

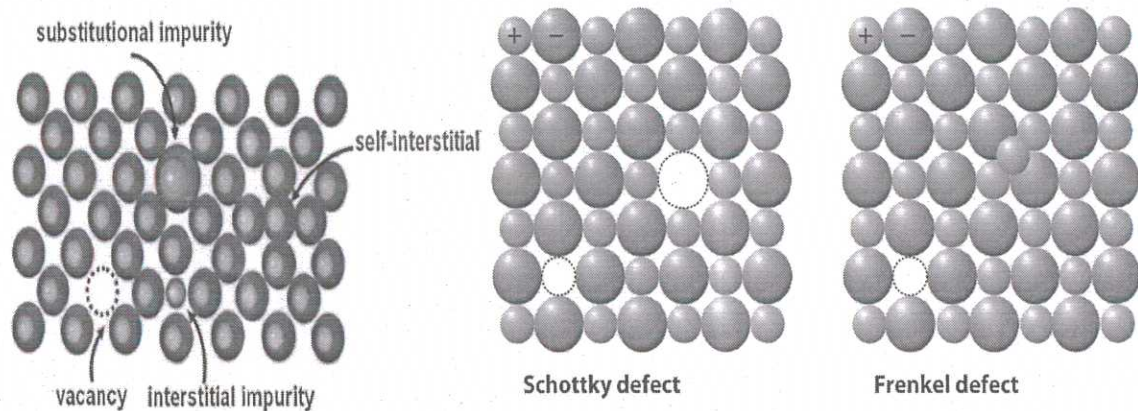
**FOURTH SEMESTER DIPLOMA EXAMINATION IN MECHANICAL
ENGINEERING/TECHNOLOGY**

METALLURGY AND MACHINE TOOLS – Answer key

Marks

- I. 1) CCT curve shows gradual cooling of austenite to room temperatures instead of rapid cooling and maintaining high constant temperature (isothermal temperature) represented in TTT curve. ($\frac{1}{2} \times 4 = 2$)
- 2) Minimum Quantity lubrication (MQL): Lubricant applied using compressed air or it is “shot” at the tool in the form of droplets (5 to 50 ml / hr.) which is much less than traditional flood cooling system (2x1 = 2)
- 3) Lathe centers, Chucks, Faceplates, Mandrels, Steady and follower rests, Lathe dogs, Drive plates, Angle plates ($\frac{1}{2} \times 4 = 2$)
- 4) The clapper box allows the cutting tool to lift on the return or idle stroke so that tool is not dragged back through the uncut work piece. (2x1 = 2)
- 5) Plain Milling Cutter, Face Milling Cutter, Side Milling Cutter, Metal Slitting Saw, Angle Milling Cutter, End Mill Cutter, T-Slot Milling Cutter, Woodruff Key Slot Milling Cutter, Fly Cutter, Formed Cutter ($\frac{1}{2} \times 4 = 2$)
- II. 1)
1. Can produce components with good surface finish and tolerance
 2. No further machining needed
 3. No waste of material
 4. Parts can be produced from high melting point refractory materials with less difficulty and cost. Eg: Tungsten filament in incandescent bulb
 5. Production rates are high due to automated equipment
 6. Skilled labour not needed.
 7. Labour cost low
 8. Parts with controlled porosity can be produced (production of porous metal parts such as filters and oil-impregnated bearings and gears).
- (1x6=6)
- 2) They are imperfect point like region in a crystal. Various point defects are
- Vacancy:** An atom missing from regular lattice position. **Self interstitial:** When an extra atom within the crystal occupies a space between regularly positioned atoms in a crystal. **Impurity** is the presence of foreign atoms in a crystal. **Substitutional Impurity:** When impurity atom occupies the void space where regular atoms are missing. **Interstitial Impurity:** A small sized impurity atom occupying void space between the regularly positioned atoms in a

crystal. **Frenkel defect:** Combination of vacancy and interstitial defect. An ion displaced from normal lattice site to interstitial site. **Schottky defect:** A pair of cations and anions missing from lattice site of an ionic crystal. Closely related to vacancy



(Expl.3 + Diag.3 =6)

3) Time elapsed between two successive grinding of cutting tool. Measured in the following ways.

1. Number of pieces machined between tool sharpening
2. Time of actual operation, time tool contact with work piece
3. Total time of operation
4. Equivalent cutting speed
5. Volume of material removed between tool sharpening.

