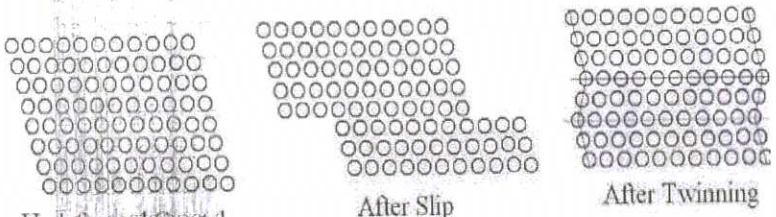
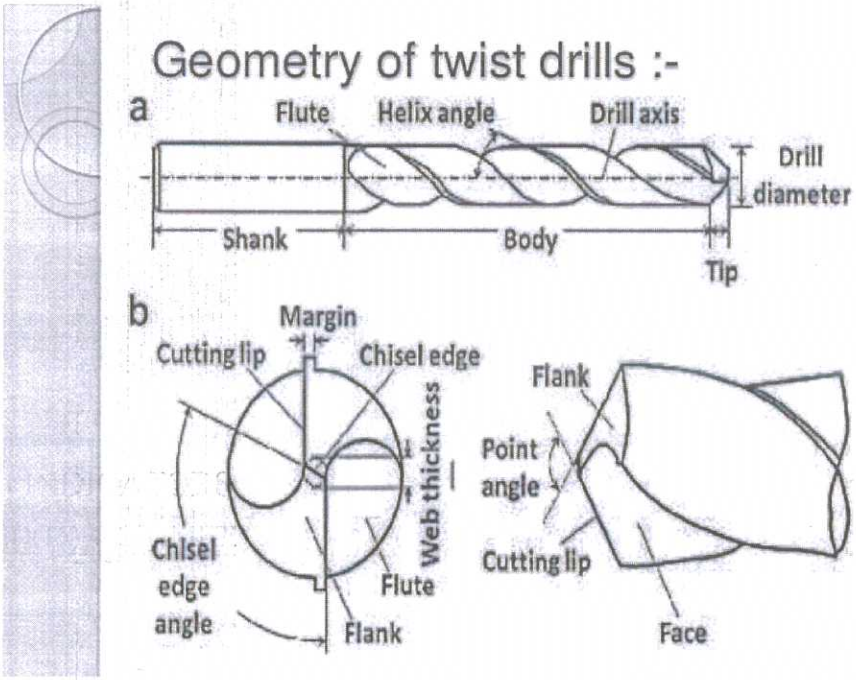
CORING INDICATORS

