CBCS SCHEME

USN

18ME35A/18MEA305

Third Semester B.E. Degree Examination, Dec.2019/Jan.2020
Metal Cutting and Forming

Time: 3 hrs. Max. Marks: 100

Note: Answer any FIVE full questions, choosing ONE full question from each module.

Module-1

1 a. Name and explain with example the different types of chips formed during metal cutting. **(06 Marks)**

b. Draw Merchant's circle diagram and state the assumptions made in establishing the relationship among the various forces. **(08 Marks)**

c. During an orthogonal cutting process the following observations were made-chip thickness = 0.62mm feed 0.2 mm rake angle 15°. Calculate the chip reduction coefficient and shear angle. **(06 Marks)**

OR

2 a. Differentiate between Turret lathe and Capstan lathe. **(06 Marks)**

b. Draw the tool layout for producing a hexagonal headed bolt on a capstan lathe from a hexagonal bar stock. Assume the dimensions. **(08 Marks)**

c. Write the functions of following lathe accessories :
(i) Live centre (ii) Dead centre (iii) Steady rest (iv) Follower rest
(v) Dogs and face plates. **(06 Marks)**

Module-2

3 a. With sketch write the comparison between up milling and down milling. **(06 Marks)**

b. Sketch and explain radial drilling machine highlighting its advantages and disadvantages. **(08 Marks)**

c. What is indexing? Name the different methods of indexing and explain compound indexing. **(06 Marks)**

OR

4 a. Differentiate Shaper and Planer? **(06 Marks)**

b. With sketch explain the external centreless grinding highlighting the feed mechanism. **(08 Marks)**

c. How the shapers are classified? How a vertical shaper is different from slotter. **(06 Marks)**

Module-3

5 a. Write a note on functions and types of cutting fluids used in metal cutting. **(06 Marks)**

b. Explain the various mechanisms responsible for different forms of tool wear. **(08 Marks)**

c. A cast iron plate of dimensions 450×150×60 mm, is to be rough shaped along its wider face. Calculate the machining time taking cutting speed = 10 mpm, return speed = 15 mpm, approach length = 30mm, over travel length = 30 mm, allowance on either side of the plate width = 6mm and feed per cycle = 15mm. **(06 Marks)**

OR

6 a. Which are the different forms of wear on the cutting edge of a tool? With appropriate sketch explain. **(06 Marks)**

b. Explain the critical cutting parameters which effect the tool life. **(08 Marks)**

c. The tool life for a HSS tool is expressed by the relation $VT^{1/7} = C_1$ and for Tungsten-Carbide $VT^{1/5} = C_2$. If the tool life for cutting speed of 24 mpm is 128 min, compare the life of the two tools at a speed of 30 mpm. **(06 Marks)**

Module-4

7 a. List the differences between cold working and hot working. **(06 Marks)**

b. What is forging? Explain the working of board hammer with sketch. **(08 Marks)**

c. With sketch explain : (i) Two high rolling mill (ii) Planetary rolling mill. **(06 Marks)**

OR

8 a. How the extrusion process is classified? Write a note on the difference between direct and indirect extrusion. **(06 Marks)**

b. With neat sketch explain the wire drawing process. **(08 Marks)**

c. Explain the defects in extruded products. **(06 Marks)**

Module-5

9 a. With a neat sketch explain V-bending and edge bending operations. **(06 Marks)**

b. What do you mean by dies? Write brief note on (i) Progressive dies (ii) Combination dies. **(08 Marks)**

c. With neat sketch explain shearing of sheet metal. **(06 Marks)**

OR

10 a. What is stripper? With neat sketch explain fixed plate stripper. **(06 Marks)**

b. With a neat labeled sketch explain the parts of open back inclinable press. **(08 Marks)**

c. Calculate the bending force for the 90° bend part from the steel sheet with air bending. The bend length is 30 cm, the material thickness is 2.5 mm and beam length is 25mm. The tensile strength of the material is 32 kN/cm^2. Die opening factor = 1.33. **(06 Marks)**

* * * * *

Solved question paper

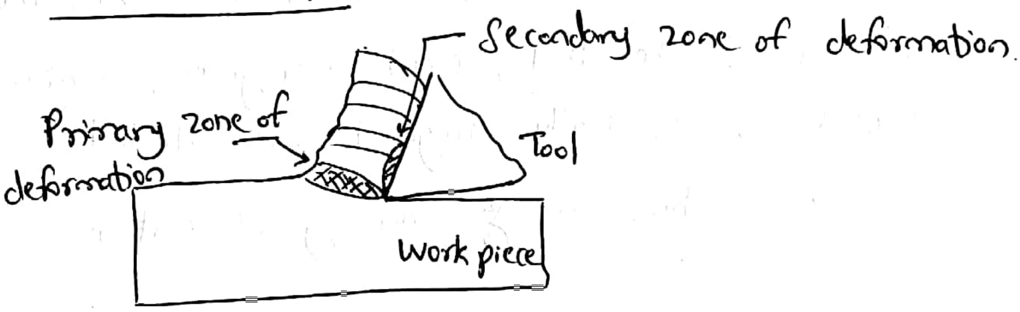
Sub: Metal Cutting & Forming
Sub code: 18ME35A
Exam: Dec 2019 / Jan 2020

Module - 1

Q1. a. In metal cutting operation 3 types of chips are formed.

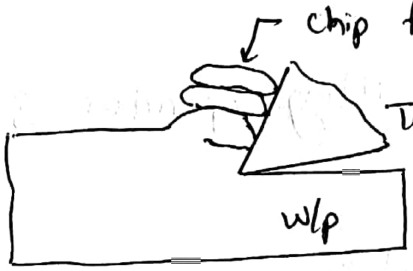
i) Continuous chips
ii) Discontinuous "
iii) Continuous chips with built up edge

i) Continuous chips: - 2M



When ductile materials are cut at high speeds & relatively small feed & d.o.c. continuous chips are produced. These chips come out as long ribbon. The pressure of the tool makes the material to plastically deform, it undergoes initially compression and then shear. The chip slides over the rake face and then leaves the tool. It undergoes deformation twice (shown in the figure). 1st at shear zone, 2nd on rake face.
ex: chips produced during machining of low carbon steel, copper, aluminium

ii) Discontinuous chips: — 2M



When brittle materials are machined, the chips come out as segments, called as discontinuous chips. Small plastic deformation produced by the tool leads to crack formation in the deformation zone. With the further advance of the tool, crack propogates, material lump moves & eventually fragment gets detached.