Relation between cutting speed and tool life is expressed by Taylor's formula which $VT^n = C$

V = Cutting speed in m/min

T = Tool life in minutes

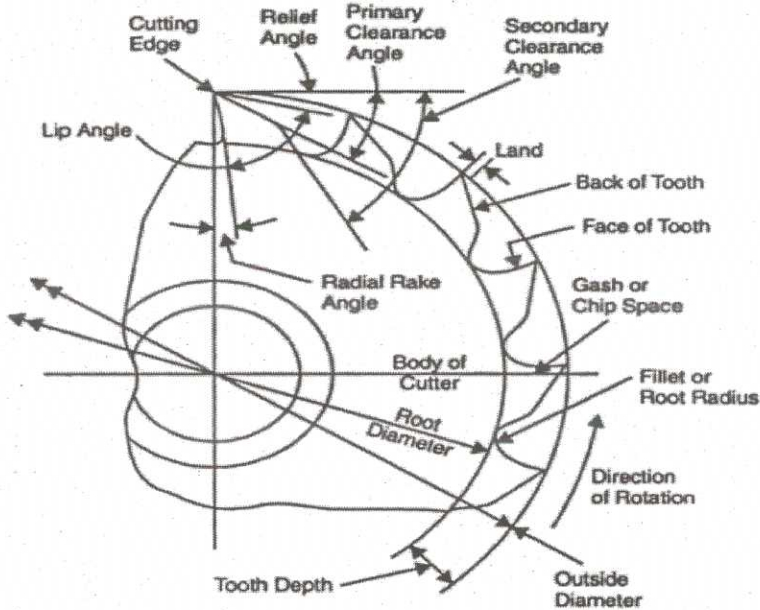
n - exponent which depends on the tool and work (For machining mild steel using high speed steel tool, the value of n = 0.1) (2 + 4 =6)

4) Properties of Cutting fluid

1. High heat absorption
2. Good lubricating qualities
3. Stable on use and storage
4. Possess high flash point to eliminate fire hazard
5. Neutral so as not to react chemically
6. Odourless so as not to produce any bad smell on heating
7. Harmless to skin of operators
8. Harmless to bearings
9. Non corrosive to work or machine
10. Transparent so that cutting action of tool can be observed
11. Low viscosity to permit flow of liquid
12. Low price to minimise production cost

(1x6 =6)

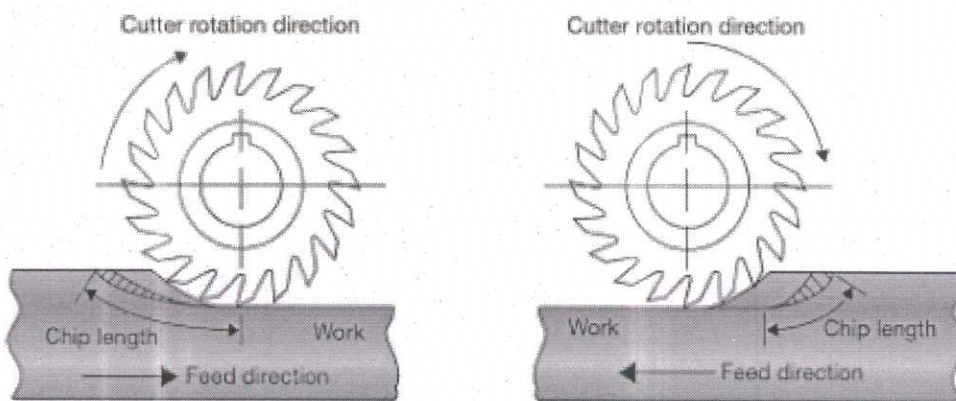
5)



(Drg. 1 + Marking $\frac{1}{2} \times 10 = 6$)

6)

Up Milling	Down Milling
Also called conventional milling	Also called climb milling
Cutter rotated against the direction in which work is being fed.	Cutter rotates in the same direction in which work piece is being fed
Chip thickness varies from minimum to maximum	Chip thickness varies from maximum to minimum
Cutting force increases from zero to maximum	Fixture design is easier
Cutting force directed upwards, this tends to lift the work from the fixture.	Chips are disposed off easily, do not interfere with the cutting.
Use of cutting fluid is difficult	Coolants can be poured directly at the cutting zone.



Up Milling and Down Milling

(Exp.1x3=3 + Drg3 =6)