ODE : TED(15) 4023 METALLURGY AND MACHINE TOOLS VERSION :A

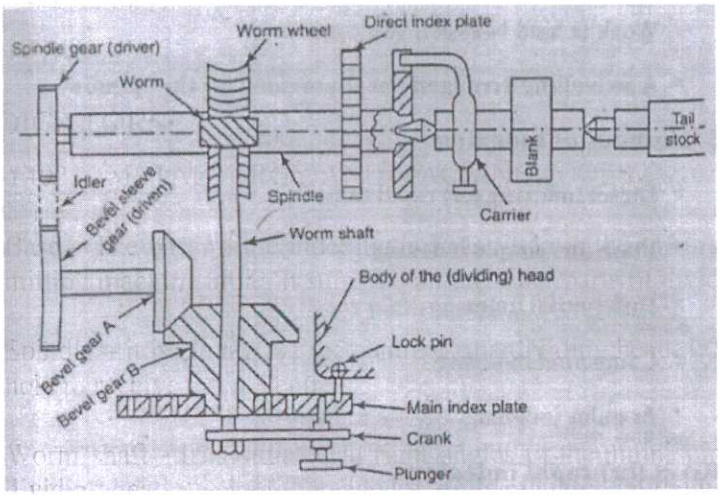
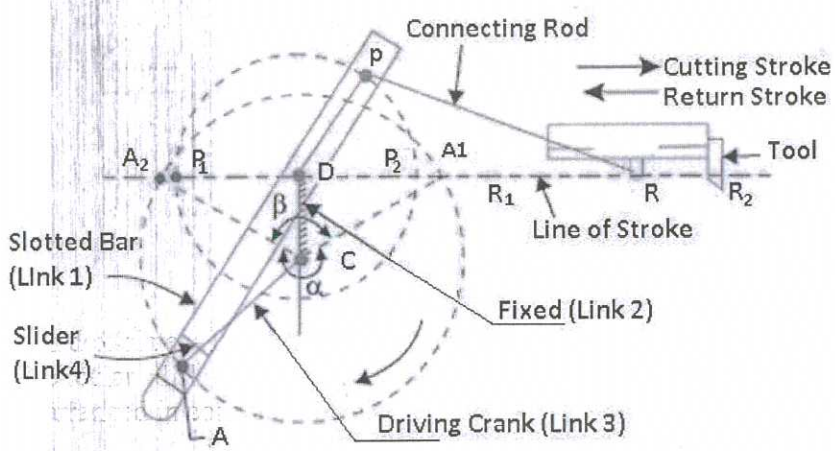
Qn No.	Scoring indicators	Split up score	Total Score
	PART - A		
I.1	➢ 1) Part to part uniformity for improved product quality. ➢ 2) Shape and material flexibility. ➢ 3) Application versatility. ➢ 4) Cost effectiveness	2	2
I.2	➢ Back rake angle is the angle between the face of the single point cutting tool and a line parallel with base of the tool measured in a perpendicular plane through the side cutting edge.	2	2
I.3	➢ By directly fitting in the spindle ➢ By a sleeve ➢ By a socket ➢ By a chuck ➢ Tapping attachment	2	2
I.4	➢ Clapper box carries the tool holder. The main function of the clapper box is to provide clearance for tool in return stroke. It prevents the cutting edge dragging the work piece while return stroke and prevent the tool from wear.	2	2
I.5	➢ Length of stroke. ➢ Length and width of table. ➢ Distance between Columns. ➢ Cutting speed. ➢ Method of drive.	2	2
	PART - B		
II.1	➢ It is the process of hardening the surface of a metal object while allowing the metal deeper underneath to remain soft, thus forming a thin layer of harder metal at the surface. ➢ 1) Flame or induction hardening:- It is in which the surface of the steel is heated very rapidly to high temperatures by direct application of an oxy gas flame, or by induction hardening then cooled rapidly, generally using water; this creates a "case" of martensite on the surface ➢ 2) Carburising:- In this process steel is introduced to a carbon rich environment and elevated temperatures for a certain amount of time, and then quenched so that the carbon is locked in the structure ➢ 3) Nitriding:- Nitriding heats the steel part to 482–621 °C in an atmosphere of ammonia gas and dissociated ammonia ➢ 4)Cynaiding:- It is mainly used on low-carbon steels. The part is heated to 871-954 °C in a bath of sodium cynaide and then is quenched and rinsed, in water or oil, to remove any residual cyanide	1 mark for each max 6 marks	6

	5) Carbonitriding :- In this process a gaseous atmosphere of ammonia and hydrocarbons is used instead of sodium cyanide. If the part is to be quenched, it is heated to 775–885 °C . if not, then the part is heated to 649–788 °C .		
II.2	➢ Slip is defined as that mechanism of deformation where in one part of the crystal moves/ slips over another part along certain planes known as slip plane. Slip due to pure shearing stresses that are acting across the specimen irrespective of whether the crystal is subjected to tensile/ compressive stresses. ➢ In twinning each plane of atoms move through a definite distance and in the same direction. The extent of movement of each plane is proportional to its distance from the twining plane, as shown in fig. The distance moved by each successive atomic plane is greater than the previous plane by a few atomic spacings. When a shear stress is applied the crystal will twin about the twinning plane in such a way that the region to the left of the twinning plane is not deformed where as the region to the right is deformed. The atomic arrangement on either side of the twinned plane is in such a way they are mirror reflections of each other. Twins are known as anneling twins when they are produced during annealing heat treatment and mechanical twins when they are produced by mechanical deformation of metals.  Undeformed Crystal After Slip After Twinning	4 marks for explanation and 2 marks for sketch	6
II.3	➢ Cutting speed is defined as the speed at which the work moves with respect to the tool and is usually measured in feet per minute. The proper cutting speed for a given job depends upon the hardness of the material being machined, the material of the tool bit, and how much feed and depth of cut is required. Cutting speeds for metal are usually expressed in surface feet per minute, measured on the circumference of the work. ➢ Feed rate is defined as the distance the tool travels during one revolution of the part. Cutting speed and feed determines the surface finish, power requirements, and material removal rate. ➢ Depth of cut is the distance that the tool bit moves into the work	2 marks each	6

