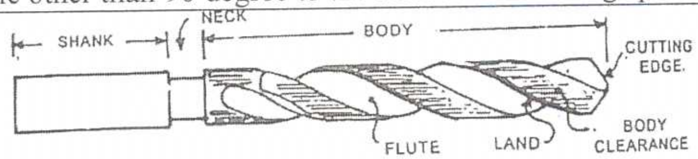
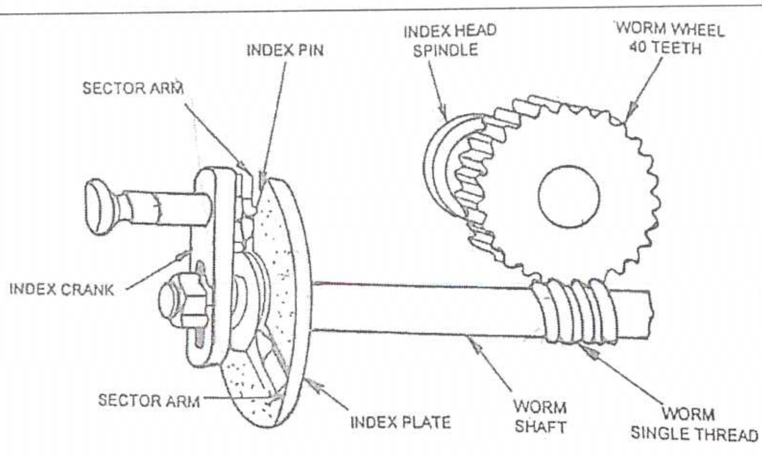
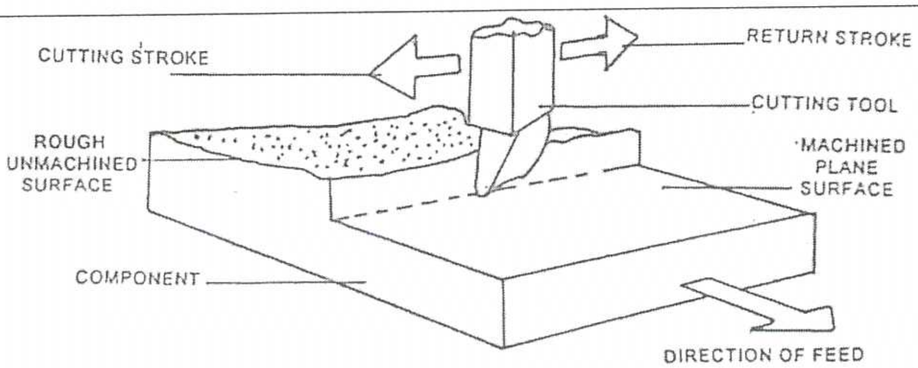
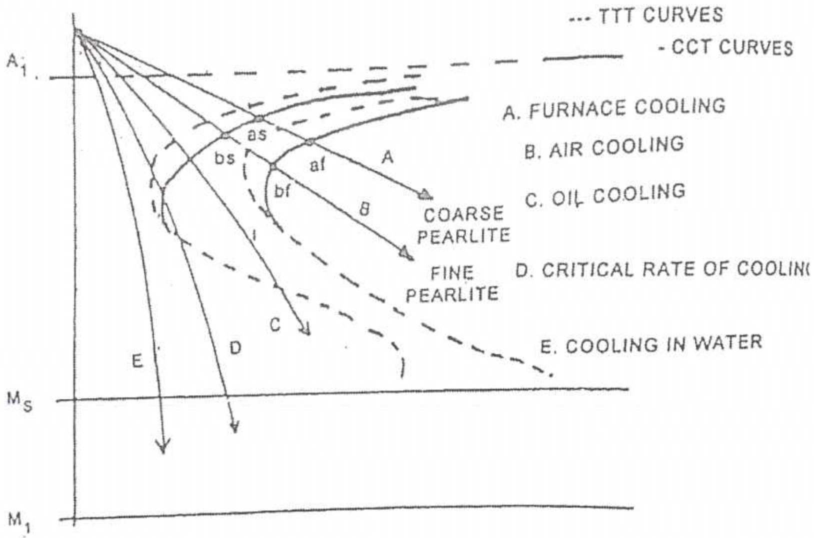
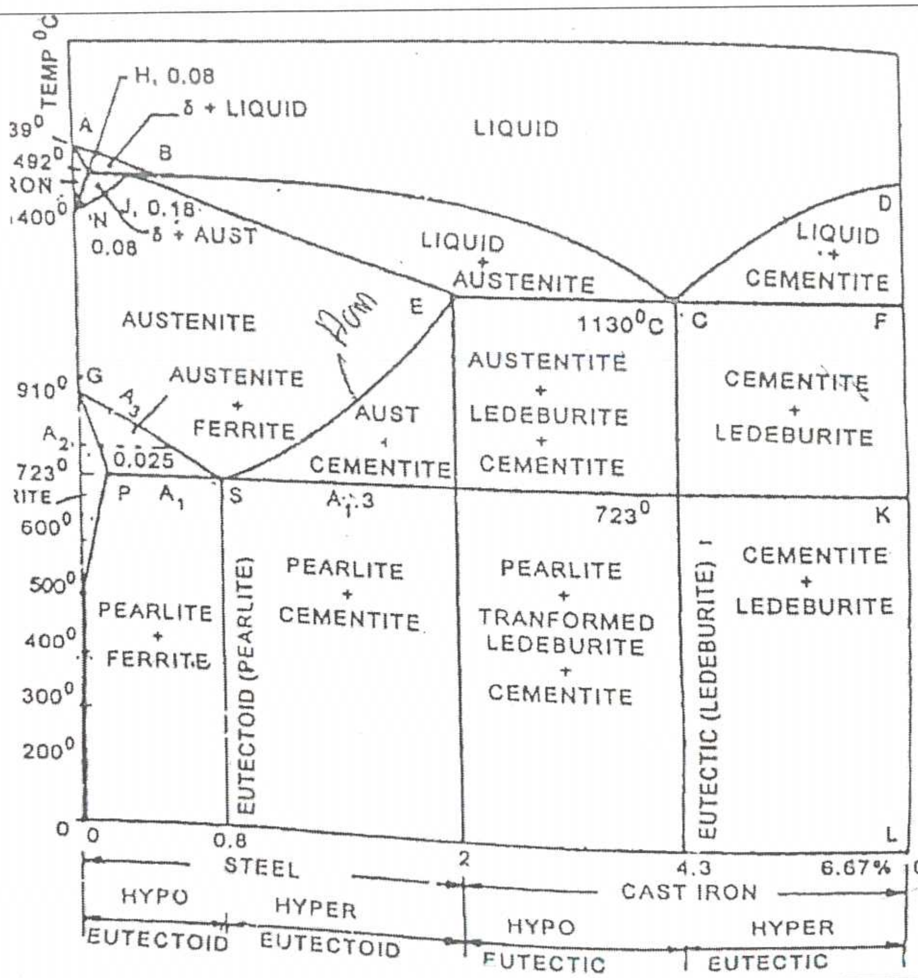
SCHEME OF VALUATION