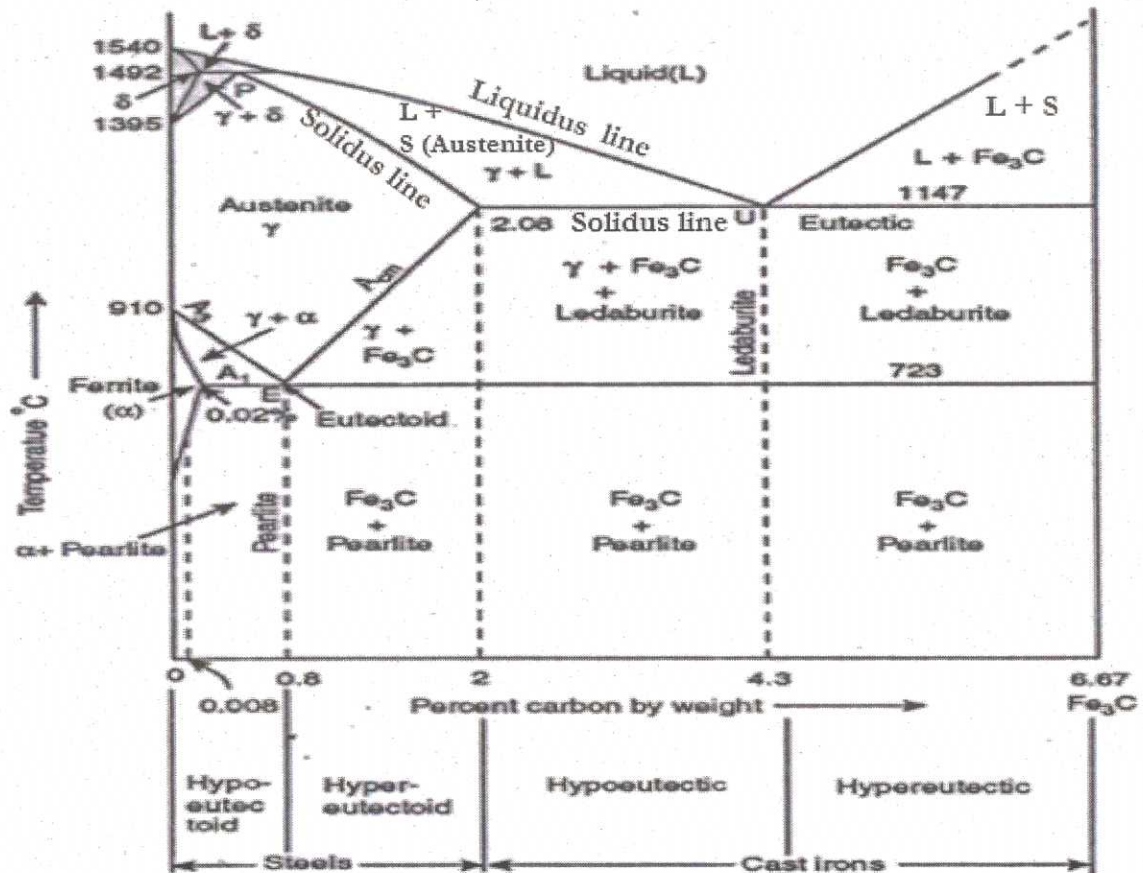
7)

- Horizontal distance between two housing
- Maximum stroke length of table
- Size of table

- Height of cross rail from the top of table
- Type of drive
- Power required for the motor
- Net weight
- Type of feed

(1x6=6)

III. a)



A1 – Lower critical temperature line

A3 & A_{cm} – Upper critical temperature line

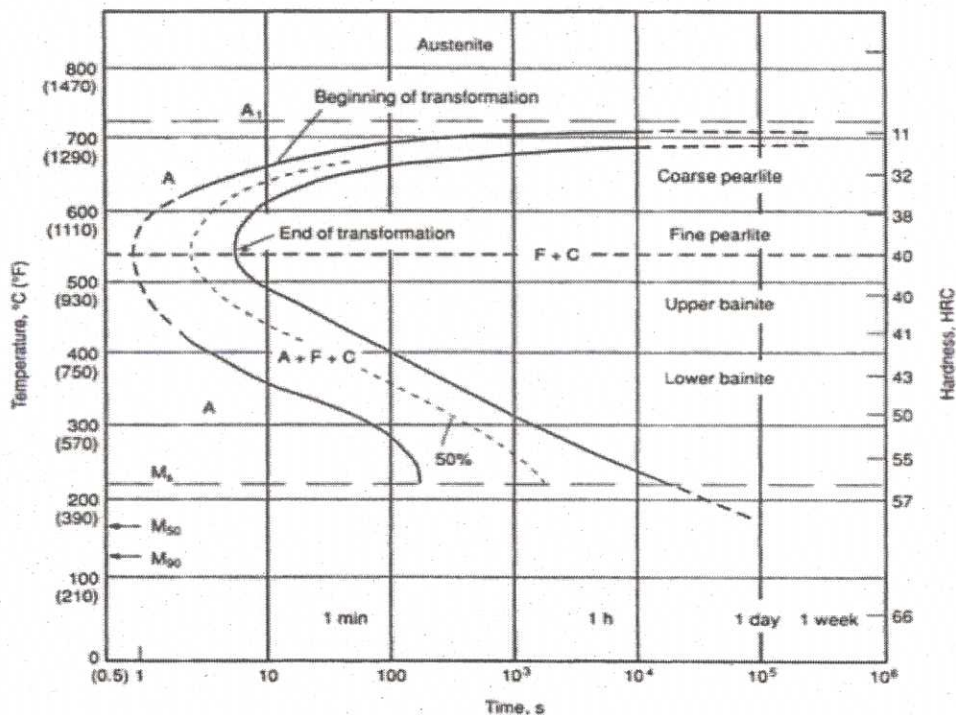
(8x1=8)

b)

