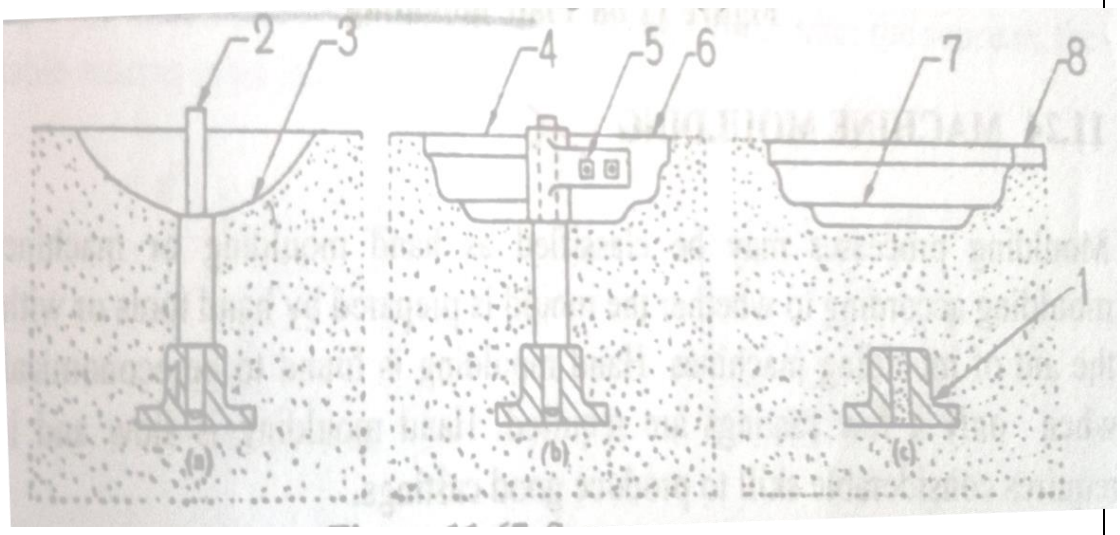
Important Instructions to examiners:

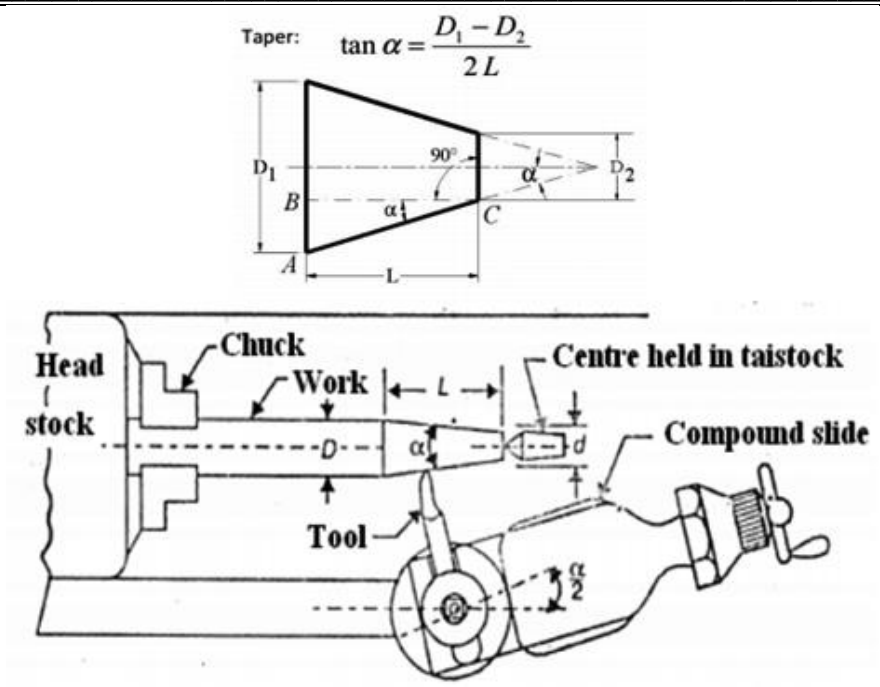
1) The answers should be examined by key words and not as word-to-word as given in the model answer scheme.
2) The model answer and the answer written by candidate may vary but the examiner may try to assess the understanding level of the candidate.
3) The language errors such as grammatical, spelling 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 judgement 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.

