Machine Tools & Operations

Visveswaraya Technological University.

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1 (a) A tool which uses some form of mechanical or electrical energy to operate is called a machine tool.

Classification of m/c tools is given by:-

(i) General purpose m/c tools
(ii) Single purpose m/c tools
(iii) Limited purpose m/c tools
(iv) Production m/c tools
(v) Specialized m/c tools
(vi) Special m/c tools.

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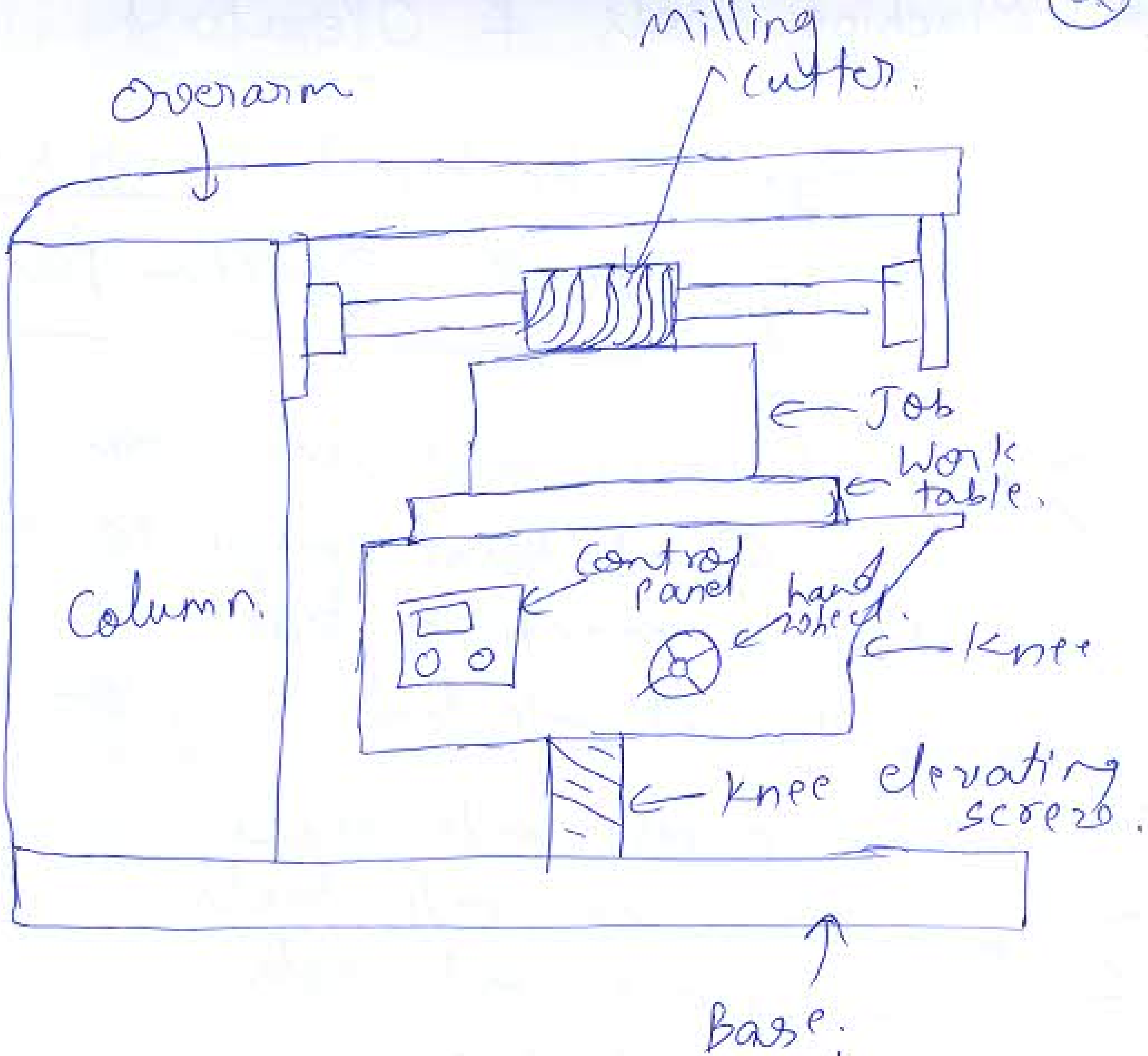
1 (b)

Construction:-

The base is a strong and hollow part which forms the foundation of the machine and bears all the load both dead load and load due to cutting



Horizontal Milling m/c

forces which are exerted on the machine. Column is attached to the base and is vertical hollow casting. The column houses the spindle and bearings as well as the drive units. Spindle is a hollow shaft supported by the column with suitable bearing, the over arm is adjustable and is mounted on the column. The knee is a casting which ~~st~~ moves up and down on the knee elevating screw. Saddle is placed above the knee and it holds the work table. Work table has the fixtures to hold the work firmly in place.