- During annealing a component is cooled in furnace whereas during normalising a component is cooled in still air
- In annealing pearlite is coarse whereas in normalising pearlite is fine
- In annealing internal stress is least whereas in normalising internal stress is slightly high
- Normalising gives better strength than annealing
- Normalised steel exhibits less percentage elongation than annealed steel
- Annealed component is comparatively softer and more machinable compared to normalised steel
- Normalised component shows gives more impact strength than annealed component of same material
- Normalising is quicker and cheaper than annealing

(1x7 = 7)

IV. a) TTT curves shows the transformation of Austenite into different phases with time and temperature. Temperature is plotted on vertical axis and the logarithm of time on horizontal axis. Upper part of the curve shows transformation of austenite to pearlite. At 700°C thick layers of α - ferrite and cementite are produced *coarse pearlite*. Between 700°C to 550 °C thinner layers of α - ferrite and cementite are produced - *finer pearlite*. Part below nose of curve, *bainite* is produced. Feathery mass of ferrite and cementite (*Upper bainite*) is formed around 550°C and 500°C. Acicular (needle shaped) bainite formed in between 500°C to 300°C (*lower bainite*). Between 250 and 50°C diffusion less transformation of austenite into a hardened steel structure called *martensite* is observed.



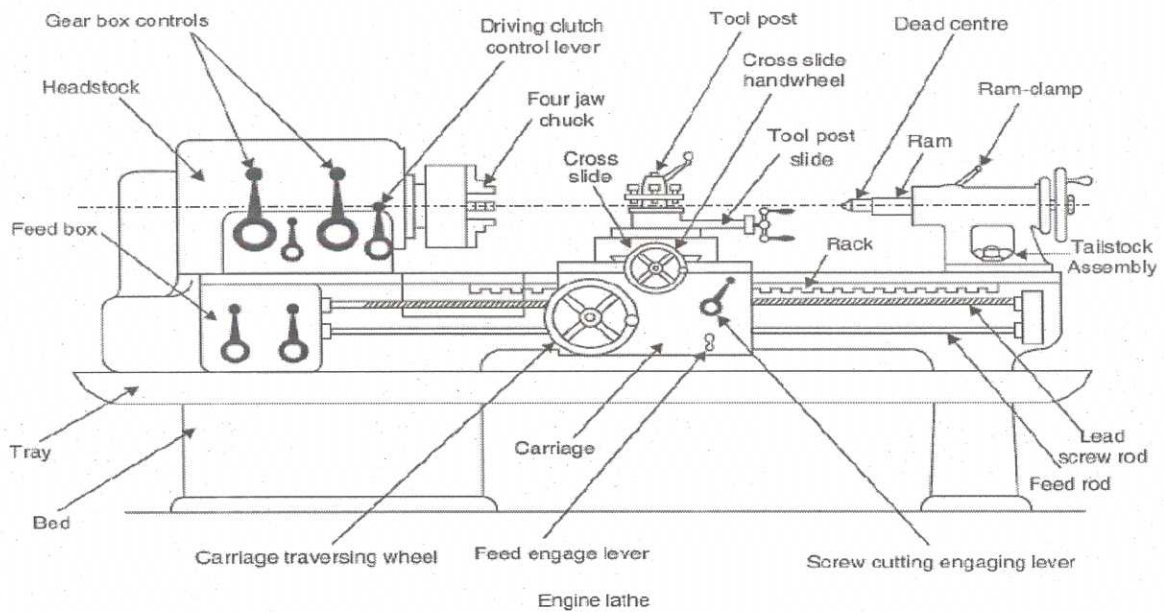
(Curve 5 + Exp. 3 = 8)

b)

1. To relieve internal stresses set up during cold working, casting, welding and hot-working
2. To improve electrical and magnetic properties
3. To refine grain structure
4. To soften the metal for further cold working as in wire drawing
5. To improve hardness of metal
6. To improve machinability
7. To improve mechanical properties like strength, hardness, ductility, shock resistance etc.
8. To increase resistance to wear, corrosion etc.
9. To remove entrapped gases during casting