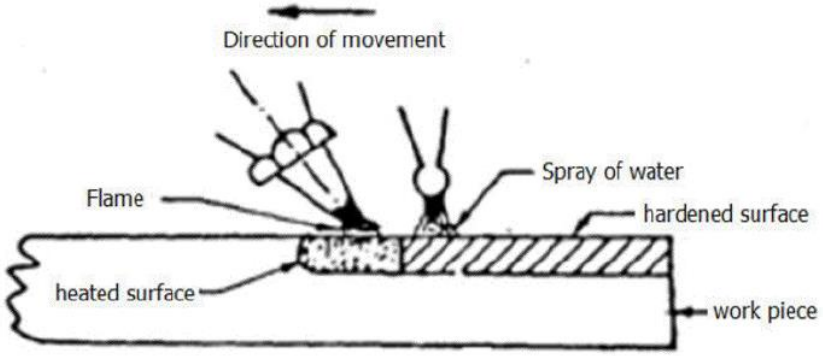
Q. No.	Sub Q. N.	Answer	Marking Scheme
01		**Attempt any FIVE of the following**	**10**
	a)	**List four types of cast iron.**	**2**
	Ans:	Types of Cast Iron: *(Any four ½ mark each)* 1. Gray Cast Iron 2. White Cast Iron 3. Malleable Cast Iron 4. Ductile Cast Iron 5. Nodular cast iron 6. Meehanite cast iron	*Any four ½ mark each*
	b)	**State two purposes of heat treatment.**	**2**
	Ans:	Purposes of Heat treatment: *(Any two 1 mark each)* ❖ Improve machinability ❖ Relieve the internal stresses ❖ Improve mechanical properties such as ductility, strength, hardness, toughness, etc. ❖ Change in grain size ❖ Increase resistance to heat and corrosion ❖ Modify electrical and magnetic properties. ❖ Change in chemical composition ❖ Remove gases	*Any two 1 mark each*
	c)	**Define the term casting.**	**2**
	Ans:	Casting means pouring molten metal poured into a refractory mold cavity and allows it to solidify. The solidified object is taken out from the mold either by breaking or taking the mold apart. The solidified object is called casting. The technique followed in method is known as casting process.	**02**
	d)	**State the four properties of cutting fluids.**	**2**

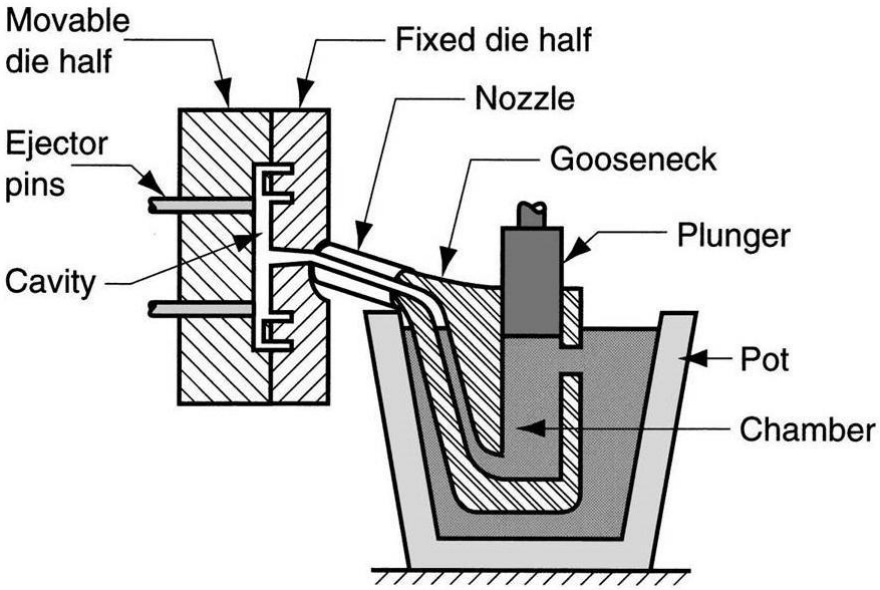
	Ans:	Properties of cutting fluid: *(Any four ½ mark each)* 1. High heat absorption 2. Good lubricating qualities to produce low coefficient of friction 3. Low viscosity to permit free flow of liquid 4. Non-corrosive to the work or the machine 5. High flash point so as the eliminate the hazards of fire 6. Odourless, so as not to produce any bad smell 7. Harmless to the skin of operator 8. Transparency so that the cutting action of the tool may be observed	*Any four ½ mark each*
	e)	**Enlist different types of chips formed during machining**	**2**
	Ans:	Different types of chips: 1. Discontinuous or segmental chips 2. Continuous chips 3. Continuous chips with built-up edge (BUE) 4. Non homogeneous chip	**02**
	f)	**List the main four parts of a lathe**	**2**
	Ans:	Parts of Lathe Machines are as follows : *(Any four ½ mark each)* 1. Bed 2. Head stock 3. Carriage 4. Main spindle 5. Tailstock 6. Tool post 7. Compound Rest 8. Cross slide 9. Saddle.	*Any four ½ mark each*
	g)	**State four operations performed by the lathe.**	
	Ans:	Operations performed on lathe machine *(Any four ½ mark each)* 1. Facing, 2. Plain turning, 3. Step turning, 4. Taper turning, 5. Drilling, 6. Reaming, 7. Boring, 8. Undercutting, 9. Threading, 10. Knurling	*Any four ½ mark each*
02		**Attempt any THREE of the following**	**12**
	a)	**Describe plain carbon steel with its application.**	**4**
		Plain carbon Steel: *(Description 2 Marks, Application 2 Marks)* Plain-carbon steel or Carbon steel is a metal alloy. It is a combination of two elements, iron and carbon. Other elements are present in quantities too small to affect its properties. The only other elements allowed in plain-carbon steel are: manganese (1.65% max), silicon (0.60% max), and copper (0.60%	**02**