(Scoring Indicators)

Revision:(2015)		Course code:4023		
Course Title	**METALLURGY AND MACHINE TOOLS**			
Qst No	**Scoring Indicator**	**Split up score**	**Sub Total**	**To tal**
	PART-A			
1	Steels which have a carbon content less than0.8% carbon are called hypo eutectoid steel. Its structure consists of ferrite and pearlite.	2		2
2	The term is used to refer to the ease with which a given work material can be machined under a given set of cutting conditions. The machinability depends on the nature of work material and cutting conditions. The machinability of different materials can be compared in terms of the values of tool life, cutting forces and surface finish under similar machining conditions			2
3	Sleeve is used to hold the taper shank drills whose taper is less than taper hole of the spindle. The outside taper of the sleeve matches with spindle hole taper			2
4	Straddle milling is used for machining two or more vertical/parallel surfaces simultaneously by mounting required number of cutters on to the arbor. In this operation, cutters are separated by spacing collars .Straddle milling has many useful applications in machining. Parallel slots of equal depth can be milled by using straddle milling cutters.			2
5	1. Horizontal cutting, 2. Vertical cutting, 3. Angular cutting 4. Key ways, grooves & slot cutting, and 5. Irregular cutting.	1/2X4	2	2
	PART-B			
II 1	1-A variety of metal or non metal powders can be used. 2-Refractory materials are popularly processed by PM. 3-Can be very economical for mass production (100,000 parts). 4-Long term reliability through close control of dimensions and physical properties. 5-Very good material utilization - loss of material very less. 6-Minimization or elimination of Machining. 7-Very good surface finish can be easily obtained.	1x6	6	6
II 2	1. They should possess good lubricating properties to minimise the friction. 2. They should possess high heat absorption capacity so as to carry away the heat generated. 3. They should present no fire or accidental hazards. 4. They should not cause skin irritation. 5. They should not emit obnoxious odours and vapours harmful to the operator, workpiece or surrounding area.	Any 6 point	6x1	6