During operation, the job is fixed to the table firmly and then the spindle is rotated then the knee is moved up and the job is brought in contact with the milling cutter than the work table is moved to remove material in the desired location.

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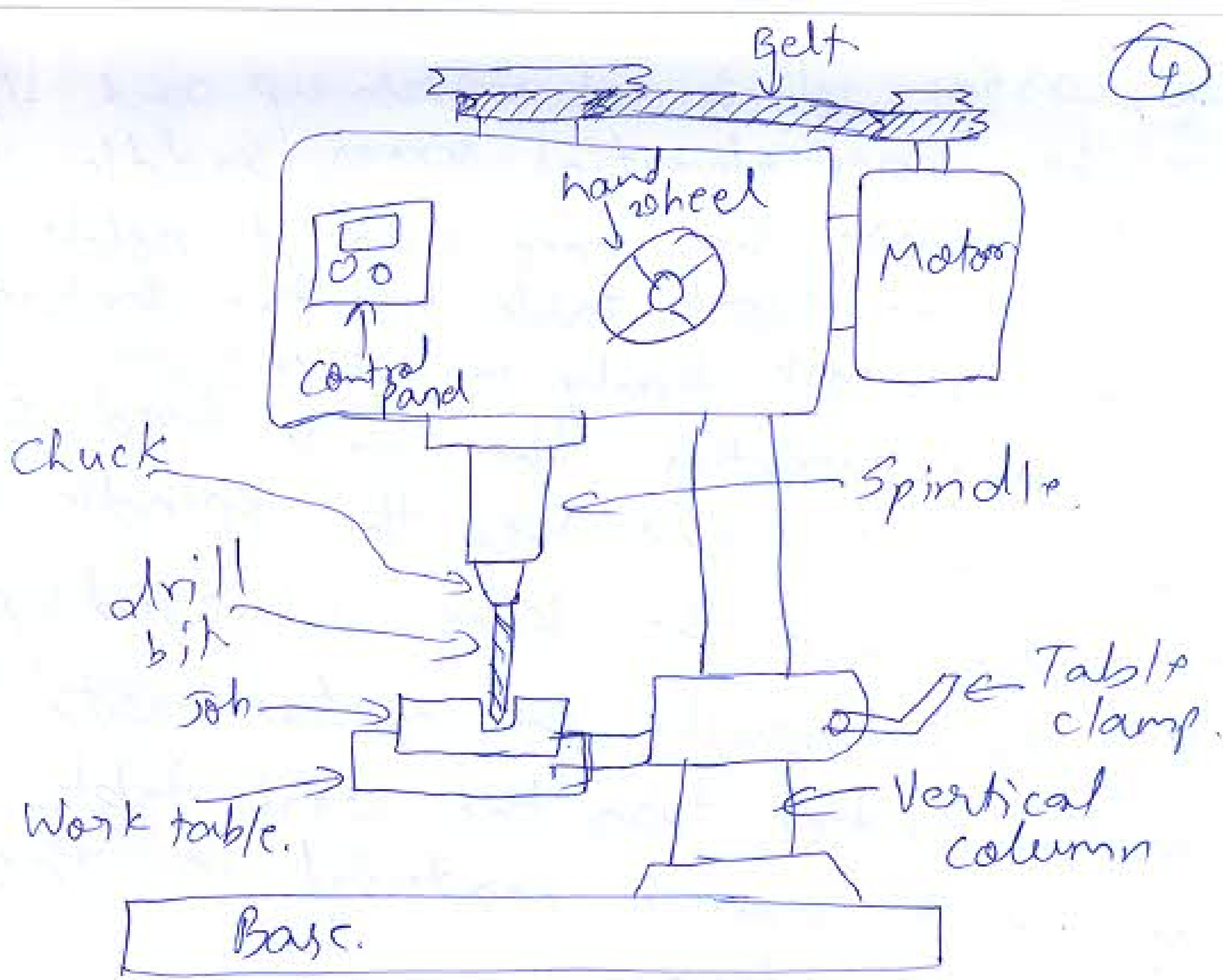
(2)(a) Drilling is a machining operation of producing a cylindrical hole in a solid workpiece by means of a revolving tool called a drill bit.