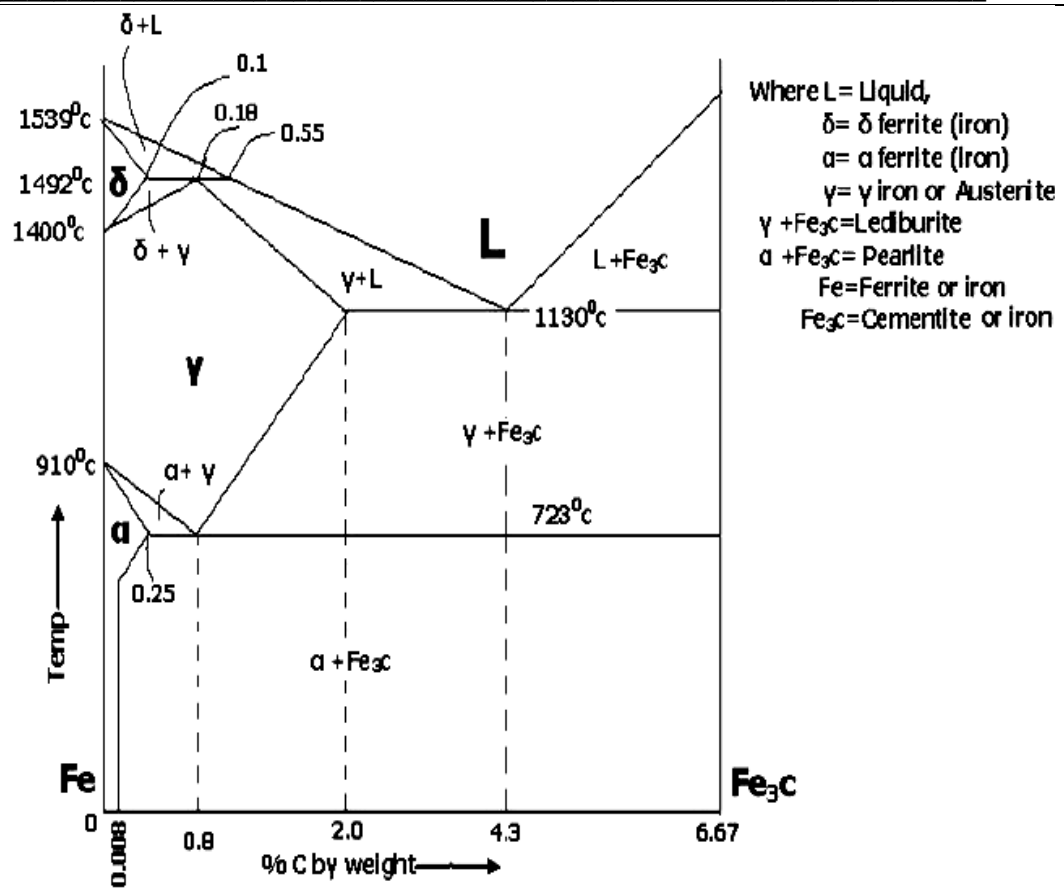
		max). Steel with low carbon content has the same properties as iron, soft but easily formed. With more carbon the metal gains hardness and strength but becomes less ductile and more difficult to weld. Higher carbon content lowers steel's melting point and its temperature resistance. **Applications of Plain Carbon steel** (any four ½ mark each) Building bars, grills, beams, angles, channels, bolts, axles, lock washers, large forging dies, springs, wires, wheel spokes, hammers, rods, turbine rotors, crank pins, cylinder liners, railway rails ,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.	**02**
	b)	**Describe the normalizing process with its purpose.**	**4**
	Ans:	*(Description 2 Marks, Purposes 2 Marks)* **Normalizing:** Normalizing is the heat treatment which involves heating of the given steel to "austenite temperature range" holding it and there after cooling to room temperature at slow rate of cooling, generally "Air cooling". A typical normalizing process involves following steps, 1. **Heating of steel:** The steel, depending upon its type is heated to the normalizing temperature range. For plain carbon steel this range is, ➢ Ac3 + 50 for hypo eutectoid steels. ➢ Ac1 + 50 for eutectoid steel. ➢ Acm + 50 for hyper eutectoid steels. For various alloy steels the normalizing temperature range is around 780 to 850 ^{0}c, depending upon the type of steels . **2. Holding of steel:** The steel is kept at this normalizing temperature for some time for equalization of temperature depending upon the weight and area of steel part. **3. Cooling of steel:** The steel is cooled from this normalizing temperature to room temperature with a slow rate of cooling in the "Air". Here the austenite in the steel is transformed into the "fine pearlite structure". The air cooling used may be still air cooling or Forced air cooling. **Purposes:** • To eliminate coarse grained structure. • To reduce segregation. • To refine grain structure. • To produce harder and stronger steel than annealing. • To obtain required mechanical properties. • To relieve internal stresses in some cases.	**02** **02**
	c)	**Explain sweep mounding with sketch**	**4**