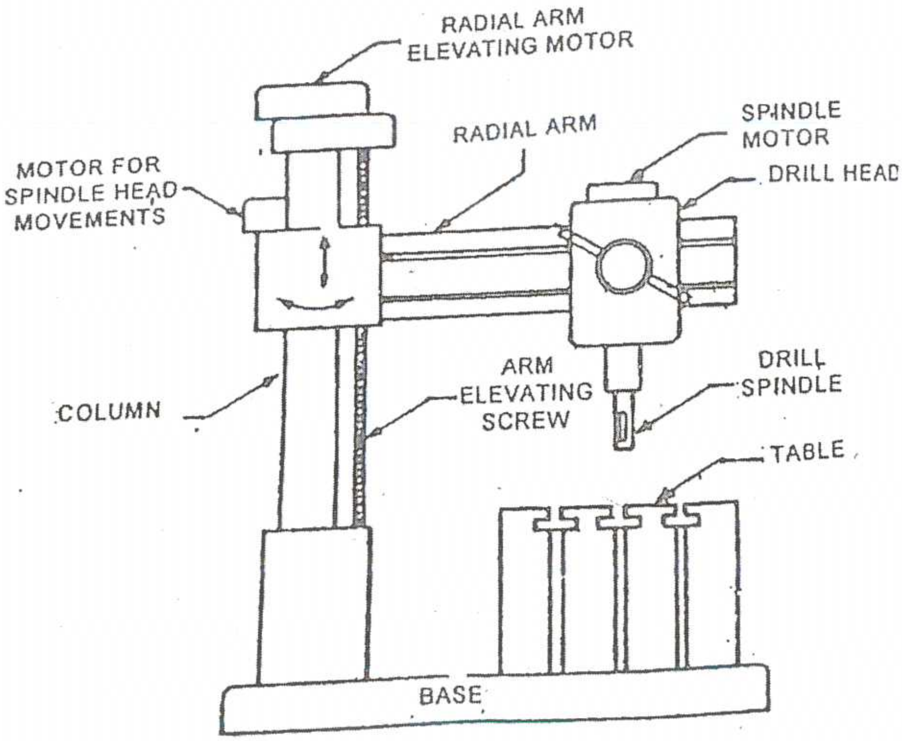
	6. They should be of low viscosity to permit free flow and easy separation from chips collected. 7. They should be transparent, so that an operator can clearly view tool and work. It is very important where high dimensional accuracy and fine finish are required. 8. They should prevent rusting of the machine slidings and working surfaces. 9. They should be suitable for a variety of cutting operations, and should be easily available at lowprice so as to minimise Production cost. 10. They should be chemically stable. 11. They must possess a law evaporation rate and must not fume. 12. They should not deteriorate in storage. 13. They should have high flash point			
3	**1. Orthogonal cutting and 2. Oblique cutting** In ***Orthogonal cutting***, the cutting edge of the tool is perpendicular to the direction of cutting speed whereas in ***oblique cutting***, it is set at some angle other than 90 degree to the direction of cutting speed.	1x3 1x3	3 3	6
4		Fig Parts 6x1/2	3 3	6
5		Fig parts	3 3	6
6	 The shaping machine is used for producing flat surfaces. Machining on shaper is more economical with easier work setting and cheaper tooling. On a shaper, job is fixed on table and the cutting tool reciprocates across the work piece.	Fig Explai n	3 3	6