II.4	S. No.	Orthogonal Cutting	Oblique Cutting	1 mark for each max 6 marks / 6
	1.	The cutting angle of tool make right angle to the direction of motion.	The cutting angle of tool foes not make right angle to the direction of motion.	
	2	The chip flow in the direction normal to the cutting edge.	The chips make an angle with the normal to the cutting edge.	
	3.	In orthogonal cutting only two components of force considered cutting force and thrust force which can be represent by 2D coordinate system.	In oblique cutting three component of force are considered, cutting force, thrust force and radial force which cannot represent by 2D coordinate. It used 3D coordinate to represent the forces acting during cutting, so it is known as 3D cutting.	
	4.	This tool has lesser cutting life compare to oblique cutting.	This tool has higher cutting life.	
	5.	The shear force act per unit area is high which increase the heat developed per unit area.	The shear force per unit area is low, which decreases heat develop per unit area hence increases tool life.	
	6	The chips flow over the tool.	The chips flow along the sideways	
II.5	➢ Tang - The flattened end of the taper shank is known as tang. It is meant to fit into a slot in the spindle or socket. ➢ Neck –It is the part of the drill, which is diametrically undercut between the body and the shank of the drill. The size of the drill is marked on the neck ➢ Land – It s the cylindrically ground surface on the leading edges of the drill flutes adjacent to the body clearance surface. The alignment of the drill is maintained by the land.			3 marks for explanation and 3 marks sketch / 6

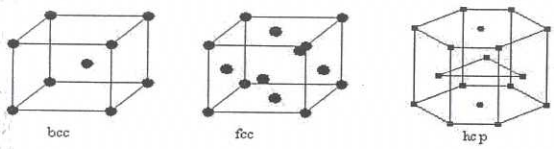


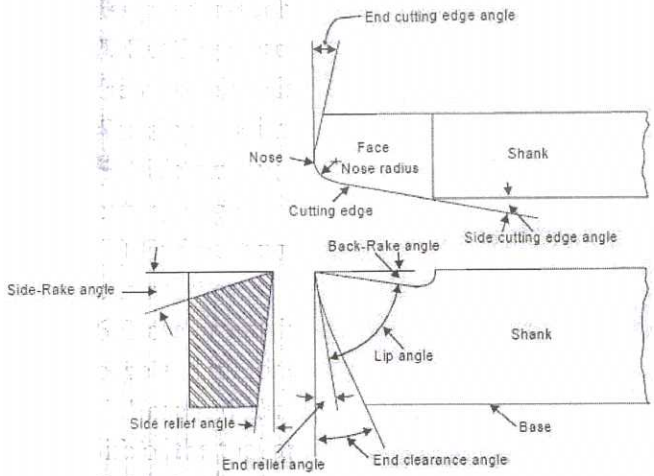
- Axis –It is the longitudinal centerline of the drill running through the centers of the tang and the chisel edge.
- Shank –It is the part of the drill by which it is held and driven. It is found just above the body of the drill. The shank may be straight or taper. The shank of the drill can be fitted directly into the spindle or by a tool holding device
- Body –It is the part of the drill from its extreme point to the commencement of the neck, if present. Otherwise, it is the part extending unto the commencement of the shank. Helical grooves are cut on the body of the drill.

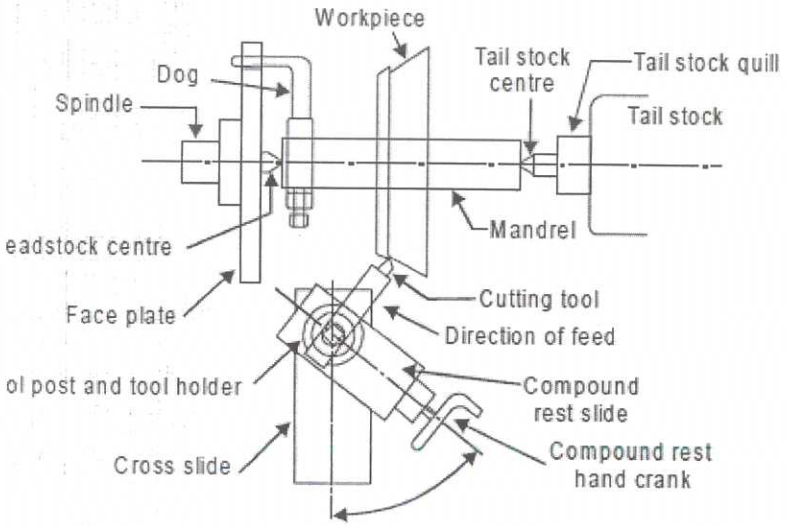
II.6	➢ Base – The base of the indexing head is fitted in the 'T' – slots of the milling machine table. It supports all the other parts of dividing head ➢ Spindle – it is situated at the centre of the dividing head. It has a taper hole to receive a live centre ➢ Worm shaft - It is situated at right angles to the main spindle of the dividing head. A single threaded wormis mounted on the worm shaft, which meshes with the worm.  ➢ Index plate – It is mounted on the front end of the worm shaft. It is a circular disk having different numbers of equally spaced holes arranged in concentric circles. ➢ Driven shaft – it is parallel to the spindle and perpendicular to the worm shaft.	3 marks for explanation and 3 marks sketch	6
II.7	 ➢ The Whitworth quick return mechanism converts rotary motion into reciprocating motion, but unlike the crank and slider, the forward reciprocating motion is slower rate than the return stroke. This is why	3 marks for Explanation and 3 marks for sketch	6