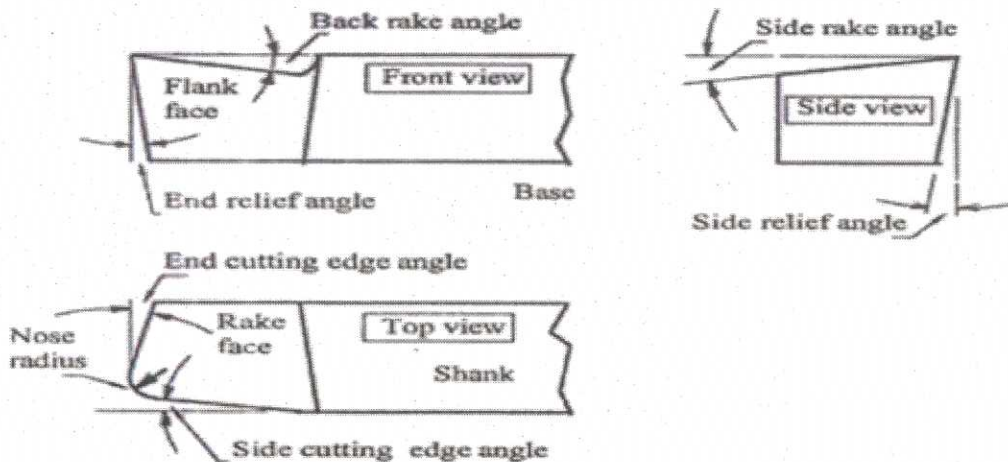
(1x7 = 7)

V. a)



(Sketch 4 + Parts 4 =8)

b)



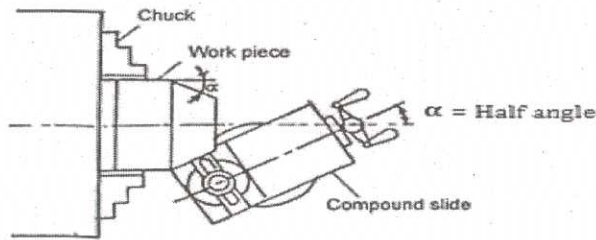
(Sketch 3 + Elements 4 = 7)

VI. a) Taper turning methods

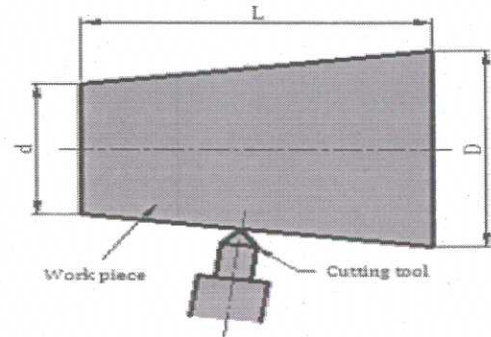
- Using Form Tool
- Swiveling Compound Rest
- Tailstock Set Over Method
- Using Taper Turning Attachment
- Combining Longitudinal And Cross Feed

Swivelling Compound Rest method

Work held in chuck or between centers. Compound rest carrying the tool is swivelled to half of taper angle with respect to work. Tool is fed manually by rotating the feed hand wheel of compound rest. Half taper angle $\tan \alpha = \frac{D-d}{2l}$



Taper turning by swiveling the compound rest



$(\frac{1}{2} \times 2 = 2 + \text{Drg } 2 + \text{Exp } 4 = 8)$

b)

SI No.	Orthogonal cutting(2 D cutting)	Oblique cutting(3 D cutting)
1	Cutting edge of tool is normal to direction of tool feed (work feed)	Cutting edge is inclined at an angle less than 90 ° to direction of tool feed (work feed)
2	Chip coils in tight flat spiral	Chip flow sideways in long curl
3	Direction of chip flow velocity is normal to cutting edge	Direction of chip flow velocity is at an angle
4	For same feed and depth of cut, the cutting force acts on smaller area. So tool life is less	Cutting force acts on larger area. So tool life is more
5	Produce sharp corners	Produce chamfer at end of cut
6	Smaller length of cutting edge is in contact with the work	For same depth of cut greater length of cutting edge is in contact with the work
7	Un suitable for efficient chip removal	Suitable for efficient chip removal
8	Generally parting off in lathe, broaching and slotting operations are done by this method	This method of cutting is used in almost all machining operations