Bench drilling machine is used to drill very small holes for very small depths. The dia of the hole varies from 1.5mm to 15mm. The m/c is supported/placed on a work bench hence the name bench



Bench drilling machine

drilling machine. The base is made of cast iron and supports the vertical column and the entire machine. The vertical column is a hollow steel pipe which supports the work table and the head. The workpiece is fixed on the work table and then the worktable is moved up and down on the screw thread given on the column. The head of the m/c has a motor which is connected to the spindle of the m/c via a ~~belt~~ belt drive. The spindle rotates because of the motor and then ~~as~~ as the spindle is connected to the drill bit through a chuck, the drill bit also rotates. Now the location where the hole is required on the work is selected, the hand wheel is used to bring it in position and then the workpiece is raised until it makes contact with the rotating drill bit and the hole is drilled

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2 (b) Grinding is a process of removing excess material from the work piece by the mechanical action of abrasive particles that are held together by a bonding material, generally in the form of a wheel.

In cylindrical grinding, the cylindrical job is held in place by the center of their circular faces on the spindle and rotated. Then the grinding wheel also ~~rotes~~ rotates at a ~~dif~~ different speed and then moves along the length of the job to finish the work.

In center-less grinding the job is not held in place by a spindle instead there are two wheels, one is the grinding wheel and the other one being the regulating wheel. This regulating wheel is tilted slightly so that the workpiece can move forward. the other wheel is the grinding wheel which not only supports the job but also grinds it.

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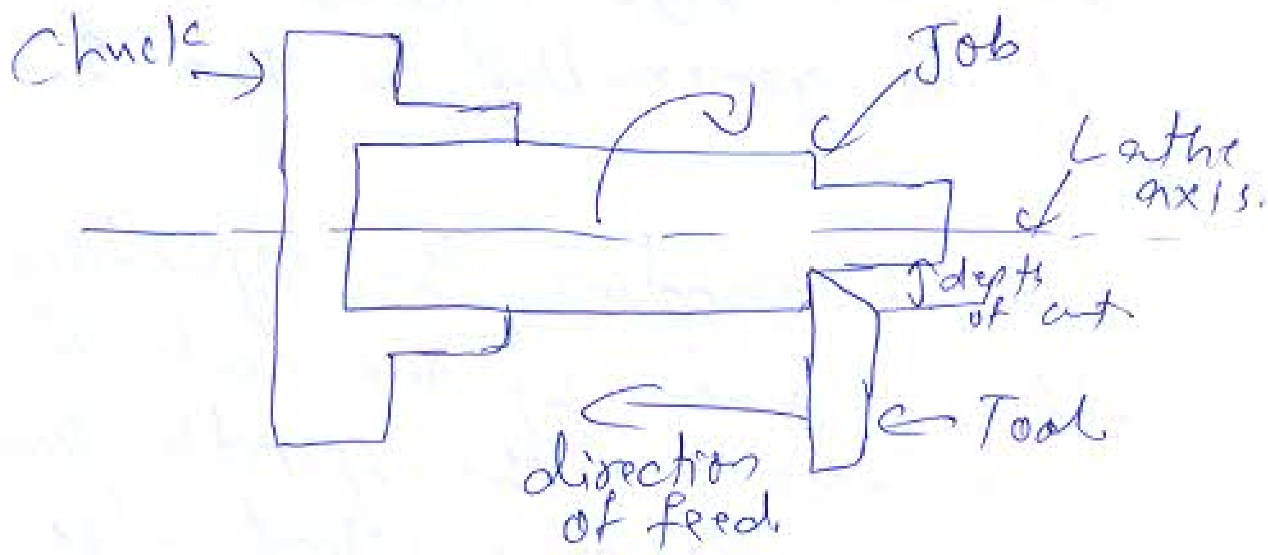
3) (a)

(i) Turning:-



Turning operation

In this operation the dia of the job is reduced. The job is held in the chuck firmly and rotated about the lathe axis.

The tool is fixed on the tool post. The tool is brought in contact with the job as the job is rotated, the depth is set by moving the tool perpendicular to the lathe axis and then the feed is given by moving the tool parallel to the job.