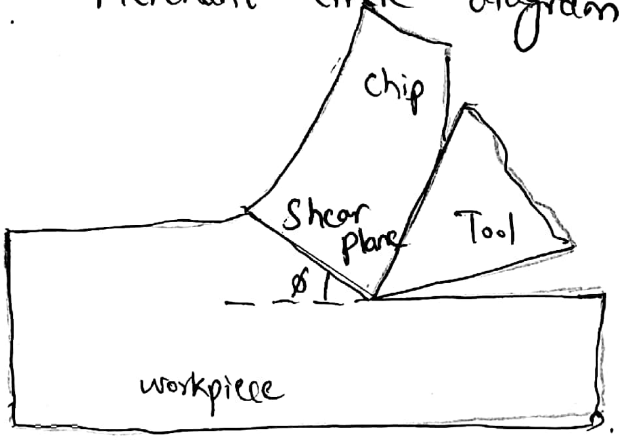
ex: chips during machining of cast iron.

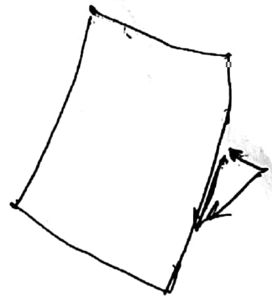
iii) Continuous chip with built up edge: — 2M

When machining ductile materials (Al) at low cutting speeds, friction b/w tool & chip tends the work material to adher (weld) to tool. Layer by layer deposition takes place, which is called as built up edge. Over a period of time it becomes unstable & will be carried with chips & machined surface. It can be avoided by increasing the cutting speed / using cutting fluid.

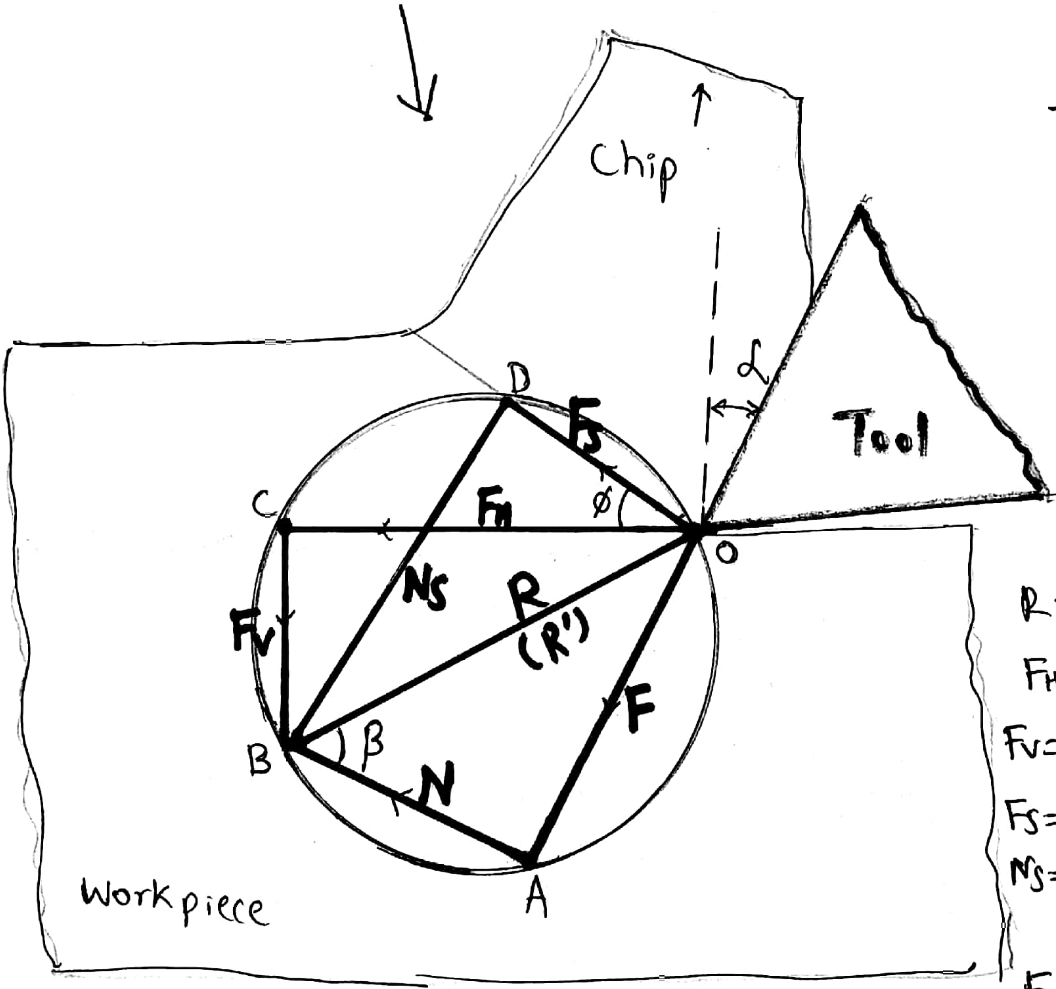
(3 × 2M = 6M)

Q1. b. Merchant circle diagram





— 5M



ϕ – Shear plane ∠le

α = rake ∠le of tool

β = friction ∠le

R = Resultant

F_H = Horizontal component

F_V = Vertical component

F_S = Force along shear plane

N_S = Force normal to shear plane

F = Friction force

N = Normal force to tool

Q1.(b) contd.

Assumptions made in establishing the relationship among the various forces :

— 3M.

- Inertia forces of chip are neglected
- The tool is perfectly sharp and there is no contact along the clearance face.
- Only continuous type of chip is formed
- The chip doesnot flow to either side, that is chip width is constant
- The depth of cut remains constant
- Width of tool is greater than that of the work.
- Work moves with uniform velocity relative to chip.
- No built up edge is formed.

[Merchant circle diagram — 5M
Assumptions — 3M.]