	Ans:	**Sweep mounding** *(Description 2 Marks, Figure 2 Marks)* Sweep mouldings are employed for moulding parts whose shape is that of a surface of revolution. A base 1 and spindle 2 is well placed in the foundry floor. The sand is filled in and rammed until the excavation forms approximately the shape and size of the required casting. The sweep holder 5 is then placed in the spindle land and weep 6 is attached by bolts and nuts. The surface of the mold is produced by the profile of the sweep as it is rotated about the spindle as shown in fig (b). After sweeping, the spindle is removed and the mould patched at the centre. The gate is then cut and the mould is ready for pouring as shown in fig(c)  Fig (a) Fig(b) Fig (c)	**02** **02**
	d)	**Explain the taper turning method by swiveling the compound rest method.**	**4**
	Ans:	*(Description -2 marks,sketch-2 Marks)* **Taper turning by swiveling compound rest:** Figure below shows the arrangement made for the taper turning 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. Following formula is used for calculation of taper turning.	**02**

		 Figure: Taper turning method by swiveling the compound rest	**02**
03		**Attempt any THREE of the following:**	**12**
	a)	**Describe thermoplastic with its properties.**	**04**
		Answer: **Thermoplastic:** These are composed of linear and long chain straight or slightly branched molecules. They can be resoftened and remelted by application of heat and pressure. The materials which can be remelted to manufacture fresh new products are called as thermoplastics **Properties** *(Any four 1/2 mark each)* 1) They are highly plastic 2) They are easily moulded or shaped. 3) They have low melting point 4) As they can be repeatedly used so they have good resale value 5) Relatively soft and ductile i.e not more stronger and harder 6) Cannot be used at high temperature as they tend to soft under heat 7) Usually soluble in some organic solvents.	**02** **02**
	b)	Identify the properties of material used for connecting rod with justification	**04**
		Answer: 1. There are some materials that are commonly used in connecting rods such as alloys of steel, aluminum and titanium. Mostly connecting rods are made by forged steel. It is widely use because it has high tensile and compressive strength.	

		2. Titanium is used in making connecting rods, since very long time but when it comes to lightweight of connecting rod, aluminum is preferred. Titanium is the most costly material among steel and aluminum. Another demerit of titanium is their fatigue life. Aluminum is also used for a long time. 3. Most of the connecting rods are made of steel but aluminum can also be used to manufacture connecting rods because of its light weight and it can also absorb high impact shock but its durability will be suffered. Titanium can also be used because it has good strength but it is expensive. 4. When the carbon steel material of connecting rod is replaced with aluminum 360 it has been found that the weight of aluminum 360 connecting rod is 4 times lighter than carbon steel. It is because density of Al360 is very less compared to carbon steel	**04**
	c)	Explain Flame hardening process with neat sketch	**04**
	Ams :	*(Note: Credit shall be given to the suitable sketch)* **Flame Hardening:** The surface to be case hardened is heated by means of an oxyacetylene torch for sufficient time and Quenching is achieved by sprays of water which are integrally connected with the heating device. The heating is generally accomplished for sufficient time so as to raise the temperature of the surface of the specimen above the critical temperature. As the temperature desired is achieved immediately, spraying of water is started. In mass production work, progressive surface hardening is carried out where it is arranged to have the flame in progress along with quenching.  **Fig: Principle of flame hardening**	**02** **02**
	d)	Explain hot chamber die casting process with neat sketch.	**04**
		Answer: Hot chamber die casting (Sketch 02 mark, Explanation 2 marks) 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, just below the plunger and the entrapped liquid metal is forced into the die through the gooseneck channel and in-gate . 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. Heating is continued throughout the operation to keep the molten metal sufficiently liquid.  **Figure: Hot chamber die casting**	**02** **02**
4		**Attempt any THREE of the following:**	**12**
	a)	**Identify the need of advanced materials in automobile sector**	**4**
		Answer: The general finding highlights the need for developing material systems methodology and for approaching research issues in terms of material life cycles. Improved materials and material processing can and must play a large role in generating productive and effective responses to the forces that will drive the automotive industry in future. For example : Aluminum alloys can be used to reduce vehicle weight, thereby reducing emissions and improving fuel economy, but the added materials costs currently offset these advantages for many applications. Material life cycle: Modeling of material system. Materials system research, Lightweight material for body structure.	**04**
	b)	**Illustrate Iron-Iron Carbide(Fe-Fe3C) diagram showing critical temperatures on it.**	**04**
	Ans:	**Answer:***(Credit should be given to suitable figure showing all details such as temperature percentage of carbon and state)*	