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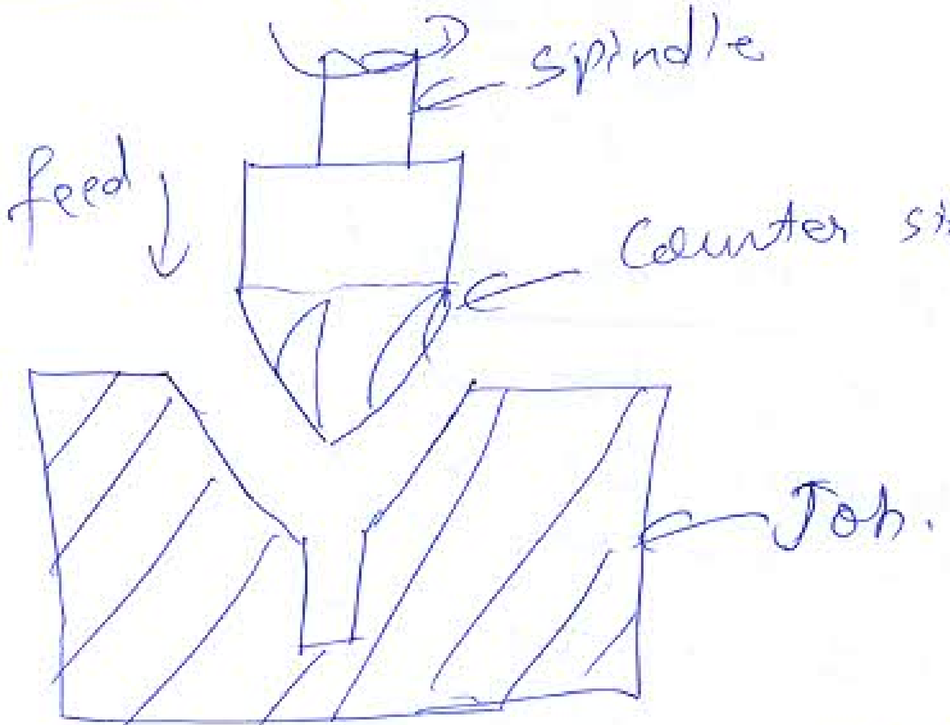
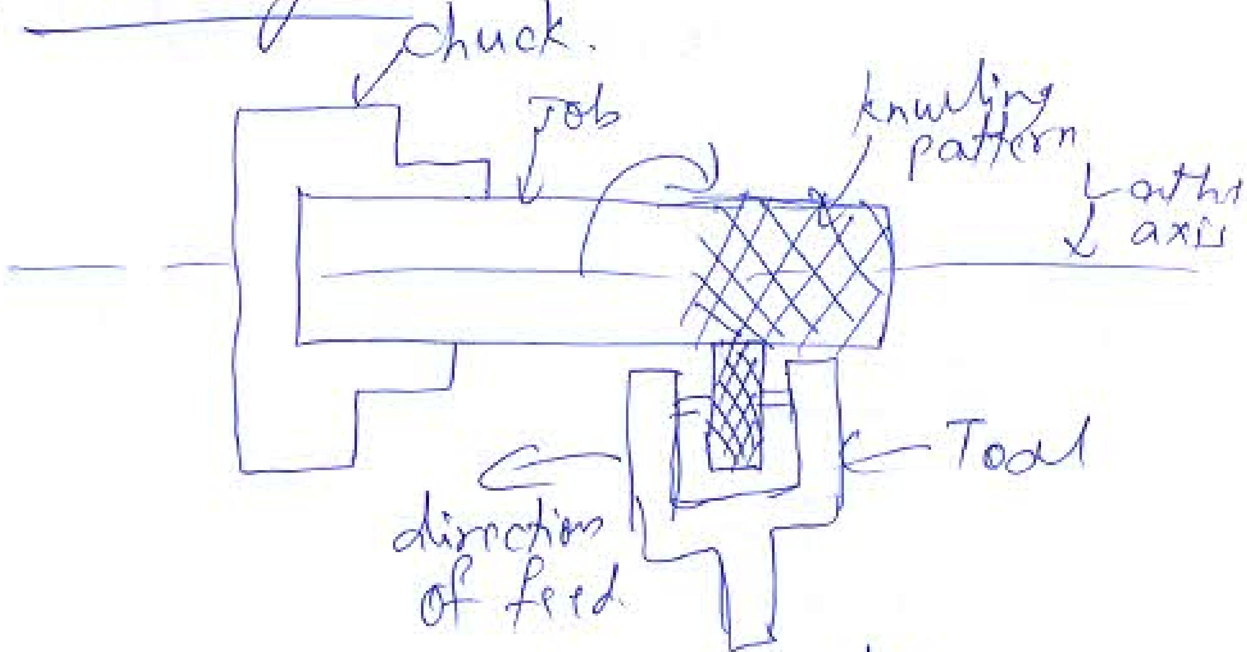
3 (a) (ii) Counter sinking :-



Counter sinking is done to obtain a tapered at the begining of the previously drilled hole. As the rotating tool enters the drilled hole, because of the conical shape of the tool, it produces a taper at the begining of the hole. This is to accomodate screws with conical (or) tapered heads.