Q1. c. During an orthogonal cutting process, the following observations were made. Chip thickness = 0.62 mm, feed = 0.2 mm, rake ∠le = 15°. Calculate the chip reduction co-efficient and shear ∠le. (6M)

Soln: **Data:**

Chip thickness, $t_c = 0.62$ mm

feed = 0.2 mm (Note: for turning operations, feed will be equal to uncut chip thickness or undeformed chip thickness)

$\therefore t = 0.2$ mm.

rake ∠le, $\alpha = 15°$.

$r = 2$ $\phi = 2$.

Chip thickness ratio:

$$r = \frac{t}{t_c} = \frac{0.2}{0.62} = 0.32 \quad -3M$$

Chip reduction co-efficient $= 1/r = 1/0.32 = 3.125$

Shear ∠le, $\phi = \tan^{-1}\left[\frac{r \cdot \cos\alpha}{1 - r\sin\alpha}\right]$

$$= \tan^{-1}\left[\frac{0.32 \cos 15°}{1 - 0.32 \times (\sin 15°)}\right]$$

$$= \tan^{-1}[1.0865]$$

$$= 47.37° \quad -3M$$

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Q2. a. Differences between Turret lathe & Capstan lathe.

Turret lathe	Capstan lathe
1) Turret is mounted directly on the saddle	Turret is mounted on auxiliary slide which moves & which inturn is mounted on saddle.
2) For feeding the tool, entire saddle is moved	Saddle is fixed at certain distance & only auxiliary slide is moved.
3) Very high rigidity & usually of larger size.	Turret & slide will have cantilever effect, subjected to deflection. m/c is usually smaller in size.
4) can handle large & heavy workpieces.	Confined to smaller workpieces.
5) Rate of tool feeding is slower.	Rate of tool feeding is faster
6) Tool travel is almost to full length of bed.	Tool travel is limited.

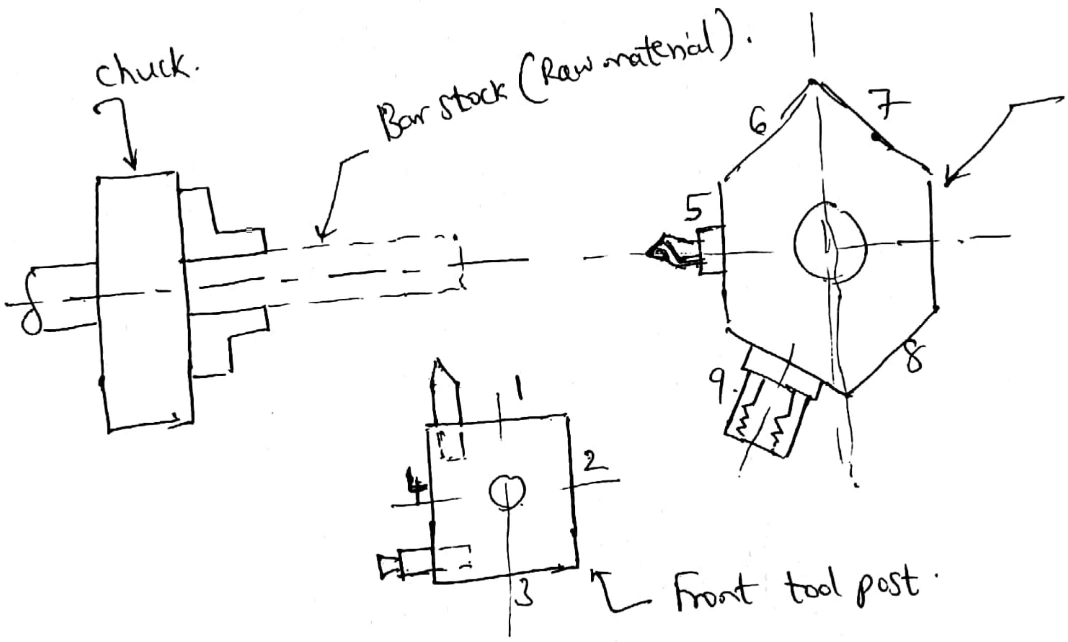
(Minimum 4 differences → 6M)

Q2: b: Tool layout for producing hexagonal headed bolt

Assumed thread size M8 x 40.

Bar stock size : Hex 16.

(8M).



[layout - 5M
Table / description - 3M]

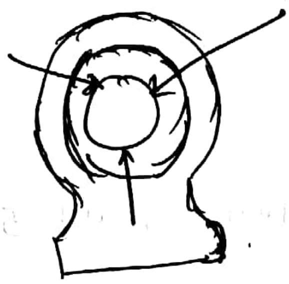
Sl. No.	Operation	Tool	Tool station / No.
1	facing	Turning Tool	Tool No. 1 – Front tool post.
2.	turning.	Turning Tool	Tool No. 1 – ".
3.	grooving / undercut.	Parting tool	Tool No. 4 – ".
4.	Centre drilling.	Centre drill	Tool No. 5 – Hexagonal turret.
5	Threading.	M8 die	Tool No. 9 – "
6.	Parting (last operation)	Parting tool	Tool No. 4 – Front tool post.

Q2. C. Functions of lathe accessories:

i) Live centre: The centre which is mounted on headstock side and which revolves with workpiece is called live centre. Whenever the work piece has to be machined accurately the workpiece will be mounted in b/w centres with the help of conical holes.

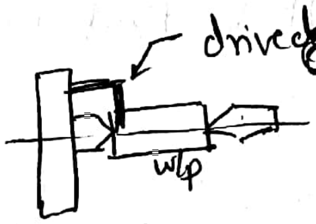
ii) Dead centre: The centre mounted on the opposite side (tailstock spindle) and which does not revolve is called dead centre.
The cone L'les of both centres will be accute than the cone L'le of centre holes on the w/p.

iii) Steady rest: It is the lathe accessory used to support the lengthy workpieces to avoid sagging effect. It is fixed in the position on lathe guideways.



iv) Follower rest: It is used to support the lengthy workpieces to avoid the sagging effect, but it follows the tool all along the length, hence the name. It consists of C-clamp like casting having 2 adjustable jaws which support the O/br w/p. It moves along with the carriage.