04

	c)	**Apply proper heat treatment process for manufacturing connecting rod of an engine.**	**04**
		Answer: The connecting rod may either be cast or forged when created and may also include allowable secondary alloy elements. The normalizing step includes heating a rough connecting rod to an austenite transformation temperature and holding the connecting rod above the austenite transformation temperature until the rough connecting rod is substantially completely austenitized. The connecting rod is then air cooled to create a part with a BCC structure having two structure phases composed of alternating plates of alpha-ferrite and iron carbide. The induction hardening step is accomplished by energizing at least one electrical coil and bringing an electrical coil into functional proximity with an end of a connecting rod. The end of the connecting rod is heated above the austenitic temperature and quenched. This quenching forms a martensitic structure in a limited area of the rod. The induction hardening step may be selectively imparted on a first, second or both ends of the connecting rod to provide a martensitic structure in either	**04**

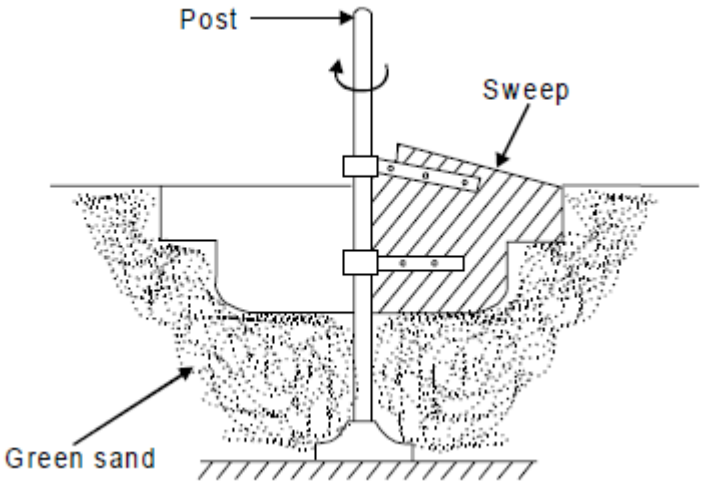
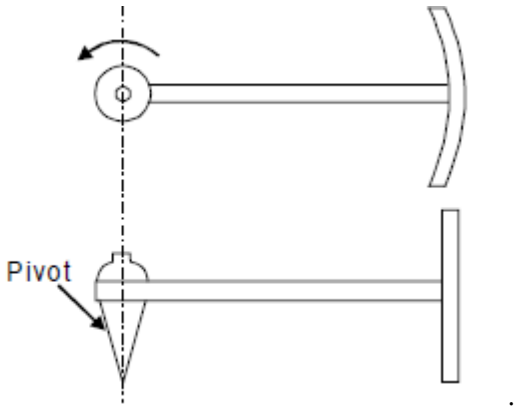
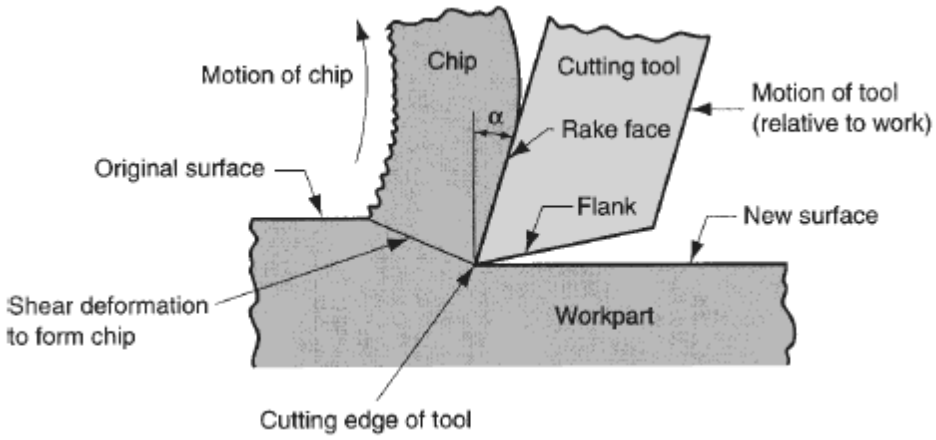
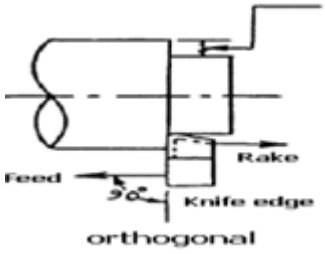
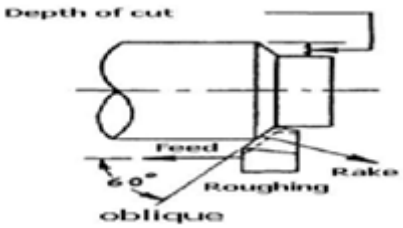
		or both ends of an exact size and of an exact location on the rod. The step of induction hardening creates a connecting rod with high hardness due to the martensitic transformation, not throughout the entire rod, but instead only where high hardness is required functionally.	
	d)	**Identify the causes of generating blow holes and misrun in casting and also suggest remedies to avoid them.**	**04**
		Answer: **1) Blowholes:** **Causess:** 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. **2)Misrun:** Causes: 1. Lack of fluidity ill molten metal. 2. Faulty design. 3. Faulty gating **Remedies :** □ Adjust proper pouring temperature □ Modify design □ Modify gating system.	**02** **02**
	e)	**Use suitable pattern for producing circular part in foundry.**	**04**
		Answer: **Sweep pattern:** Sweep patterns are used for forming large circular moulds of symmetric kind by revolving a sweep attached to a spindle as shown in Fig. Actually a sweep is a template of wood or metal and is attached to the spindle at one edge and the other edge has a contour depending upon the desired shape of the mould. The pivot end is attached to a stake of metal in the center of the mould.  	**02** **02**