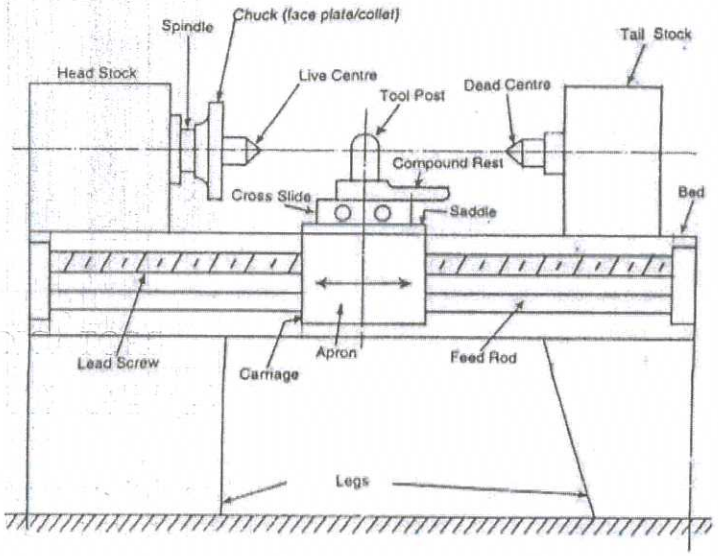
	it is called quick return mechanism ➢ When the driving crank CA moves from the point CA1 to CA2. (or the link DP from the point DP1 to DP2) through an angle α in the clockwise direction, the tool moves from the left hand end of its stroke to the right hand end by a distance 2 PD. ➢ Now when the driving crank moves from the point CA2 to CA1. (or the link DP from DP2 to DP1) through an angle β in the clockwise direction, the tool moves back from the right-hand end of its stroke to the left-hand end ➢ Similarly, the time needed during the right to left movement of the ram (or during the idle or return stroke) will be equal to the time taken by the driving crank to move from CA2 to CA1. ➢ Since the crank link CA rotates at uniform angular velocity, thus, the time taken during the cutting stroke (or forward stroke) is more than the time taken during the return stroke		
	PART - C		
	UNIT - I		
III.a	➢ Power production:Numerous processes can produce metallic powders: grinding, electro deposition, comminution, atomization, chemical reduction, etc. In atomization, a liquid metal stream produced by injecting molten metal through a small orifice and the steam is broken up by jets of inert gas, air or water. The powder is also produced by reduction of metal oxides using hydrogen or carbon monoxide, as reducing agents. Mechanical comminution involves crushing, milling in a ball mill or grinding brittle or less ductile metals into small particles. ➢ Powder Mixing: The process of mixing includes mixing of various metal powders are thoroughly intermingled. This is carried out in batch mixers. The temperature during mixing affects the friction between powder particles. ➢ Compacting :- A controlled amount of the mixed powder is introduced into a precision die, and then it is pressed or compacted at room temperature and pressure in the range 100 Mpa to 1000 Mpa. In doing so, the loose powder is consolidated and densified into a shaped model. The model is called green compact. As it comes out of the die, the compact has the size and shape of the finished product. The strength of the compact is just sufficient for in-process handling and transportation to the sintering furnace. ➢ Sintering :- Sintering involves heating of the green compact in a protective atmosphere furnace to a suitable temperature below the melting point of the metal. Typical sintering atmospheres are endothermic gas, exothermic gas, dissociated ammonia, hydrogen, and nitrogen. Sintering is responsible for producing physical	2 marks each max 8 marks	8