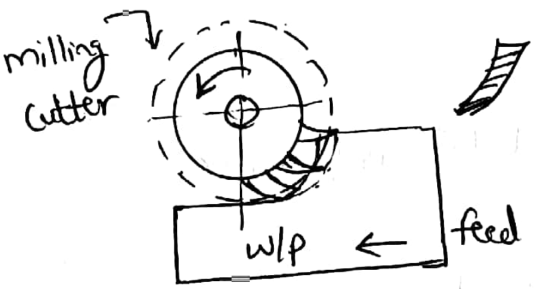
v) Dogs & face plates: Drive dogs & face plate are used to ensure +ve rotation of the workpiece whenever w/p is turned in b/w centres. Face plate will be mounted on chuck plate / spindle nose. One end of drive dog is mounted on face plate, the other end is made to butt / clamp the workpiece.

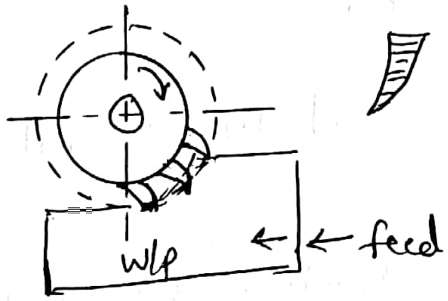


(Brief explanation of all 5 parts — 6 M.)

Module- 2

Q3. a. Comparison b/w upmilling & down milling.





– 2M.

Upmilling	Down milling
1. Cutter rotates against the direction of table feed.	Cutter rotates along the direction of table feed.
2. Chips are progressively thicker	Chips are progressively thinner
3. Chip load on teeth increases gradually from zero to maximum during contact period on each tooth.	It decreases gradually from ~~zero to~~ maximum to zero.
4. Cutting force in upmilling is directed upward and thus it tends to lift the w/p from table. ∴ Stronger clamping is required.	Cutting force is directed downward and thus it tends to press the w/p.

– 4M.

Sketch – 2M

Differences – 4M

(Min. 4 points)

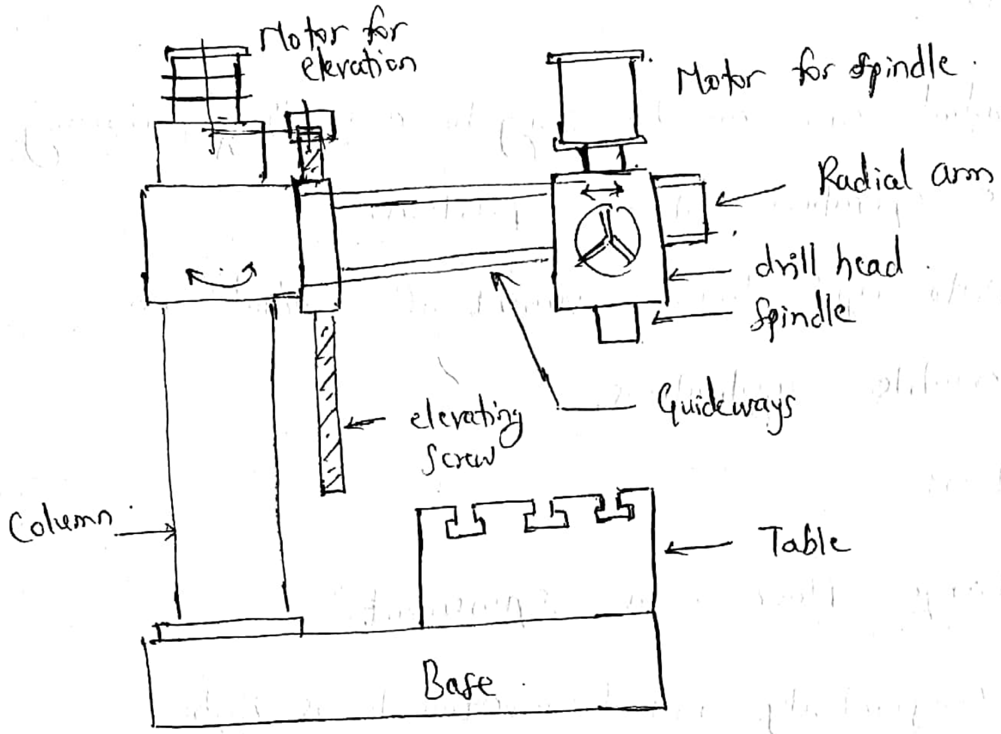
5.	Surface finish is poor	Surface finish is better
6.	Tool life is short	Tool life is better
7.	Practiced on conventional machines.	Practiced on CNC & rigid machines where backlash error is minimum.

[- Diagram - 2M.

- Differences - 4M.

(at least 4 important points - mentioned in the order)]

Q3. b. Radial drilling m/c :



— 3M.

- Radial drilling m/c consists of base, column, table, radial arm, drill head and 2 motors.
- 1 motor for up & down movement of radial arm & 1 motor for drive spindle — 3M
- Radial arm can swing about the cylindrical column for carrying the spindle to required point
- Drill head consisting of motor, drive spindle & feed arrange--ments moves over the guideways of radial arm.
- Table is mounted on the base and the workpiece can be fixed on the table with the help of fixture / vise / clamps.
- Drilling can be done at any point within the area of reach of radial arm.

Advantages :

- Radial arm can be swung to any ∠le for performing the operation at any position.
- Auto up & down movement of radial arm
- versatile applications.

— 2M.

Limitation:

- Large floor area requirement
- Comparatively initial investment is high

[Sketch - 3M

Explanation - 3M

Advantages & limitations - 2M.]

Q3. C.