3 (a) (iii) Knurling:-

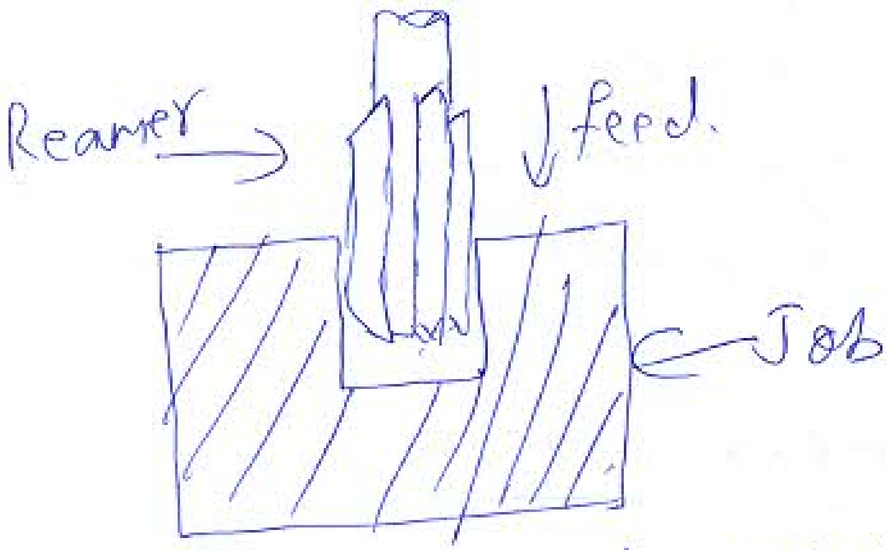


~~Kun~~ Knurling operation

It is an operation which imprints a pattern on the workpiece. It is carried out at slower speeds when compared to other operations. A roller which has the pattern to be imprinted on the job is used as the tool. It is pressed against the workpiece and the feed direction is ||le to the lathe axis. It is important that the job is softer than the tool. This pattern improves the grip on the job.

3 (a)

(iv) Reaming:-



Reaming is an operation carried out for finishing a pre-drilled hole. The reamer rotated along the drill axis and the feed is parallel to the axis. The reamer has cutting edges running the entire length of the tool. This tool removes only small amounts of material but it gives a good surface finish to the inner walls of the previously drilled hole.

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3 (b) (i) Motions on drilling machine

- → Rotational motion of the tool.
- → Longitudinal motion of the table.
- → Transverse motion of the table.

→ Up-down motion of the table.

3 b ii Planer:-

→ To-fro motion of the work table.
→ sideways motion of the work table.
→ Up-down motion of the tool.

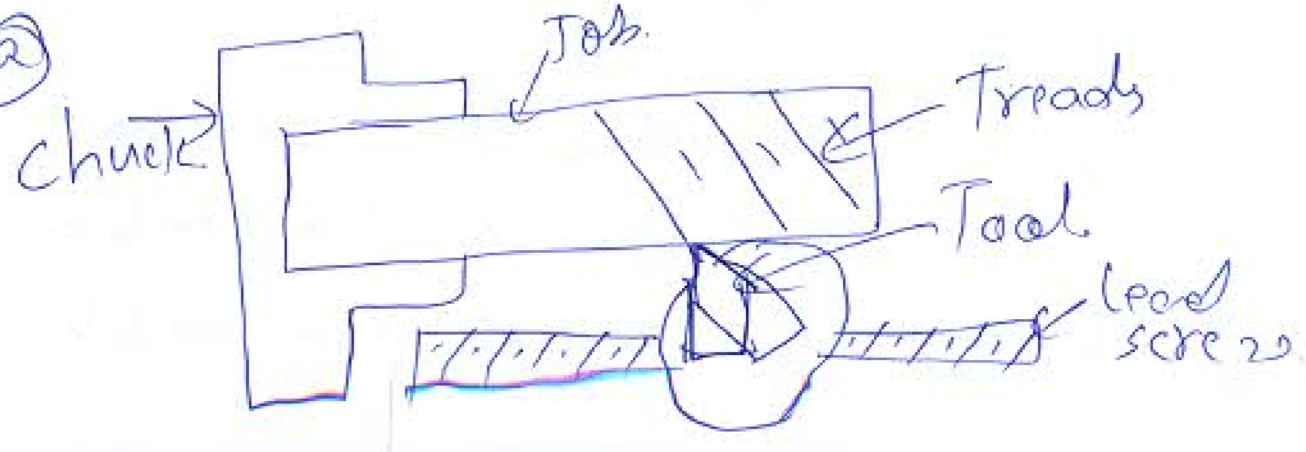
3 b iii Grinding machine:-

→ Rotational motion of the grinding wheel.
→ Longitudinal motion of the wheel.

3 b iv Shaping machine:-

→ To-fro motion of the tool.
→ sideways motion of the table.
→ Up-down motion of the table.

4 a



Tread cutting is carried out on workpieces to get treads on the outer surface of the workpiece. The tool is brought to the edge of the workpiece with an appropriate depth of cut. The feed of the tool parallel to the lathe axis. The feed cannot be manual because it can change the pitch of the tread, therefore the carriage is connected to a lead screw which gives a uniform feed.