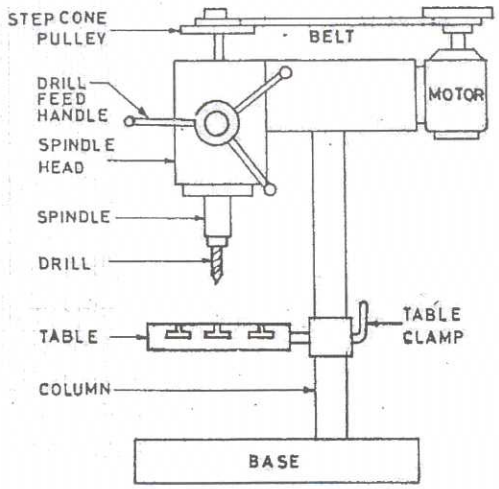
	properties developing a metallurgical bond among the powder particles. It also serves to remove the lubricant from the powder, prevents oxidation, and controls carbon content in part.		
III.b	➢ Annealing is a method of heat treatment that usually alters physical properties and at times the chemical properties of the material when exposed to heat. In the annealing process, the material is first heated beyond its critical point/recrystallization temperature and is being held at this temperature for a while before cooling it. This is usually done when the material's hardness needs to be reduced in order to make it easily mouldable. Annealing also increases the ductility of a material. Ductility is the ability of a material to deform under tension making it softer and easier to handle. The cooling process is usually done at a slow pace by letting the material cool in air, or it can be also done much quicker by quenching it in water. ➢ Normalizing is another type of heat treatment, applied specifically to alloys made from Iron, in order to achieve a uniform grain size. It is actually considered as atype of annealing which is only done for Ferrous or Iron alloys. In the normalizing process, the metal/alloy is heated to a temperature above the critical point and then is cooled in air. In this case, it is important to cool it slowly in the air rather than quenching it in the water like for the other metals. This step helps to get a uniform grain size throughout the alloy. However, normalizing produces less ductile alloys in contrast to a full annealing process	max 7 marks	7
	OR		
IV.a	➢ Cementite :- A fixed amount of carbon and a fixed amount of iron are needed to form cementite. Its chemical formula is Fe_3C. It contains 6.67 percent carbon by weight. It is a hard and brittle interstitial compound of low tensile strength , but high compressive strength. Its crystal structure is orthorhombic. It is the hardest structure that appears on the iron-iron carbide diagram. ➢ Austenite :- Austenite is the name given to the Î³ solid solution. It is an interstitial solid solution of carbon dissolved in Î³ iron having a face centered cubic (f.c.c.) crystal structure. Maximum solubility is 2 percent carbon at 2065Â°F . ➢ Pearlite :- It is the eutectoid mixture containing 0.80 % carbon and is formed at 1333Â°F on very slow cooling. It is a very fine plate like or lamellar mixture of ferrite and cementite. The structure of pearlite includes a white matrix which includes thin plates of cementite (black). ➢ Ledeburite : -. It is the eutectic mixture of austenite and cementite. It contains 4.3 percent carbon and is formed at 2065Â°F . It exists when	Max 8 marks	8