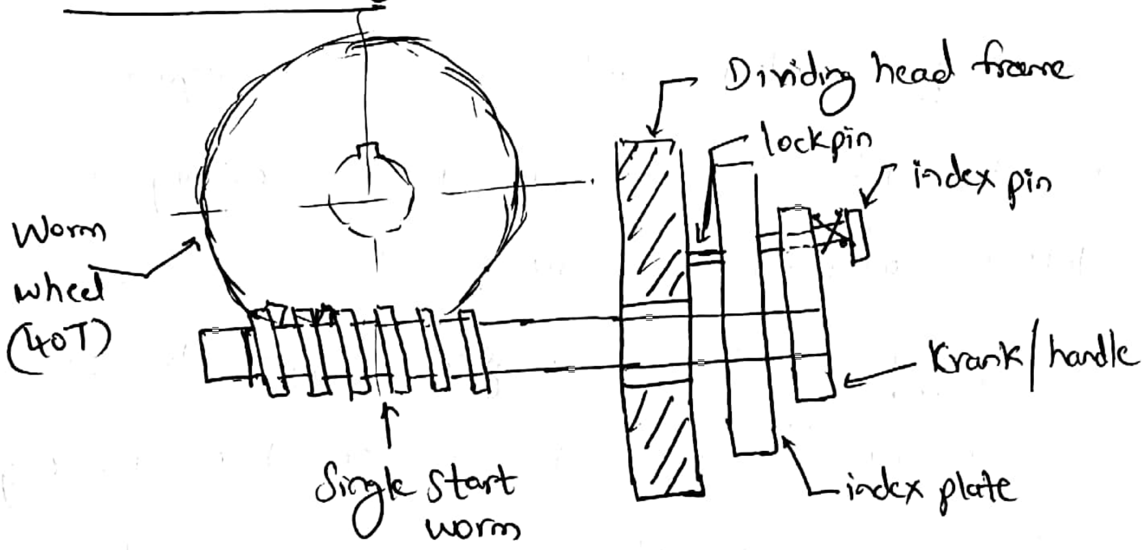
Indexing: Milling operations sometimes require the accurate rotation of components for even cutting of slots & grooves on the surface. The operation of rotating the workpiece through required ∠le b/w 2 successive milling cuts is termed as indexing — (1M)

ex: machining of splines, gears, polygons etc.

Different methods of indexing:

- Direct indexing
- Simple indexing
- Compound indexing — (1M)
- Differential indexing
- Angular indexing
- Indexing with servomotor.

Compound indexing:



— 4M

Compound indexing is used when workpiece cannot be indexed by simple indexing method. It is achieved in 2 stages.

i) By movement of crank pin as in simple indexing, say 'n_1' holes in hole circle 'N_1' of index plate with lock pin engaged in circle N_2 of index plate.

ii) By rotating crank & index plate together forward or backward through 'n_2' spaces in N_2 hole circle.

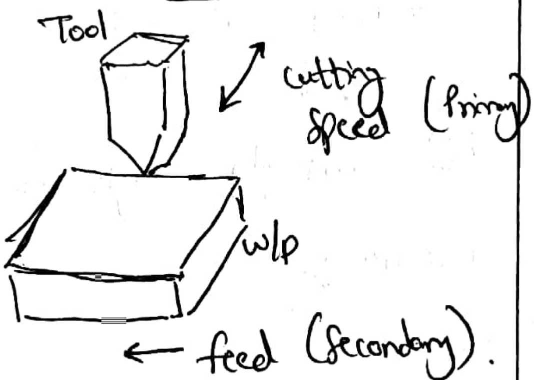
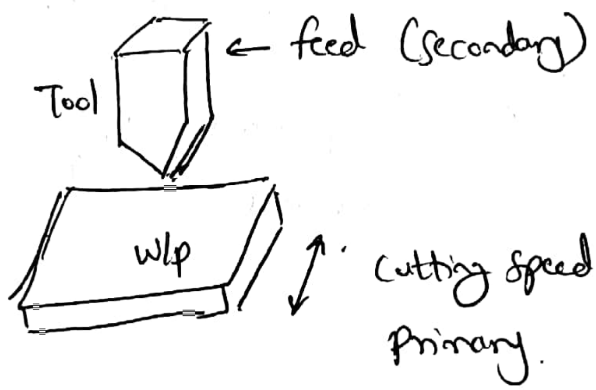
Compound indexing eqn:

$$\frac{n_1}{N_1} \pm \frac{n_2}{N_2} = \frac{40}{Z}$$

(Z = No. of div required)