		Figure:Sweep pattern: **Segmental pattern** Patterns of this type are generally used for circular castings, for example wheel rim, gear blank etc. Such at terns are sections of a pattern so arranged as to form a complete mould by being moved to form each section of the mould. The movement of segmental pattern is guided by the use of a central pivot. A segment pattern for a wheel rim is shown in fig.  	**OR** **02** **02**
5		**Attempt any TWO of the following**	**12**
	a)	Describe the mechanism of chip formation during metal cutting with the help of sketch.	06
		Mechanism of chip formation (Description – 3 Mark, sketch – 3 Mark) In Fig. the tool is considered stationary, and the work piece moves to the right. The metal is severely compressed in the area in front of the cutting tool. This causes high temperature shear and plastic flow if the metal is ductile. When the stress in the work piece just ahead of the cutting tool reaches a value exceeding the ultimate strength of the metal, particles will shear to form a chip element which moves up along the face of the work. The outward or shearing movement of each successive element is arrested by work hardening and the movement transferred to the next element. The process is repetitive and a chip is formed.  Figure :- Mechanism of chip formation	03 03

	b)	Differentiate between orthogonal and oblique cutting with sketch.	06

Answera: (Any six points 06 marks)

	Orthogonal cutting	Oblique cutting
1	The cutting edge of the tool is perpendicular to the cutting velocity factor.	The cutting edge is inclined at an angle with the current velocity factor.
2	The cutting edge clears the width of the workpiece on either ends.	The cutting edge may not clears the width of the workpiece on either ends.
3	The chip flows over tool face.	The chip flows on the tool face.
4	Only two components of the cutting forces are acting on the tool.	Onlt three components of the cutting forces are acting on the tool.
5	Tool is perfectly sharp.	Tool is not perfectly sharp.
6	Tool contacts the chip on rake face only.	The tool may not generate a surface paralel to workpiece.
7	Relatively short tool life	Longer tool life.
8	Only one cutting edge in action.	More than one cutting edges are in action.
9		

6

	c)	Write the suitable cutter for carrying following operations on milling machine (i) Gear Tooth (ii) Parting off (iii) Keyway (iv) V-grooves	06

		(v) Rounding of corner (vi) Cutting of narrow slot and groove	
	Ans:	(i) Gear Tooth : Form milling cutter, Cylindrical type or End mill type, Gear cutter. (ii) Parting off: Slitting Cutter (iii) Keyway : Staggered teeth side milling cutter, End mill cutter, key way cutter (iv) V-grooves : Angular milling cutter (v) Rounding of corner : Profile milling cutter, Formed cutter, Corner Rounding Milling Cutters. (vi) Cutting of narrow slot and groove : Slot milling operation can use any type of milling cutter like plain milling cutter, metal slitting saw or side milling cutter. Selection of a cutter depends upon type and size of slot or groove to be produced.	01 01 01 01 01 01
6		Attempt any TWO of the following	12
	a)	Describe the single point cutting tool with nomenclature.	06
		(Sketch 03 marks and description 03 marks) **Terminology used in Single Point Cutting Tool:** **Size:** It is determined by the width of shank, height of shank and overall length. **Shank:** Shank is main body of a tool. It is held in a holder. **Flank :** Flank is the surface or surfaces below and adjacent to cutting edge. **Heel :** Heel is intersection of the flank and base of the tool. **Base :** Base is the bottom part of the shank. It takes the tangential force of cutting. **Face :** Face is surface of tool on which chip impinges when separated from workpiece. **Cutting Edge:** Cutting edge is the edge of that face which separates chip from the workpiece. The total cutting edge consists of side cutting edge, the nose and end cutting edge.	03

Tool Point

That part of tool, which is shaped to produce the cutting edge and the face.

The Nose

It is the intersection of side cutting edge and end cutting edge.

Neck

Neck is the small cross section behind the point.