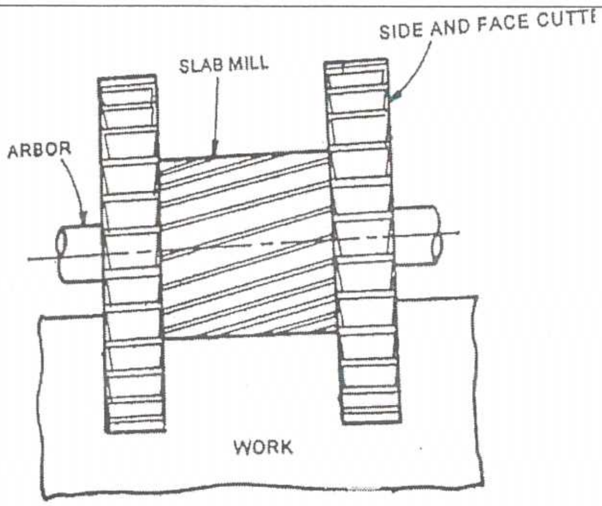
	The tool cuts on forward stroke and the return stroke remains idle as there is no cutting action in that stroke.			
7	1-In planer work reciprocates past the tool which is held stationary on cross rail whereas in shaper tool reciprocates past the work which is held securely to the table. 2-The planer is particularly adopted to large work whereas shaper can be used only for small work. 3-On the planer the tool is fed into work; on the shaper the work is usually fed across the tool. 4-Setting of jobs on a planer table is difficulty than setting the jobs on shaper table. 5-Multiple tooling in a planer makes it possible to machine more than one surface together. 6. In planer the speed is constant through out the cutting stroke. 7. Planer tools are heavier and stronger than the shaper tools. 8. Planers are costlier machines and occupy more floor space than shapers.	6point (6x1)	1	6
	PART-C			
	UNIT-1			
III a	 TTT diagrams are useful in respect of heat treatment as they give the nature of transformed products of austenite at varying degree of cooling. It has a great practical importance to special heat treatment practice, transformation occurs during continuous cooling. **Continuous cooling transformation (CCT) diagram** correlates the transformation, temperature and time during continuous cooling. CCT curves are drawn in a similar way as TTT diagram except that, in the case of CCT diagrams, point of start and end of austenite transformation (decomposition) are recorded on continuous cooling curves Various cooling rates give various combination of phases. **Cooling A** indicates very slow cooling rate equivalent to furnace cooling of full annealing process and that results coarse pearlite. **Cooling B** is faster cooling can be obtained by air cooling. This type of cooling can be obtained by normalising and that results finer pearlite. **Cooling C**: just touches the finishing end of nose that gives fully fine pearlite.	**Figure 3marks** **Explain 3** **Mark all points in figure 2**	3 3 2	8

	Cooling D is faster cooling that can be obtained by oil quenching. This is a hardening heat treatment process and that produces fine pearlite and untransformed austenite transforms to martensite below MS Cooling **curve E** just touches the nose of CCT diagram and that produces almost fully martensite. Cooling curve F avoid nose of C curve in CCT but touches the nose of TTT gives entirely martensite. Notice the critical cooling rate to avoid nose of CCT diagram .			
III b	1. Atomization 2. Machining 3. Crushing and Milling 4. Reduction 5. Electrolytic Deposition 6. Shotting 7. Condensation	**Any 5x1**	5	7
	Atomization : In this method molten metal is forced through a small orifice and is disintegrated by a powerful jet of compressed air, inert gas or water jet. These small particles are then allowed to solidify. These are generally spherical in shape. Atomization is used mostly for low melting point metals/alloy such as brass, bronze, zinc, tin, lead and aluminium powders.	2	2	
IV a		**Figure 4marks** **Mark all points in figure 4**	4 4	8
1V b	**Normalising consists** of Heating the steel 30 to 50°C above upper critical temperature (A3for hypo-eutectoid steel and Acm for hyper-eutectoid steel)	**3.5**		