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(4)(b) Machining parameters on a lathe:-

(i) Depth of cut:- The amount of material the tool removes as soon as it makes ~~an~~ contact with the job, its usually ⊥ʳ to the direction of the feed.

(ii) Feed rate:- The amount of movement of tool in the ~~a~~ feed direction for every rotation of the job.

(iii) Spindle speed:-

The different speeds at which the spindle can rotate.

→ Length of the job:-

The maximum length of the job that it can hold.

→ Overall dimensions

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(5) (a) Desirable properties of cutting fluids:-

(i) Should have high specific heat to remove maximum heat.

(ii) Should possess good lubricating properties.

(iii) Should be non corrosive.

(iv) Non-toxic & odourless.

(v) High flash point

(vi) Low viscosity.

(vii) Chemically stable.

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(5) (b) Given:-

Initial dia = 90mm, l_o = 5mm

l_j = 130mm, V = 30m/min

f = 0.3mm/rev.

l_a = 12mm, T = ?

$$T = \frac{L}{N \times f}$$

But $L = l_i + l_a + l_o$

$L = 130 + 12 + 5$

$\Rightarrow \boxed{L = 147\,mm}$

$V = \frac{\pi D N}{1000} \Rightarrow N = \frac{1000 \times V}{\pi D}$

$\Rightarrow N = \frac{1000 \times 30}{\pi \times 90} \Rightarrow \boxed{N = 1061\,rpm}$

$\Rightarrow T = \frac{147}{1061 \times 0.3}$

$\Rightarrow \boxed{T = 0.46\,min}$

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(6) (a) Desirable properties of a cutting tool material:-

(i) Should maintain its hardness even in red hot conditions.

(ii) Should be wear resistant.

(iii) Should be tough.

(iv) should have high thermal conductivity & specific heat.

(v) Should be chemically stable.

(vi) should be cheaply available.

List of cutting materials

→ Carbon & medium - alloy steel

→ High speed steel

→ Cast cobalt alloy.

→ carbides

→ Coated tools

→ ceramics

→ Cubic Boron Nitride

→ Diamond.

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(6) (b) Given:-

$L = 18cm = 180mm = 0.18m$

$b = 35cm = 350mm = 0.35m$

$V = 26m/min$

$f = 0.8mm/cycle.$

$R = 3:2 = \frac{3}{2} = 1.5.$

$T = ?$

$$T = \frac{L \times b(1+R)}{1000 \times V \times f}$$

$$= \frac{180 \times 350(1+1.5)}{1000 \times 26 \times 0.8}$$

$$\Rightarrow \boxed{T = 7.57 \text{min}}$$

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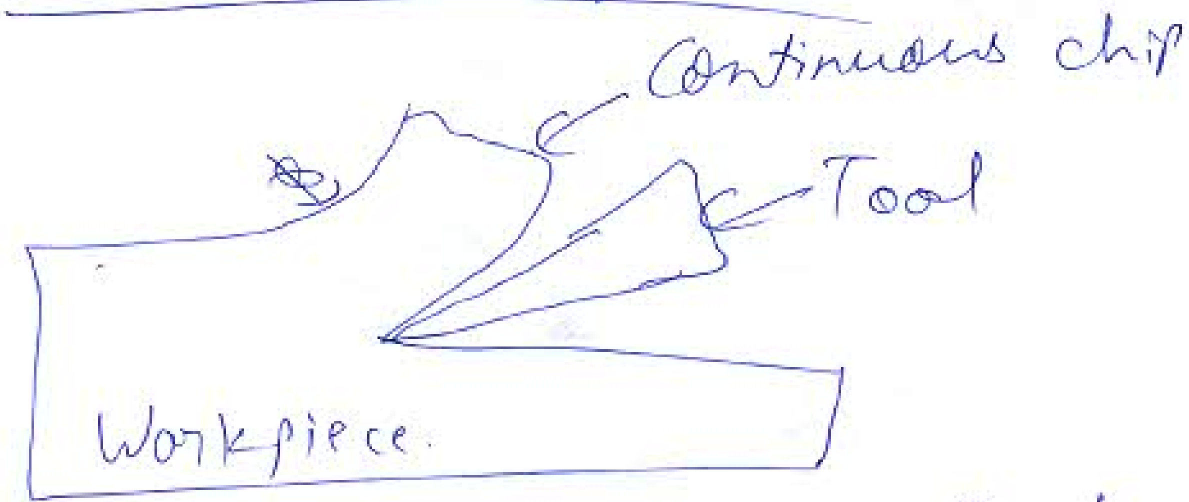
(7) (a) Continuous chips:-