Defn: 1M
Types: 1M
Compound indexing: 4M

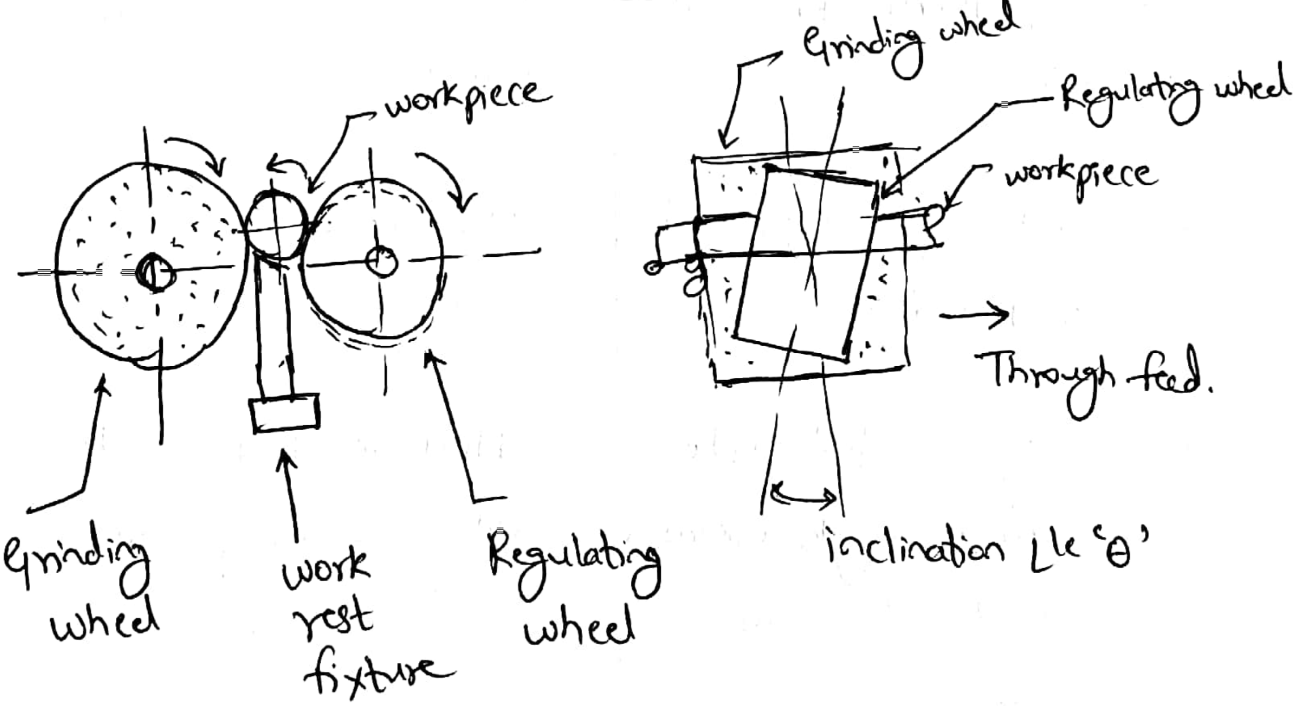
Q4. a. Differences b/w Shaper & planer

	Shaper	Planer
		
1.	Here the tool reciprocates and the workpiece is given the feed.	Here the workpiece reciprocates & the tool mounted on tool head is given the feed
2.	Shaper is a smaller m/c and preferred for small jobs.	Planer is a larger machine and can accommodate large & heavy jobs.
3.	Machining – light cut & fine feed.	Machining – heavy cut & coarse feed is possible.
4.	Only one tool can be used & single operation can be done at a time	Multiple tools can be accommodated and machining up to 3 faces can be done.

Shaper	Planer
5. Normally quick return mechanism is used.	Gear driven or hydraulic mechanism is used.
6. Comparatively less accurate.	Comparatively high machining accuracy..

[Sketch - 2M.
Differences - 4M.
(Min 4 points)]

Q4. b. External centreless grinding



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- External centreless grinding process is used where there is no provision of centre holes to be made on the component. Especially small pins, shafts, gudgeon pins are ground by this method.

- Process makes use of 2 wheels – 1) ~~regulator~~ grinding wheel (of required grade) & 2) regulating wheel (of softer grade – rubber bond).

- Regulating wheel is inclined by small angle – θ which helps for through infeed of the workpiece.

- Workpiece may be supported at the bottom by work rest fixture.

- Regulating wheel will feed the workpiece against the grinding wheel

- Both the grinding wheels rotate in same direction while the workpiece direction of rotation is reversed.

[Sketch – 4M
Explanation – 4M.]

Q4. c.

Classification of shaping machine:

a) based on direction of ram travel

- Horizontal shaper
- Vertical shaper

b) based on driving mechanism

- Crank type - ex: quick return motion mechanism
- Hydraulic type — 3M.
- Geared type.

c) based on stroke

- Push type shaper
- pull type shaper

Difference b/w vertical shaper & slotter — 3M.

- Both machines have stroke movements in vertical direction. Slotter is more rigid in construction as compared to vertical shaper.
- Slotter is predominantly used to produce

(Classification -3M
Differences -3M)

accurate internal/external slots & keyways.

Vertical shaper is used to produce/machine external surfaces – flat.

Module – 3

Q5: a.

Functions of cutting fluid: – 3M.

1) To carry away the heat during machining operation, improve tool life & productivity
2) Reduction of cutting force & power consumption
3) Improve surface finish and accuracy of the components
4) Breaking of lengthy chips.
5) Removal of chips from machining area
6) Corrosion prevention on component
7) Lubrication of m/c guideways
8) Reducing the distortion on component due to cooling effect.

Types of cutting fluids: – 3M.

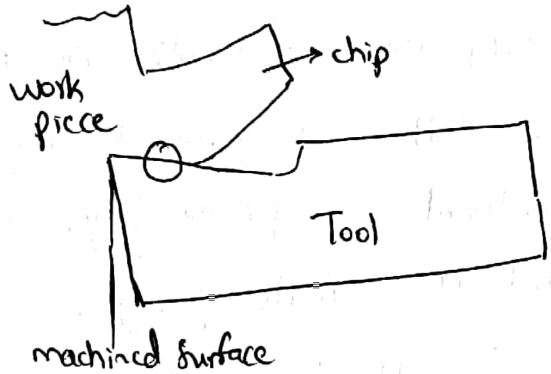
1. Straight cutting oils (used without any mixing)
   - Mineral oils
   - Fatty oils
   - Combination of mineral & fatty oils

2. Oils with additives (compounds of chlorine & sulphur are added to mineral oil to improve antirust properties and reducing welding of chip to tool)

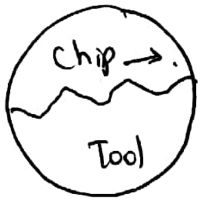
3. Water based cutting fluids
   (mineral oil + fat mixture + emulsifier + water).
   They are usually used in the ratio of 15:1 to 20:1 by mixing with water.

[Functions – 3M
Types of cutting fluids – 3M.]

Q5 b. Various mechanisms responsible for tool wear:



1) <u>Shearing at high temperature:</u>



When the chip slides over the rake, ridges of both will interlock. The chip would have work hardened & when this rubs over the tool (hardness decreases @ high temp), yielding/deformation of tool will happen.

2) <u>Diffusion wear:</u>

The tool contains alloying elements like tungsten (W), Chromium (Cr), Molybdenum (Mo) & Carbon (C), Because of high temperature at interface, these will diffuse into chip ($\because$ of concentration gradient).

3) <u>Adhesion wear</u>

Particularly when materials like Al are machined, the soft work material may weld to harder tool material. Layer by layer welding takes place - called as 'built up edge'. When this BUE is sufficiently big, it becomes unstable & gets detacted from the tool. While doing so it takes away some portion of tool. This is called as adhesion wear.

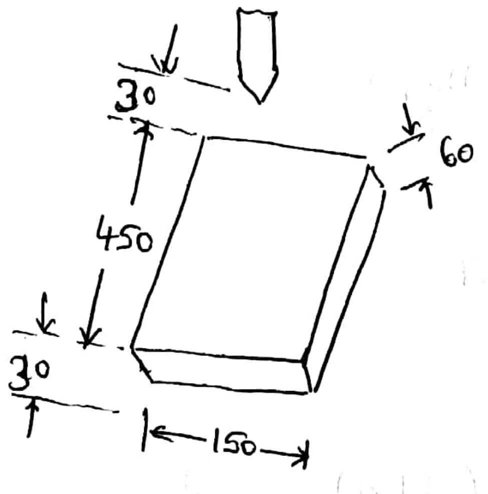
4. <u>Abrasion wear.</u>

The underside of chip may contain hard particles (ex: sand grains while machining castings). When these hard particles rub over the surface of tool, they make ploughing action on the ~~work~~ tool surface. This kind of wear is called as abrasion wear.