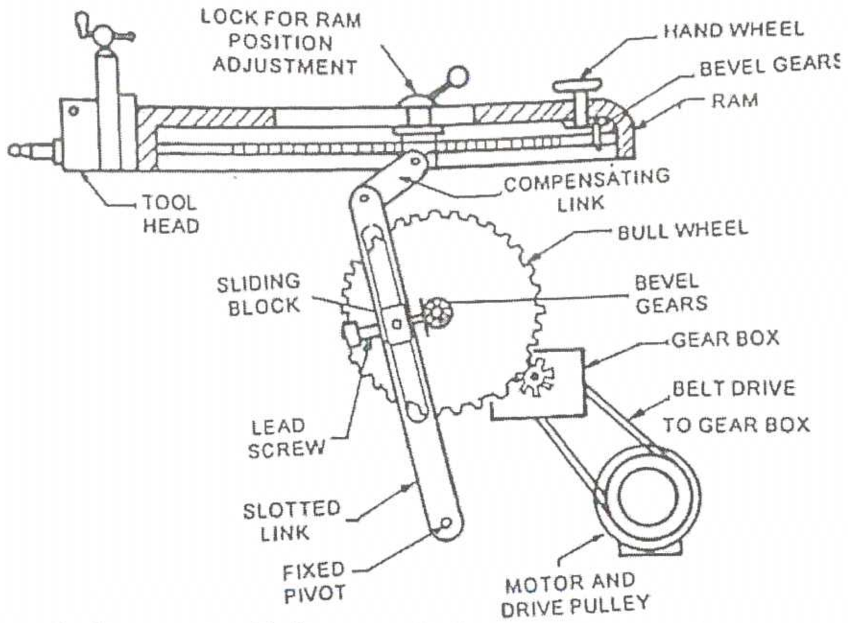
	Holding at this temperature for shorter time to prevent grain growth. But the time allowed should be sufficient so that the temperature is uniform throughout the section, and **Cooling in the air:** The cooling rate is the major difference between normalising and annealing. The micro structures produced by normalising is similar to that of annealing. But, slightly more rapid cooling results in finer grained structure than for annealing. The normalised structure of low-alloy steel consists ofsorbite (fine pearlite) and fine ferrite. The increased rate of cooling in normalising results high hardness and low ductility than annealed steel. The effect of rapid of cooling also increases the strength and toughness of the steel. **Tempering** The process involves heating the hardened steel below lower critical temperature, holding at this temperature for sufficient time and slow cooling in air. The tempering temperature must not exceed the critical point, as the steel would become austenite and the benefits of hardening treatment would be lost. The temperatures are related to the function of components. Cutting tools are tempered between 230-330°c. If greater ductility and toughness are required as in case of shafts and high strength bolts, the steel is tempered at 300°C to 600°C Tempering causes transformation of martensite in to troostite or sorbite. Formation of these structures depends These structures consists of ferrite and finely divided cementite, and are different from those produced by slow cooling, which are of laminated form.	**3.5**		7
	UNIT-2			
Va	1. Continuous chips 2. Continuous chips with buit-up-edge (BUE), and 3. Discontinuous or segmental chips. **<u>Continuous Chips</u>**: Continuous chips are formed when machining ductile materials (low-carbon steel, copper, aluminium etc.) with a cutting tool of large rake angle and sharp cutting edge. Such a chip flows off the tool face in the form of a ribbon. The other favourable conditions which give rise to this type of chip are; 1- high cutting force, 2- small feeds and depth of cut, and 3- low friction. Formation of continuous chips without BUE are desirable because a smooth surface will be obtained. **<u>Continuous Chips with BUE</u>** Continuous chips with BUE are formed when machining ductile metals with a cutting tool of smaller rake angle at lower cutting speed. The other conditions which give rise to BUE are: 1- higher values of feed and depth of cut, 2- higher co-efficient of friction, 3- poor lubrication, and 4- high cutting pressure and temperature in shear zone. Built up edge is caused by small particles of cut chip adheres, under the action	**3names** 2 2	2 2 2	8