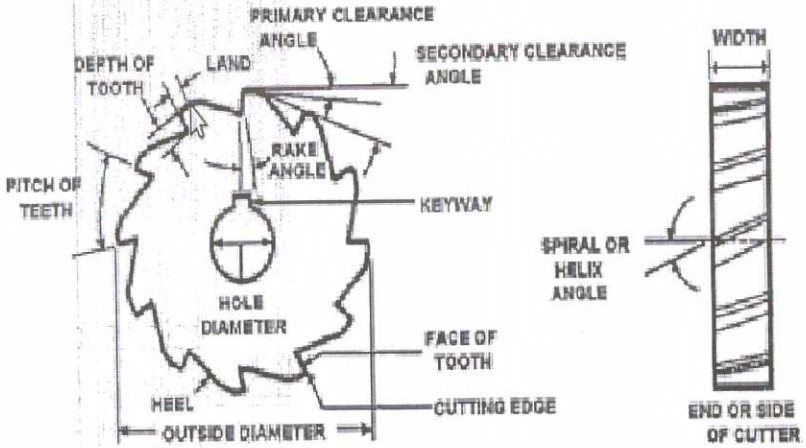
	the carbon content is greater than 2%, which represents the dividing line on the equilibrium diagram between steel and cast iron. ➢ Ferrite :- Ferrite is the name given to the Î± solid solution. It is an interstitial solid solution of a small amount of carbon dissolved in Î± iron having a body centered cubic (b.c.c.) crystal structure. The maximum solubility is 0.025 percent carbon at 1333Â°F , and it dissolves only 0.008 percent carbon at room temperature. It is the softest structure on the iron-iron carbide diagram		
IV.b	➢ The body-centered cubic unit cell has atoms at each of the eight corners of a cube plus one atom in the center of the cube. Each of the corner atoms is the corner of another cube so the corner atoms are shared among eight unit cells. It is said to have a coordination number of 8. The bcc unit cell consists of a net total of two atoms; one in the center and eight eighths from corners atoms . ➢ The face centered cubic structure has atoms located at each of the corners and the centers of all the cubic faces . Each of the corner atoms is the corner of another cube so the corner atoms are shared among eight unit cells. Additionally, each of its six face centered atoms is shared with an adjacent atom. Since 12 of its atoms are shared, it is said to have a coordination number of 12. The fcc unit cell consists of a net total of four atoms; eight eighths from corners atoms and six halves of the face atoms ➢ Another common close packed structure is the hexagonal close pack. The hexagonal structure of alternating layers is shifted so its atoms are aligned to the gaps of the preceding layer. The atoms from one layer nest themselves in the empty space between the atoms of the adjacent layer just like in the fcc structure. However, instead of being a cubic structure, the pattern is hexagonal.  bcc fcc hcp	2 marks for each explanation and 1 marks for sketch max 7 marks	7
	UNIT - II		
V.a	➢ **1. Shank:** It is that part of single point cutting tool which goes into the tool holder. Or in simple language shank is used to hold the tool. **2. Flank:** It is the surface below and adjacent of the cutting edges.	4 marks for Explanation and 4 marks for sketch	8

	There are two flank surfaces, first one is major flank and second one is minor flank. The major flank lies below and adjacent to the side cutting edge and the minor flank surface lies below and adjacent to the end cutting edge. **3. Base:** The portion of the shank that lies opposite to the top face of the shank is called base. **4. Face:** It is the top portion of the tool along which chips slides. It is designed in such a way that the chips slides on it in upward direction. **5. Cutting edge:** The edge on the tool which removes materials from the work piece is called cutting edges. It lies on the face of the tool. The single point cutting tool has two edges and these are **(i) Side cutting edge:** The top edge of the major flank is called side cutting edge. **(ii) End cutting edge:** The top edge of the minor flank is called end cutting edge. **6. Nose or cutting point:** The intersection point of major cutting edge and minor cutting edge is called nose. **7. Nose radius:** It is the radius of the nose. Nose radius increases the life of the tool and provides better surface finish. **8. Heel:** It is a curved portion and intersection of the base and flank of tool.  		
V.b	➢ 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 to a circular base, graduated in degree, which may be swivelled and clamped at any desired angle. Once the compound rest is set at the desired half taper angle, rotation of the compound slide screw will cause the tool to be fed at that angle and generate a corresponding taper. The setting of the compound rest is done by	3 marks for Explanation and 4 marks for sketch	7

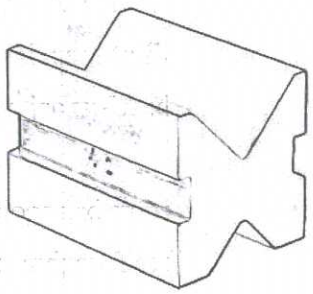
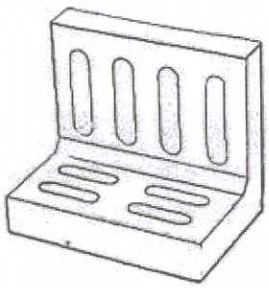
	swiveling the rest at half taper angle, if this is already known. If the diameter of the small and large end and Length of taper are known, the half taper angle can be calculated from the equation {Tan α = (D-d) / 2L}.  		
	OR		
VI.a	➢ **Bed :-** It is the main body of the machine. All main components are bolted on it. It is usually made by cast iron due to its high compressive strength and high lubrication quality. It is made by casting process and bolted on floor space. ➢ **Tool post :-** It is bolted on the carriage. It is used to hold the tool at correct position. Tool holder mounted on it. ➢ **Chuck :-** Chuck is used to hold the workspace. It is bolted on the spindle which rotates the chuck and work piece. It is four jaw and three jaw according to the requirement of machine. ➢ **Head stock :-** Head stock is the main body parts which are placed at left side of bed. It is serve as holding device for the gear chain, spindle, driving pulley etc. It is also made by cast iron. ➢ **Tail stock :-** Tail stock situated on bed. It is placed at right hand side of the bed. The main function of tail stock to support the job when required. It is also used to perform drilling operation ➢ **Lead screw :-** Lead screw is situated at the bottom side of bed which is used to move the carriage automatically during thread cutting ➢ **Carriage :-** It is situated between the head stock and tail stock. It is used to hold and move the tool post on the bed vertically and horizontally. It slides on the guide ways. Carriage is made by cast	4 marks for Explanation and 4 marks for sketch	8