Side Cutting Edge Angle :

The angle between side cutting edge and side of the tool shank is called side cutting edge angle. It is also called as lead angle or principle cutting angle.

End Cutting Edge Angle :

The angle between the end cutting edge and a line perpendicular to the shank of tool is called end cutting edge angle.

Side Relief Angle :

The angle between the portion of the side flank immediately below the side cutting edge and line perpendicular to the base of tool measured at right angles to the side flank is known as side relief angle. It is the angle that prevents interference, as the tool enters the work material.

End Relief Angle :

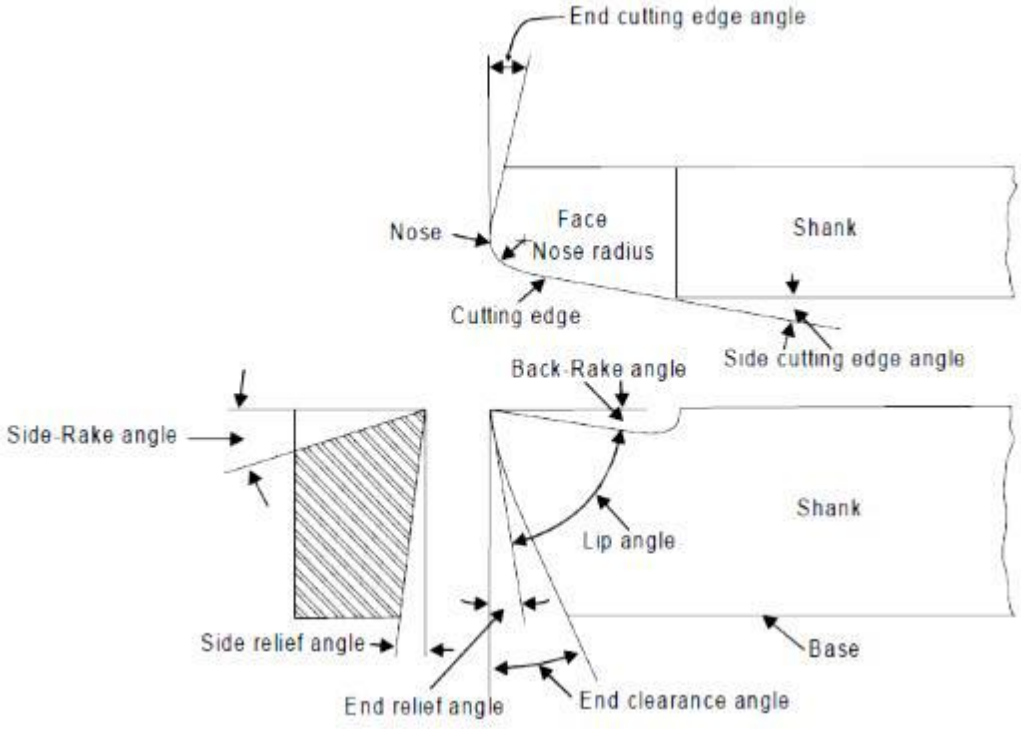
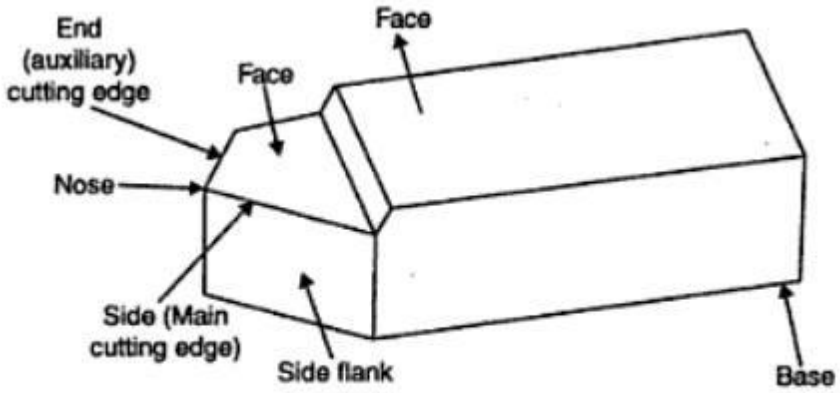
End relief angle is the angle between the portion of the end flank immediately below the end cutting edge and the line perpendicular to the base of tool, measured at right angles to end flank. It is the angle that allows the tool to cut without rubbing on the workpiece.

Back Rake Angle :

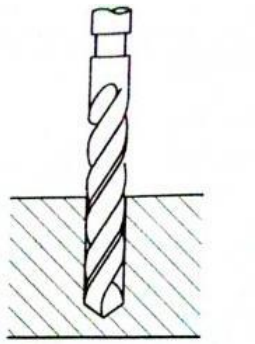
The angle between face of the tool and a line parallel with the base of the tool, measured in a perpendicular plane through the side cutting edge is called back rake angle. It is the angle which measures the slope of the face of the tool from the nose toward the rear. If the slope is downward toward the nose, it is negative back rake angle. And if the slope is downward from the nose, it is positive back rake angle. If there is not any slope, back rake angle is zero.