	of pressure and temperature, to the face of the tool. These BUE eventually swept from the tool and remain attached to the machined surface. This causes poor surface finish of work surface **Discontinuous Chips**: This type of chip is produced when machining brittle material, such as cast iron and bronze, with a cutting tool having low rake angle. The following factors favours the formation of discontinuous chips 1-low cutting speed, 2 - large feeds and depth of cut, and 3-absence of cutting fluid. in this case the chips are broken up into small segments instead of plastic flow of chip along tool face. The discontinuous chips may also result if the material is ductile and the coefficient of friction between chip and tool is very high. The most of the heat generated is carried by the chip and hence the tool is heated to a lower temperature. Thus, the tool life is longer.	**2**	**2**	
Vb	1Flood method, 2. Jet method, and 3. Mist method. **Flood Method**: In this method, a reciprocating pump is used to force the coolant over the work and tool. The outlet of the pump is connected to a nozzle through flexible pipe. The nozzle can be adjusted to direct the stream of the fluid at the cutting zone. This is the most common method of application of cutting fluid. **Jet Method:** In jet method, a small jet of fluid at high speed is directed at the point of metal separation from the underneath the tool the jet method for turning. In high-speed jet system gear or vane type pump is used to maintain high pressure. **Mist Method:** In mist method, the fluid is passed through a specially designed nozzle to form very fine droplets (mist). This mist is directed at the cutting zone at high speed. It has better cooling effect than flood or jet methods.	**Names** **2** **2** **2**	**1** **2** **2** **2**	7
VI a	1. Forming tool method, 2. Compound rest method, 3. Tailstock set-over method, and 4. Taper attachment methods. Taper turning by the compound rest method: It is used for turning longer taper than produced by a form tool, but the length of taper is limited by linear movement of compound rest slide. The base of compound rest is graduated in degrees and can be swivelled for required angle. The taper angle must first be calculated in degrees, and the rest may be swivelled to required angle (half the taper angle). The feeding of the tool is done with compound rest feed handle and is controlled by hand. This method is simple	**4x1/2** **5**	**2** **5**	8

	and easy to, setup for wide range of angles. But due to hand feed, it gives low productivity and poor surface finish. Can be determined by the Formula: - $\tan\theta = \frac{D-d}{2L}$ Where D = major dia, d = minor dia and L = length of taper in mm.	1	1	
VI b	**Centering** is the operation of producing conical holes at the ends of the work pieces. Centre holes provide bearing surfaces for the lathe centres. It facilitates turning the work between centres. Hole centres are located and marked with centre punch. Then the centre holes are produced by centre drill. **Boring** is the operation of enlarging the previously drilled hole with a aid of single point cutting tool, called boring tool. It can be referred as internal turning that is performed on the lathe. In boring, the depth of cut is adjusted with the cross slide and the tool is fed against the revolving work. The feed is given parallel to the axis of revolution. If the bar is enlarged only through a certain length, then it is referred as counter boring **Drilling** is the process of making holes on work piece. Before attempting any drilling, the work should be faced and centre drilled. The drill is held stationary in the tailstock spindle. Parallel (straight) shank drills are held in a drill chuck which is then fitted in the tailstock spindle. Taper shank drills are held in a drill holder. The drill is fed slowly into the work piece which is revolving in a chuck.	2 3 2		7
	UNIT III			
VII a		**Fig 5** **Parts 6x1/2 =3**	5 3	8

VII b	 Gang milling It is the operation of machining several horizontal surfaces simultaneously by feeding the work against the cutters. In gang milling two or more cutters are mounted adjacently on to the arbor	4 3		7
VIII a	Gears were milled with form cutter. The first step in gear cutting is to get correct blank size. The gear blank is machined to get correct diameter of gear blank. The blank diameter is calculated by the formula Blank diameter $= \frac{(Z+2)}{P_d} = m\,(Z+2)$ where Z = Number of teeth, m = module and P_d = diametral pitch. Then select the type of indexing to be performed and the gear cutter for required number of teeth and pressure angle. The index head and tail stock are bolted to machine table such that their axis is perpendicular to the machine spindle. The gear blank is connected to dividing head spindle by carrier and a catch plate. After calculating the indexing movement for given number of teeth the proper index plate is mounted on dividing head and position of crank pin and the sector arms are adjusted. The next step is to mount the cutter on arbor and position the gear blank exactly under the cutter. Raise the table till the cutter just touches the periphery of gear blank. For small gears full depth of the gear tooth is cut in a single pass. The tooth depth is calculated by using the formula. Tooth depth $= 2.25/P_d = 2.25m$. the table is raised to provide fll depth of cut next set proper feeds and speeds on the machine. Selected feed to cut the first tooth space of the gear. After the cut, the table is brought back to starting position and the blank is indexed for the next tooth space. The operation is repeated till the gear is formed			