$(1 \times 7 = 7)$

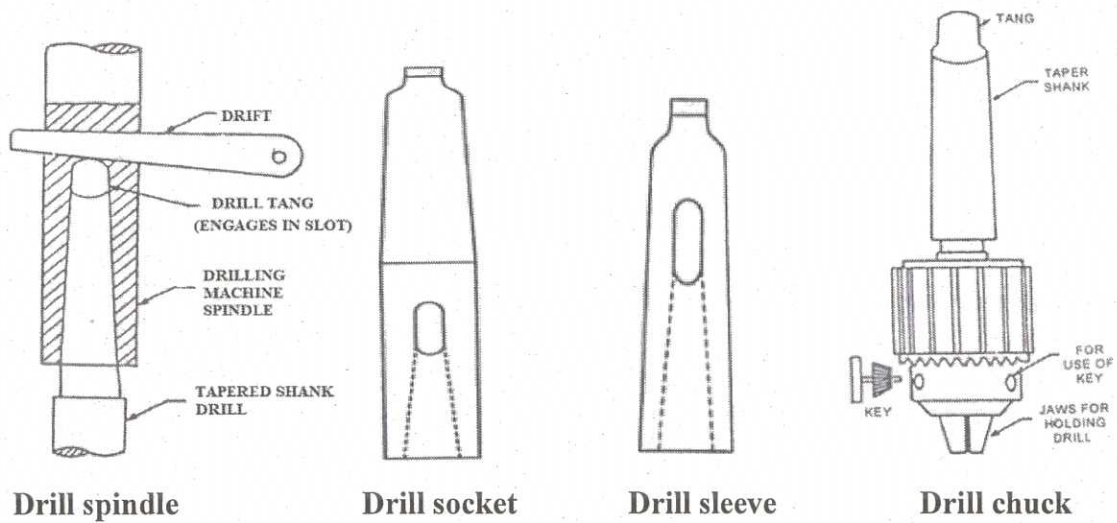
VII. a) Tool holding devices

Directly fitting in spindle: Spindle hole have standard taper (1:20) to receive taper shank of tool. Shank is forced into tapered hole and tool is gripped by friction.

Drill chuck: Holding smaller size drills. Used to hold different sizes of tool shanks

Drill Sleeve: Drill sleeve is used if taper shank of tool is smaller than tapered hole in spindle

Drill Socket: Used to hold tool when tapered tool shank is larger than the spindle taper



Drill spindle

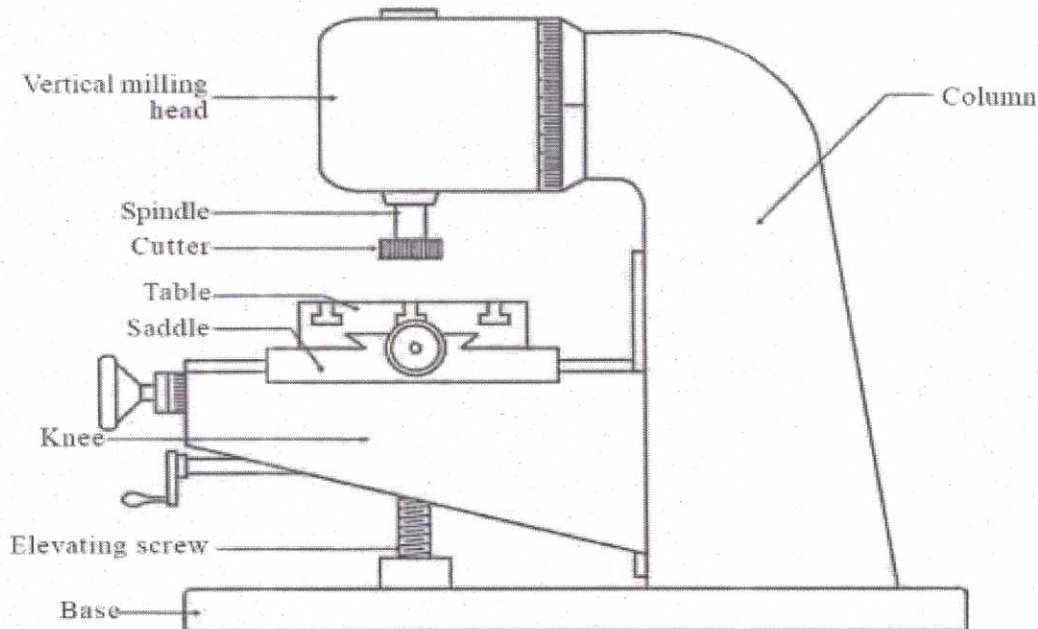
Drill socket

Drill sleeve

Drill chuck

(Sketch 1 + Exp 1 x 4 = 8)

b)



(Sketch 3 + Marking 4=8)

VIII. a)

1. Calculation of gear proportions

$$\text{Blank dia} = m (Z + 2)$$

$$\text{Tooth depth} = 2.25m, \text{ where } m = \text{module} = \text{No. of teeth}$$

2. Select the type of indexing and gear cutter for required no. of teeth

$$\text{Index crank movement} = 40 / N \text{ (if simple or plain indexing is used)}$$

3. Setting dividing head on table

- Dividing head and tail stock are bolted on the machine table such that their axis is perpendicular to machine spindle
- Gear blank is held b/w dividing head and tail stock using carrier and catch plate