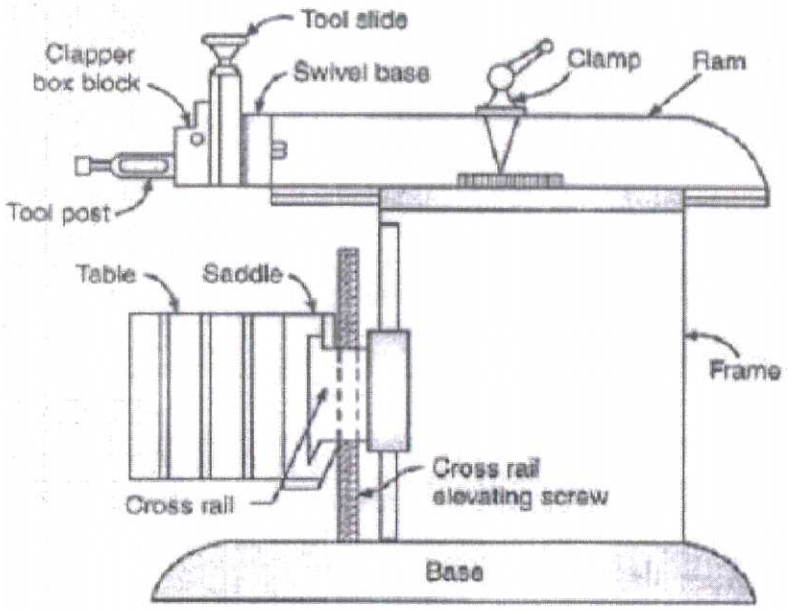
	iron. ➢ **Apron :-** It is situated on the carriage. It consist all controlling and moving mechanism of carriage.  		
VI.b	➢ Cutting fluids should have low viscosity to permit free flow of the liquid. ➢ It should posses good lubricating properties. ➢ It should have high specific heat, high heat conductivity and high heat transfer coefficient. ➢ It should be non-corrosive to work and machine. ➢ It should be non-toxic to operating person. ➢ It should stable in use and storage . ➢ It should permit clear view of the work operation.	One mark each max 7 marks.	7
	UNIT - III		
VII.a	➢ Base :- It is that part of the machine on which the verticle column is mounted. The base is made of casting. A base supports the column and worktable with other attachments. ➢ Column :- It is the vertical member of the machine which supports the table and the head containing all the driving mechanism. It is a cylindrical casting mounted vertically at one end of the base and supports the radial arm, which slides up and down. ➢ Table :- It is mounted on the column and is provided with T-slots for clamping the work directly on its face. A table is round or rectangular in shape. ➢ Radial Arm :- It is mounted on the column and extends horizontally	4 marks for Explanation and 4 marks for sketch	8

	over the base. It has guide-ways on which drill head slides. The radial arm moves around the column. ➢ Drill head :-It is mounted on the redial arm and drives the drill  *Fig.* spindle. In some of the drill machines, the drill head may be adjusted up or down for accommodating different heights of the work in addition to the table adjustment. ➢ Spindle speed and feed mechanism :- The motor at the top of the drill head drives the horizontal spindle and the motion is transmitted to the drill head through a group of bevel gears. With another group of gears, different spindle speed and feed are obtained.		
VII.b	➢ The operation of rotating the job through a required angle between two successive cuts is termed as indexing ➢ This is accomplished with the help of a milling attachment known as dividing head, which is an accessory to the milling machine. ➢ Direct Indexing: In this case, the dividing head has an index plate, fitted directly on the spindle. The intermediate use of worm and worm-wheel is avoided. The index plate has 24 holes and the periphery of job can be divided into 2, 3, 4, 6, 8 and 12 equal parts directly. This type indexing is most commonly used for indexing fixture. ➢ Simple or Plain Indexing: In this case, different index plates with varying number of holes are used to increase the range of indexing. The index is fixed in position by a pin called lockpin. The spindle is then rotated by rotating the handle which is keyed to the worm-shaft .The following relation is used for simple indexing: T = 40/N, where T gives the number of turns or parts of a turn through which the index crank must be rotated to obtain the required number of divisions (N)	7 Marks max	7