<table>
<tr><td>VIII b</td><td>1-Drill vice,2-parallel bars,3-step blocks,4-Angle plates,5-V-Blocks,
6-Clampes and T bolts,7-Drill jiges</td><td>1x7</td><td></td><td>7</td></tr>
<tr><td></td><td>UNIT- IV</td><td></td><td></td><td></td></tr>
<tr><td>IXa</td><td>



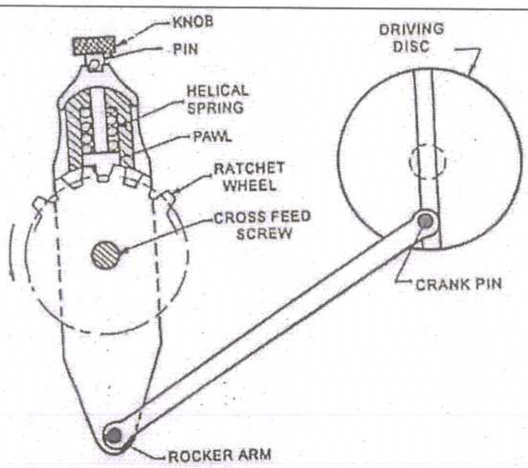
its main features are driving gear (bull gear) and slotted link (rocker arm). An electric motor drives the bull gear by means of a pinion through a gear box. A crank pin which is fastened to the bull gear moves a sliding block which is located in a slot of slotted link. One end of slotted link is pivoted at the bottom, and other end is connected to the ram. The up and down movement of slider causes the slotted lever to oscillate about its pivot as the bull gear rotates. Thus the oscillating motion of slotted lever imparts a reciprocating motion to the ram.
Crank and slotted lever mechanism enables the ram to move faster during return (idle) stroke than during forward (cutting) stroke. The cutting stroke is made less rapidly than the return stroke because crank pin produces the working stroke 'DE' during its travel through major arc 'ABC', and through minor arc 'CA' it produces the return stroke. As the speed of rotation of the bull gear is constant, this will causes the return stroke to complete in a shorter time.

The ratio between cutting time and return time may be given as,

$$\frac{\text{Cutting time}}{\text{Return time}} = \frac{\text{Angle subtended by arc ABC}}{\text{Angle subtended by arc CA}}$$
This ratio is usually 3:2, and slightly changes with length of stroke. The disadvantage with this mechanism is that the quick return effect is diminishes with smaller strokes.</td><td>Fig3 Parts2