[Explanation of min 4 wears - 4x2M = 8M.]

Data:

Q5. c.



CI plate (w/p) size: 450 × 150 × 60 mm

Along the stroke = 450 mm (wider face, as mentioned)

Cutting speed (forward stroke), V = 10 m/min

return speed (return stroke) = 15 m/min — 1M

Approach length = 30 mm

Overtravel " = 30 mm.

Allowance on either side of the plate width = 6 mm

feed per cycle = 15 mm or 15 mm/cycle

Length of tool travel = 450 + 30 + 30

L = 510 mm

Width of machining, B = width of w/p + 6 + 6 (allowance)

= 150 + 6 + 6

= 162 mm

Ratio, $\lambda = \frac{\text{forward Speed (cutting)}}{\text{return speed}}$ — 1M

$= \frac{10}{15} = 0.667$

We know that,

Cutting speed, $V = \frac{NL(1+\lambda)}{1000}$

where,
N = No. of Strokes/min

$N = \frac{V \times 1000}{L(1+\lambda)}$ —2M.

$= \frac{10 \times 1000}{510(1+0.667)} = 11.76$ Strokes/min.

Time of machining, $t_m = \frac{B}{f \times N}$

$= \frac{162}{15 \times 11.76}$ — 2M.

$= 0.918$ min

$= 55.1$ s.

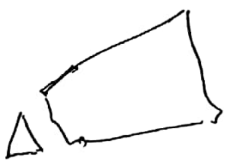
[Data : 1M
Steps : 1+2+2 M]

Q6. a. Types of tool wear / failure :

Tool Failure.

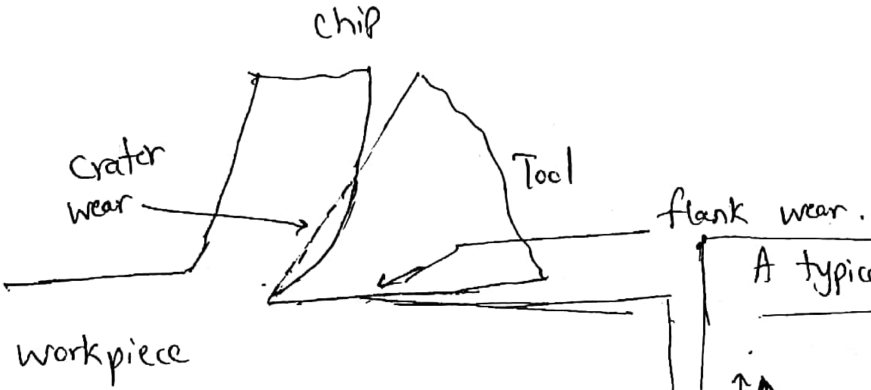
Tool breaking	Gradual tool wear
- Plastic deformation	- Flank wear
- Chipping	- Crater wear.

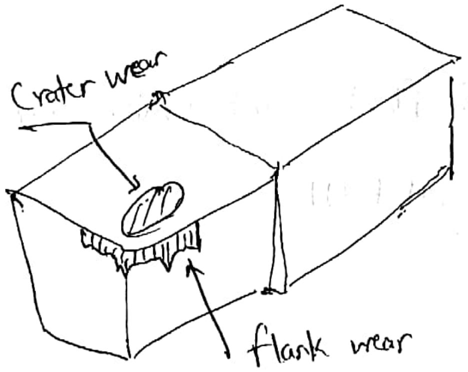
Plastic deformation
(∵ of thermal softening)
& yielding.



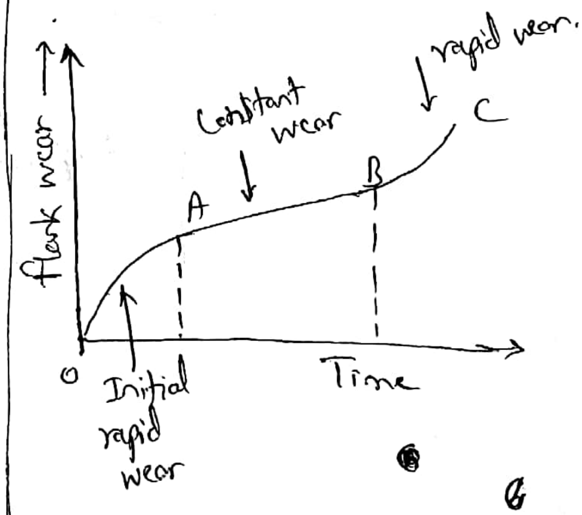
chip off
(∵ of mechanical loading)

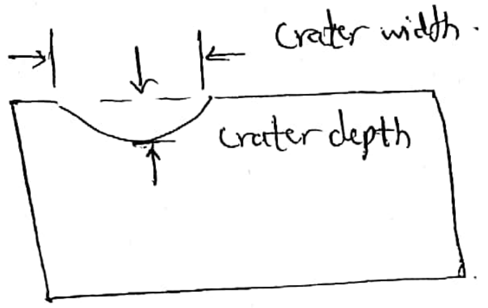
Gradual wear of tool :



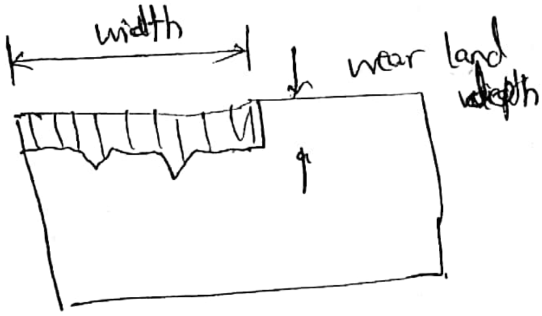


A typical wear curve for cutting tool





Crater wear



flank wear.

– When the tool is used for machining, the chip slides over the rake (top) surface of tool & the machined surface & unmachined surfaces of work piece rub the flank of the tool. As a result, the wear happens on rake (crater wear) & flank (flank wear).