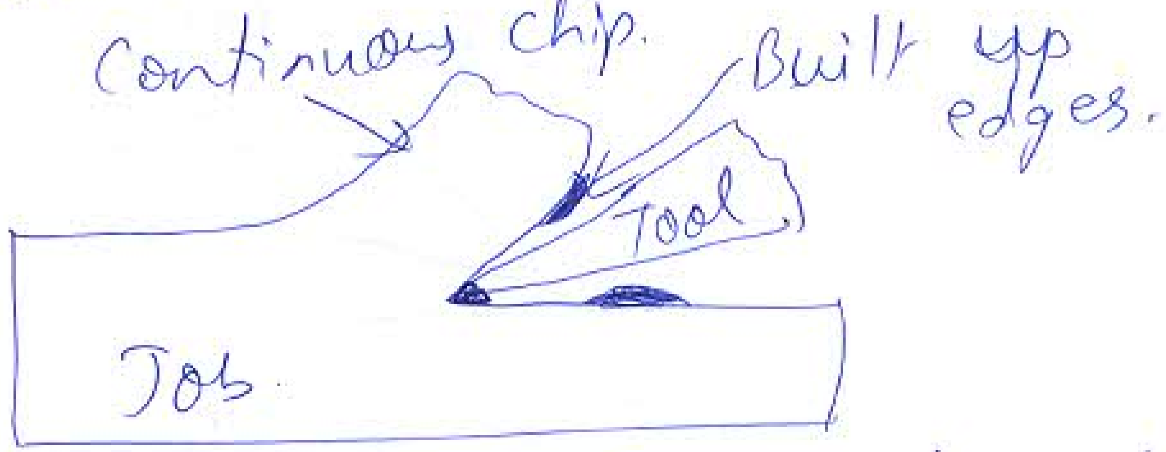


When the job is ductile fracture will not occur in the shear plane and the chip comes off in the form of long string (or) ribbon, with smooth shining surface.

Discontinuous chips:-

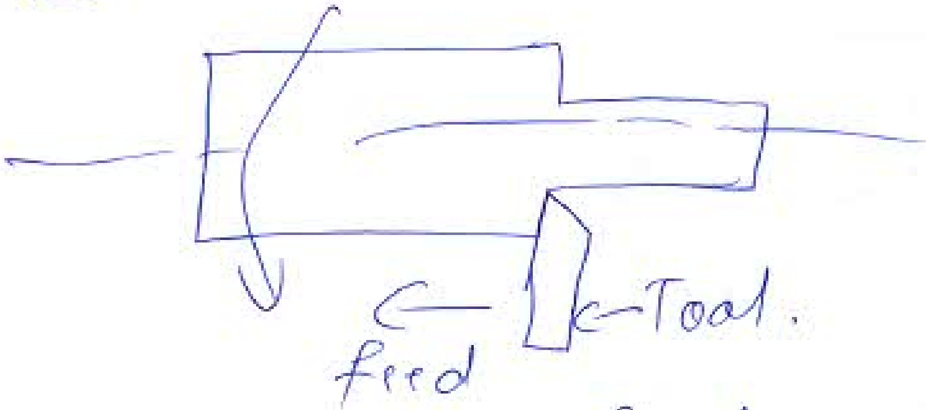
When brittle material is machined it produces discontinuous (or) segmented

Chips which cannot maintain a long ribbon like shape. This is very difficult to clean as well.

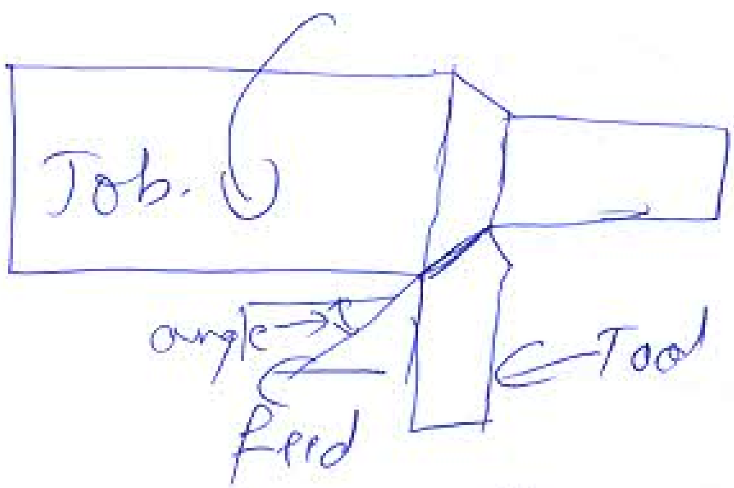


When machining tough steels such as alloy steels, toolsteels etc, larger cutting forces are required and this in turn produces a lot of heat at the tool-work interface. The high heat generated causes compressed metal adjacent to the tool nose to get welded to it in the form of metal lumps called built up edges.