	on the job periphery.		
	OR		
VIII.a	 ➢ **Body of cutter**: It is the part of the cutter left after exclusion of the teeth. ➢ **Face**: The portion of the teeth next to the cutting edge is known as face. ➢ **Land**: The relieved back portion of the tooth adjacent to the cutting edge. It is relieved to avoid interference between the surface being machined and the cutter. ➢ **Outside diameter**: The diameter of the circle passing through the peripheral cutting edges. ➢ **Central hole**: It refers to the hole present at the centre of the cutter. A key way is cut inside the hole. ➢ **Relief angle**: It is angle the between the land of the tooth and the tangent to the outside diameter of the cutter at the cutting edge of the particular tooth. (approx 7.5 °) ➢ **Primary clearance angle**: It is the angle between the back of the tooth and the tangent drawn to the outside diameter of the cutter at the cutting edge. (approx 15 °)	4 marks for Explanation and 4 marks for sketch	8

	➢ **Secondary clearance angle**: It is the angle formed by the secondary clearance surface and the tangent to the periphery of the cutter at the cutting edge. ➢ **Rake angle**: The angle measured in the diametrical plane between the face of the tooth and a radial line passing through the cutting edge of the tooth.		
VIII. b	➢ Drilling is the operation of producing a cylindrical hole of required diameter and depth by removing metal by the rotating edge of a cutting tool called drill. ➢ Reaming is an accurate way of sizing and finishing a hole which has been previously drilled by a multi point cutting tool known as reamer. ➢ Boring is the operation enlarging the diameter of the previously made hole. ➢ Counter boring is the operation of enlarging the end of the hole cylindrically. ➢ Countersinking is the operation of making a cone shaped enlargement at the end of the hole. ➢ Spot facing is the operation of smoothing and squaring the surface around a hole. ➢ Tapping is the operation of cutting internal threads by means of a cutting tool called 'tap'.	One Mark each , max 7 marks	7
	UNIT - IV		

IX.a	➢ Bolts & Clamps :-Holding jobs directly to the table. ➢ Clamping blocks:-Holding the job tightly with the table. ➢ Shims:- A shim is a thin and often tapered or wedged piece of material, used to fill small gaps or spaces between objects. ➢ Planer jacks:-Used for supporting work piece with leveling it on table. ➢ Toe-dogs and stops :- It is used for holding thick work piece. ➢ Planer strips:- Used for holding uneven work pieces. ➢ V-blocks :- Used for holding round jobs and for machining flat surfaces ➢ Angle plates:- L shaped piece of Cast iron accurately machined to 90 degree. Used for holding the work piece at right angles so the next face can be machined.   Angle plates	One mark each , max 8 marks	8
IX.b	➢ In Shaper :-. In planer :- ➢ Used for small work pieces. Used for large work piece ➢ Tool is the moving part. Work is the moving part ➢ Work piece remain stationary. Tool remains stationary ➢ Light duty machine. Heavy duty machine ➢ One cutting tool at a time. More than one cutting tool ➢ Quick return mechanism to drive. Driven by hydraulic or gear ➢ Poor accuracy. Higher accuracy ➢ Low speed ,less productivity. Large productivity	One mark each , max 7 marks	7
	OR		

X.a	➢ Shaper Machine .  	5 marks for sketch and 3 marks for parts labeling	8
X.b	➢ Flat Surfaces Machining:- The external and internal flat surfaces may be generated on a workpiece easily in a slotter machine. The work to be machined is supported on parallel strips so that the tool will have clearance with the table when it is at the extreme downward position of the stroke ➢ Machining Circular Surfaces :- The external and internal surface of a cylinder can also be machined in a slotter machine. The work is placed centrally on the rotary table and packing pieces and clamps are used to hold the work securely on the table ➢ Machining Irregular Surfaces or Cams :- The work is set on the table and necessary adjustments of the tool and the machine are made as detailed in other operation. By combining cross, longitudinal and rotary feed movements of the table any contoured surface can be machined on a workpiece. ➢ Machining Grooves or Keyways :-Internal and external grooves are cut very conveniently machine. A slotter is specially intended for cutting internal grooves which are difficult to produce in other machines	Max 7 marks	7