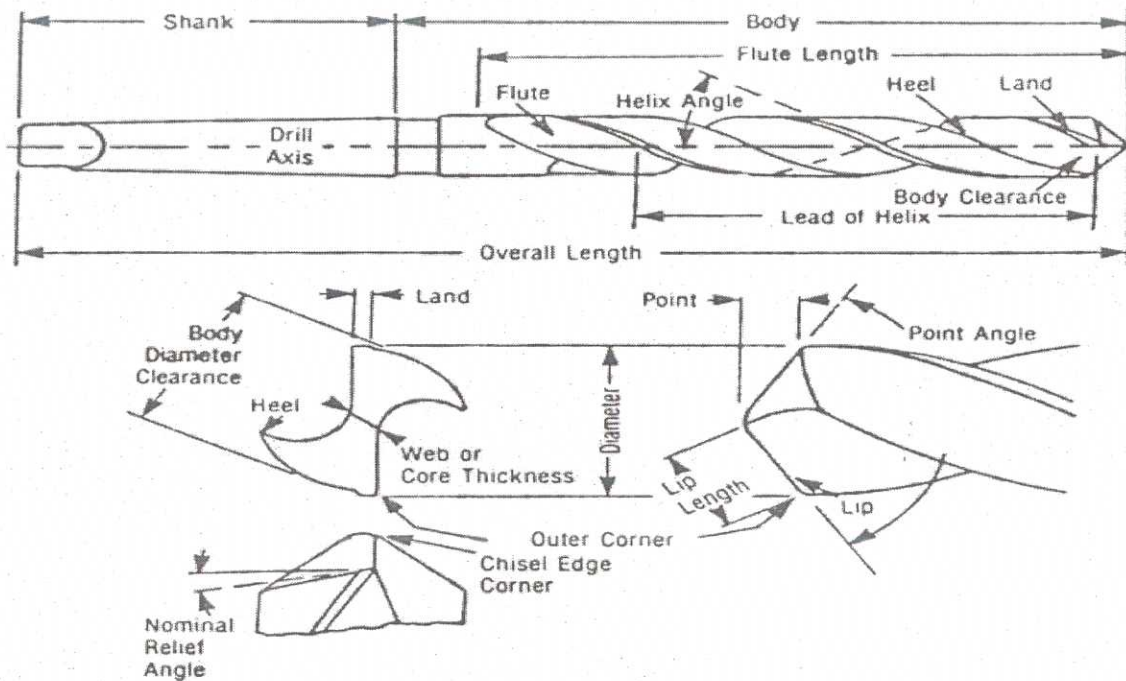
- Proper index plate is mounted on dividing head and position of crank pin and sector arm are adjusted

4. Mounting cutter on arbor and position gear blank exactly under the cutter

- Raise the table till the cutter just touches the periphery of gear blank
- The Micro meter dial of vertical feed screw is set to zero at this position. Then the table is raised further to give the required depth of cut
- After the cut, table is brought back to starting position and blank is indexed for next tooth space. Operation is repeated till all teeth are cut

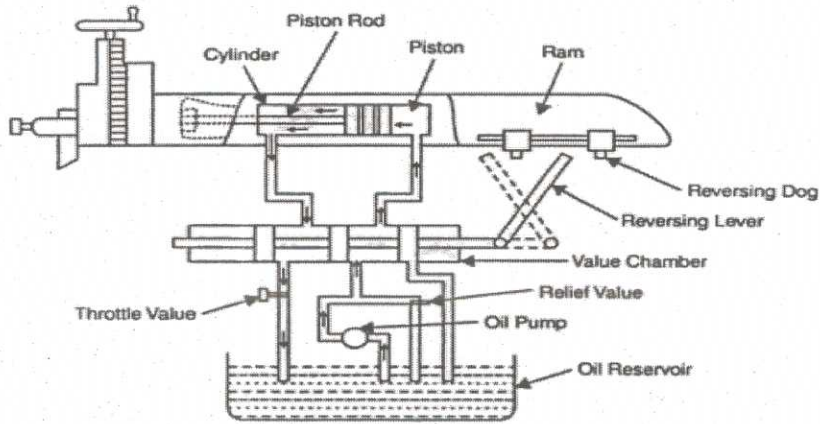
(2X4=8)

b)



(Sketch 3 + marking 4 =7)

IX. a) Oil is delivered to right side of the cylinder through valve chamber. Due to oil force piston moves from right to left. Piston is connected to ram through piston rod, so ram moves from right to left performing forward stroke. At the same time oil present in the left side of the cylinder is discharged to the reservoir through throttle valve. At the end of forward stroke the shape dog hit the reversing lever causing valve to alter their positions with the valve chamber. Now the oil pumped to the left side of the piston causing ram to perform return stroke. Oil present on the right side of the piston is discharged to reservoir. Quick return is effected due to difference in stroke volume of cylinder at both ends. Left hand end is smaller due to the presence of piston rod. As the pump is constant discharge one, same amount of oil is pumped into smaller volume. The pressure rises automatically and increase speed during return stroke