7 (b)



Orthogonal feed



Oblique cutting

In orthogonal cutting the cutting edge is perpendicular to the direction of feed but in oblique cutting the cutting edge is inclined at an angle to the direction of feed. In orthogonal cutting the point of contact is very small but in oblique cutting the surface contact is larger which means less force on the metal so better surface

8 (b) Given:

$D = 20 mm$

$f = feed = 0.25 mm/rev.$

$N = $ Drill speed $= 300 rpm$

$C = 0.36$ for mild steel.

$$P = \frac{2\pi N T}{60000} \text{ kW.}$$

$$T = C f^{0.75} D^{1.8}$$

$$T = 0.36 (0.25)^{0.75} (20)^{1.8}$$

$$\Rightarrow \boxed{T = 27.96 \text{ Nm}}$$

$$\Rightarrow P = \frac{2\pi (300) \times (27.96)}{60000}$$

$$\Rightarrow \boxed{P = 0.878 \text{ kW}}$$

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9 (a) Factors affecting tool life:

→ Cutting speed:

Its the relative surface speed b/w the tool & the work.

$VT^n = C$.

V = cutting speed in m/min

T = Tool life in min

C = M/c constant

n = exponential index.

→ **Feed:-**

The amount of material removed / revolution

→ **Depth of cut:-**

Depth of cutting edge of the tool as it engages with the job.

$$V = \frac{257}{T^{0.19} f^{0.36} t^{0.80}} \text{ m/min}$$

f = feed in mm/min

t = depth of cut in mm

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(9) (b) $V_1 = 30$ m/min

$T_1 = 80$ min

$V_2 = 60$ m/min

$T_2 = 8$ min.

$T_3 = 4$ min.

Tool life eqⁿ $= VT^n = C$

$$V_1 T_1^n = V_2 T_2^n = V_3 T_3^n = C$$

Taking $V_1 T_1^n = V_2 T_2^n$

$$\Rightarrow \frac{V_1}{V_2} = \left(\frac{T_2}{T_1}\right)^n$$

$$\frac{30}{60} = \left(\frac{8}{80}\right)^n$$

$$0.5 = (0.1)^n$$

$$\ln(0.5) = n \ln(0.1)$$

$$\Rightarrow n = 0.3.$$

Using $V_1 (T_1)^n = C$, we have

$$30(80)^{0.3} = C$$

$$\Rightarrow C = 111.7$$

$\therefore$ Tool life eqⁿ $= VT^{0.3} = 111.7$

Cutting speed V_3 for $T_3 = 4$ min

$$V_2 T_2^n = V_3 T_3^n$$

$$\frac{V_2}{V_3} = \left(\frac{T_3}{T_2}\right)^n$$

$$\Rightarrow \frac{60}{V_3} = \left(\frac{4}{8}\right)^{0.3}$$

$$\Rightarrow V_3 = 73.86 \text{ m/min}$$

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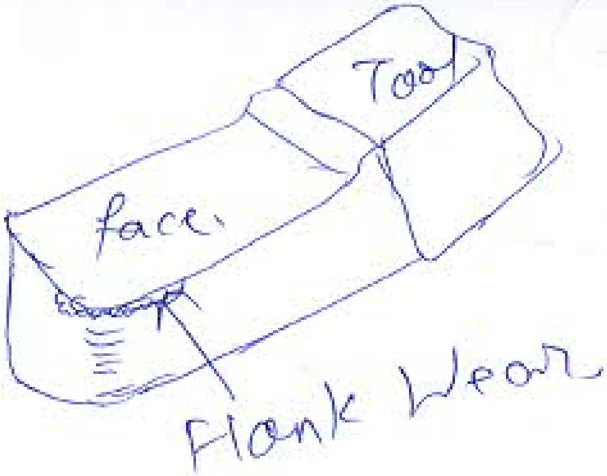
10 (a) Tool wear is a term often associated with cutting tools and describes its gradual failure due to regular operation.

Crater Wear

It is essentially the ~~to~~ erosion of an area on the tool face as shown in fig above. It occurs when m/c ductile materials.



It is a form of wear which appears on the flank below the cutting edge of the tool Its caused because of abrasive action b/w flank of the tool & the newly m/c surface

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10 b Machinability is a measure of how well any given material can be shaped using any machine tool.

Criteria for machinability are:-

→ The material should be able to machine very intricate shapes.
→ The material should not be very hard.
→ It should not wear out the tool.
→ It should produce continuous chips & avoid BUE.