Explain 3</td><td>5

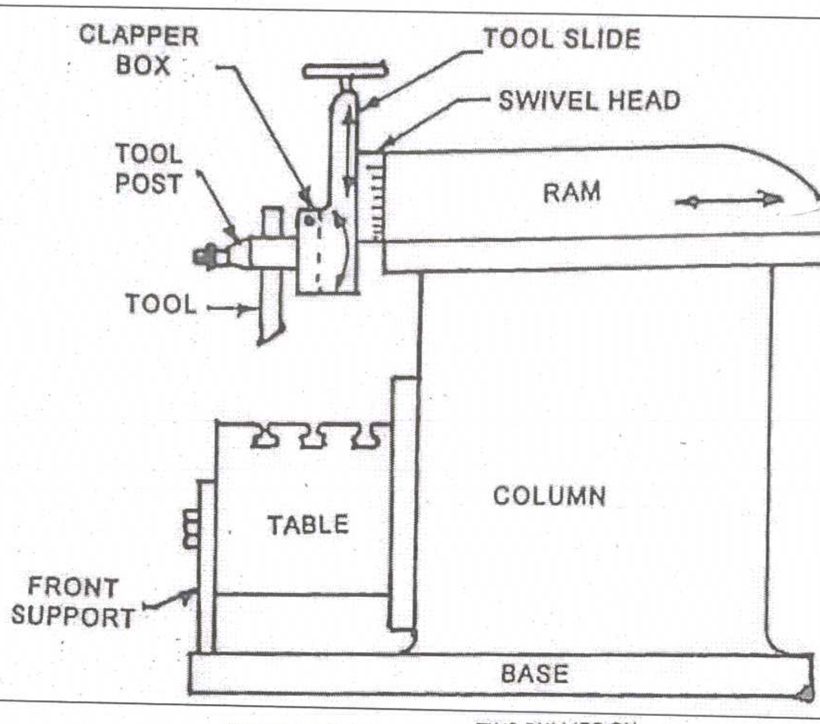
3</td><td>8</td></tr>
</table>

<table>
<tr>
<td>IXb</td>
<td>


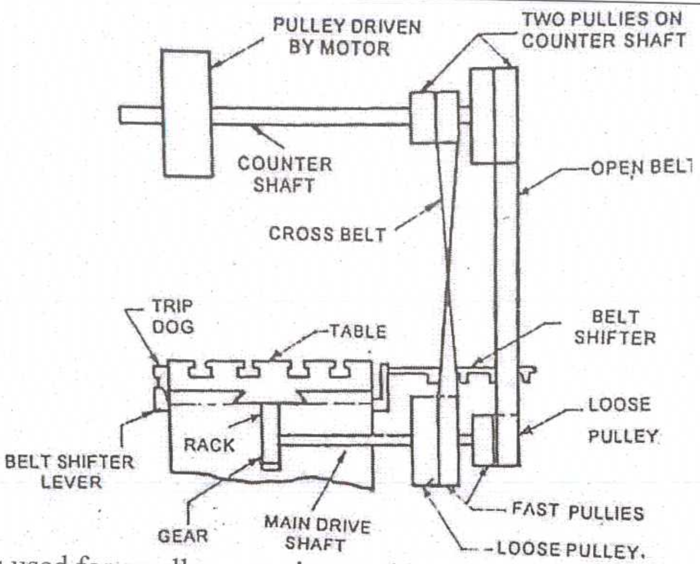
The feed movement is provided during the end of return stroke so as to bring the uncut surface of the work under the reciprocating tool. This is done by rotating the cross feed either manually or automatically

A driving disc is driven in a particular direction (clock wise direction) by the bull gear. This disc operates connecting rod by means of a crank pin. The other end of connecting rod is attached to the rocker arm by a rocker arm pin. The ratchet wheel is keyed to cross feed screw. As the driving disc rotates, the connecting rod starts reciprocating which causes an arm to oscillate. During half revolution of the disc, the half part of the rocker arm moves in the same direction (i.e. clock wise direction) and the spring load pawl slips over the teeth of ratchet wheel without moving the wheel In the next half of the revolution of disc, the top of the arm reves in anti-clockwise direction and the straight side of the pawl pashes the teeth of the ratchet wheel causing the wheel to move in anti-clockwise direction. Thus the ratchet wheel transmits an intermittent motion to the cross feed screw which moves the table. The amount of feed may be changed by adjusting the radial position of crank pin
</td>
<td>4

3</td>
<td></td>
<td>7</td>
</tr>
</table>

<table>
<tr><td>Xa</td><td>
</td><td>Fig 4

Parts 1/2x8</td><td>4

4</td><td>8</td></tr>
<tr><td>Xb</td><td>

It is used for smaller capacity machines. The table of this machine is moved by gears and rack attached to the underside of the table.
The counter shaft (receives power from motor) at the top of the housings has two pulleys for transmitting power to main shaft which drives the table by gear and rack. Two sets of fast and loose pulleys are mounted on driving shaft. Fast pulley is keyed to shaft while loose pulley is free to rotate on the shaft. The smaller fast pulley is used for backward motion of the table and is connected by open belt drive. The fast pulley used for forward motion of table is bigger in size and is driven by crossed belt drive. Thus the speed of the table in backward stroke is faster than forward (cutting) stroke.
Crossed belt is used to drive the table during cutting stroke at the end of the cutting stroke, the crossed belt from fast pulley is shifted on to loose pully while the open belt is shifted from loose pulley to fast pulley. the direction of movement is automatically reversed, and the table is now driven by fast backward pulley with much faster speed. The length and position of stroke may be adjusted by shifting the position of dog.</td><td>4

3</td><td></td><td>7</td></tr>
</table>