Side Rake Angle:

The angle between the face of the tool and a line parallel with the base of the tool, measured in a plane perpendicular to the base and side cutting edge is called side rake angle. It is the angle that measures the slope of the tool face from cutting edge. If the slope is towards the cutting edge, it is negative side rake angle. If the slope is away from the cutting edge, it is positive side rake angle.

		 **OR**  (*a*) Elements of a Single Point Tool	03
	b)	Choose proper machine tool and explain operation method for the following: (i) Producing a hole (ii) Finishing previously drilled hole	06
		MACHINE TOOL : Drilling Machine (i) Producing a hole: **Drilling operation (Fig 1 mark ,explanation 2 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. — 02



Drilling Operation — 01

(ii) Finishing previously drilled hole:

Reaming operation (Fig 1 mark ,explanation 2 marks) : 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 — 02

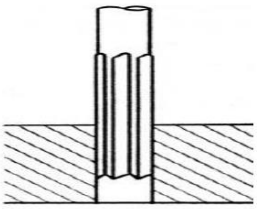


Figure :- Reaming — 01

OR

MACHINE TOOL: Lathe Machine

(i) Producing a hole:

Drilling Operation:

It is an operation of making a hole in a workpiece with the help of a drill. In this operation, as shown in Fig. 01, the workpiece is held in a chuck and the drill is held in the tailstock. The drill is fed manually, into the rotating workpiece, by rotating the

tailstock hand wheel.

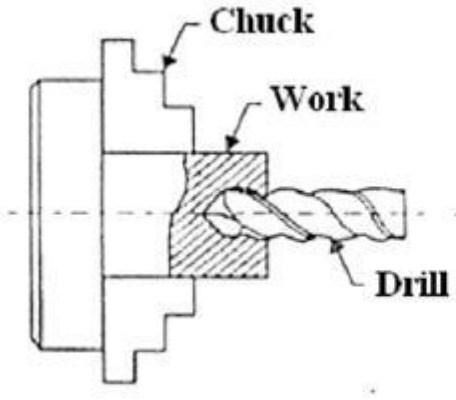


Fig. 01 Drilling Operation

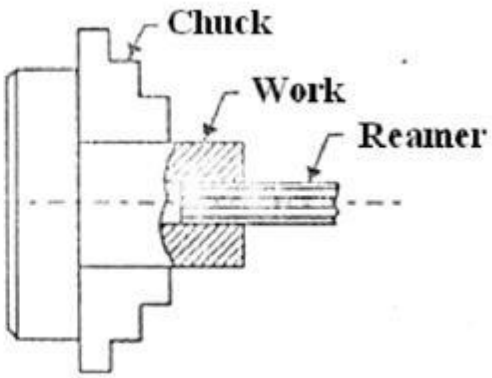


Fig. 02 Reaming Operation

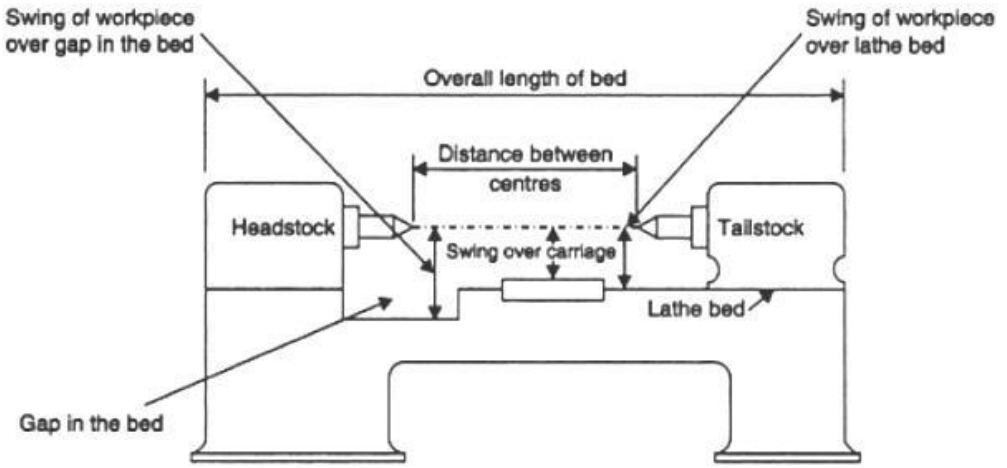
(i) Finishing previously drilled hole

Reaming Operation:

It is an operation of finishing the previously drilled hole. In this operation, as shown in Fig.02, a reamer is held in the tailstock and it is fed into the hole in the similar way as for drilling.

c) Describe with neat sketch specification of lathe machine.

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.
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.


Swing of workpiece over gap in the bed
Swing of workpiece over lathe bed
Overall length of bed
Distance between centres
Headstock
Tailstock
Swing over carriage
Lathe bed
Gap in the bed