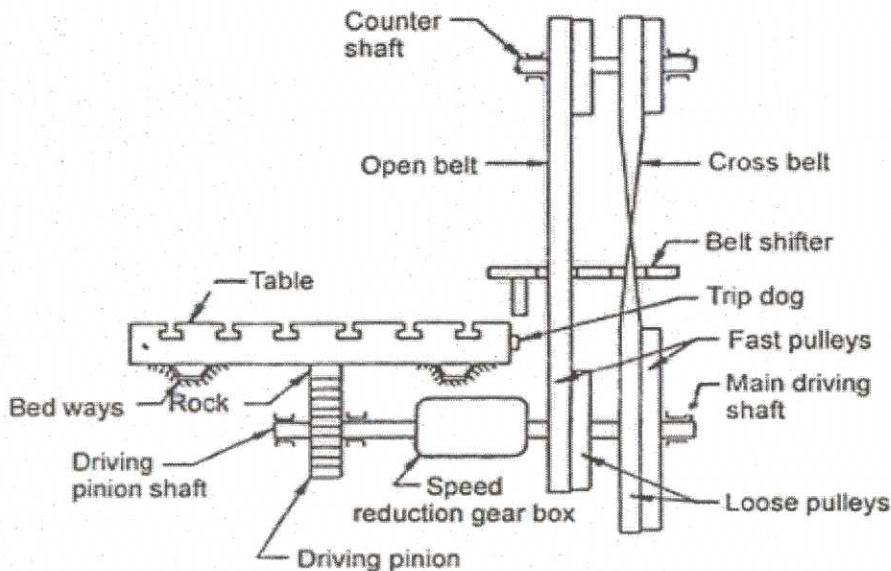
(Sketch 4 + Exp 4 = 8)

b)

Sl No.	Slotter	Planer
1	Tool reciprocates and work is stationary	Work reciprocates and tool is stationary
2	Work is fed across the tool	Tool is fed into the work
3	Feed is given to the work during the idle stroke of the ram	Feed is given to the tool during the idle stroke of the work table
4	Suitable for machining small work pieces	Suitable for machining large work pieces
5	Only light cut can be applied	Heavy cut can be applied
6	Only one tool can be used at a time. So machining takes longer time	Vertical and side heads can be used at the same time. So machining is quicker
7	Setting work piece is easy	Setting work piece is difficult
8	Only one work piece can be machined at a time	Several work pieces can be machined at the same time
9	Tools are smaller in size	Tools are larger in size
10	They are lighter and smaller	They are heavier and larger

(1 x 7 = 7)

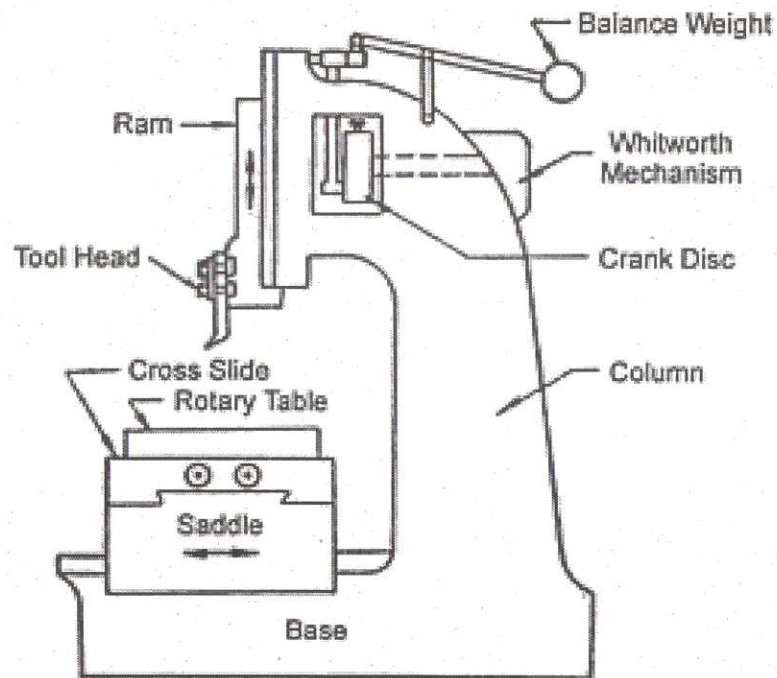
X. a)



During cutting stroke, cross belt connects larger fast pulley (keyed tightly) and open belt connects smaller loose pulley (rotates freely) on main shaft. Motion is transmitted by cross belt and no motion is transmitted by open belt to main shaft. Speed is reduced as belt connects smaller diameter pulley on counter shaft and larger diameter pulley on main shaft. Also cross belt having greater arc of contact on pulleys gives greater power for cutting stroke. At the end of forward stroke a trip dog pushes the belt shifter through a lever arrangement. Open belt is shifted to smaller fast pulley and cross belt is shifted to larger loose pulley. Now motion is transmitted by open belt and no motion is transmitted by cross belt to main shaft. Direction of rotation reverses. Speed increases as open belt connects larger pulley on counter shaft with smaller pulley on main shaft

(Diag 4 +Exp 4=8)

b)



(Diag 4 +Marking 3=7)