<u>Crater wear:</u> The wear observed on the rake surface ∵ of chip impact is called crater wear. It is a circular / elliptical pit formed on the rake and is usually formed at a certain distance from tool edge. Characterised by crater width & depth.

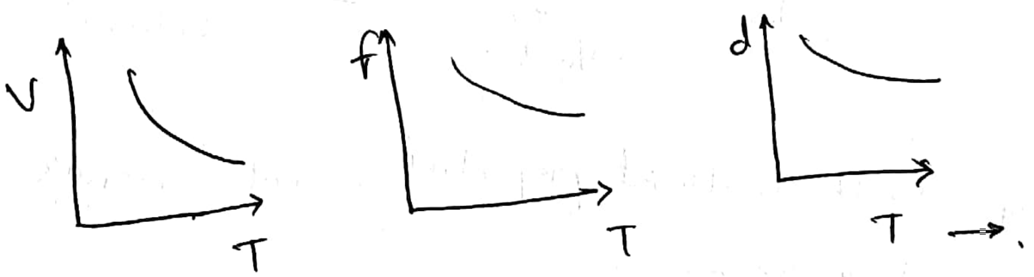
<u>Flank wear:</u> The wear observed on the side & end flanks of tool ∵ of rubbing / continuous contact of the workpiece during machining is called flank wear. Characterised by wear land width & depth.

[Explanation of flank wear & crater wear
3M + 3M]

Q6. b. Critical cutting parameters which affect the tool life:

1. <u>Cutting conditions:</u>

	Effect	Consequence
a. Increase in cutting speed ↑	tool temp ↑, Softening of tool, abrasion & adhesion wear	tool life reduces
b. Increase in feed	cutting force ↑ high temp & tool wear	tool life reduces
c. Increase in depth of cut	increase in area of chip tool contact, little increase in temp	tool life reduces

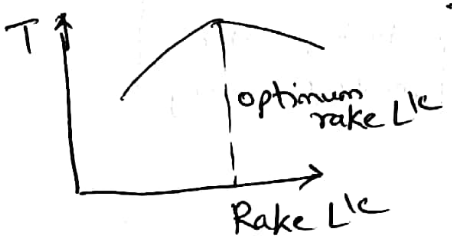


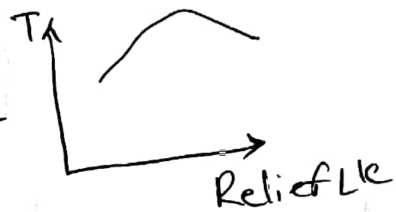
Impact of V > f > d on tool life

2. <u>Tool material properties</u> which enhance tool life: high hot hardness, toughness, wear resistance, high thermal conductivity & specific heat

3. Tool geometry.

Tool Geometry	Effect
Rake L^le ↑	Tool life initially increases & then decreases
Relief L^le ↑	"
Nose radius	Tool life increases





4. Work material properties that increase the tool life are:
- low strength & hardness
- absence of abrasive constituents
- presence of additives like lead
- favourable microstructure (CI containing graphite)

5. Coating of tool with TiC, TiN, TiC + Al_2O_3

6. Usage of cutting fluid enhances tool life.

[Min. of 4 points × 2 M = 8M.]

Q6. C. The tool life for a HSS tool is expressed by the relation $VT^{1/7} = C_1$ and for tungsten carbide $VT^{1/5} = C_2$. If the tool life for cutting speed of 24 mpm is 128 min, Compare the life of tools at a speed of 30 mpm. (6M)

Soln:

Data:

$V_{HSS} T^{1/7} = C_1$ $V_{carbide} T^{1/5} = C_2$

$V_1 = 24$ m/min & $T_1 = 128$ min. (for both).

What is tool life T_2 at cutting speed, $V_2 = 30$ m/min.

Substitute the values of V_1 & T_1 in tool life equation.

$V_{HSS} T^{1/7} = C_1$

$\therefore 24 (128)^{1/7} = C_1$ $\therefore C_1 = 47.98$

$\boxed{\therefore V_{HSS} \cdot T^{1/7} = 47.98}$ → (1).

|||ly $V_{carbide} \cdot T^{1/5} = C_2$.

$24 (128)^{1/5} = C_2$ $\therefore C_2 = 63.336$.

$\boxed{V_{carbide} \cdot T^{1/5} = 63.336}$ → (2).

— 2M

Substituting the value of $V_2 = 30$ m/min in eqn (1).

$V_{HSS} \cdot (T)^{1/7} = 47.98$.

$30 (T)^{1/7} = 47.98$

$(T)^{1/7} = \frac{47.98}{30} = 1.599$. $T = (1.599)^7$

$T = 26.76$ min. — 2M

For HSS →

Substituting the value of $V_2 = 30$ m/min in eqn (2)

$$V_{carbide} \, T^{1/5} = 63.336.$$

$$30 \cdot (T)^{1/5} = 63.336.$$

$$T^{1/5} = \frac{63.336}{30.} = 2.1112$$

$$T = (2.1112)^5 = 41.94 \text{ min.}$$

Carbide →

∴ At a cutting speed of 30 m/min, HSS tool has a tool life of 26.76 min & carbide tool has tool life of 41.94 min.

— 2M.

Module - 4

Q.7. a. Comparison of hot working and cold working.

	Hot working	Cold working.
Working temp	Above recrystallisation temp	Below recrystallisation temperature
Properties	Nearly isotropic - uniform in all directions	anisotropic properties.
Mechanical Properties	Strength and hardness decrease.	Strength & hardness increase.
"	ductility/yield strength increase	ductility/yield strength decrease
Surface finish	Poor : because of scaling at higher temperature	Better
Dimensional accuracy	Poor : because of thermal expansion of metals	Better
Strain hardening	No strain hardening.	Takes place.
Material handling	Difficult	Easy
Machine capacity	Machine capacity required is comparatively less, ∵ lesser force is required	comparatively more.
	No. of stages required to bring the deformation is less.	No. of ~~[illegible]~~ stages required is more.

	Hot Working	Cold Working
	Extra equipment - furnace is required for heating.	Extra equipment is normally not required, except in some cases where annealing is required.
Post processing.	Required - processes like oil pickling to remove the scaling are required.	Not required.

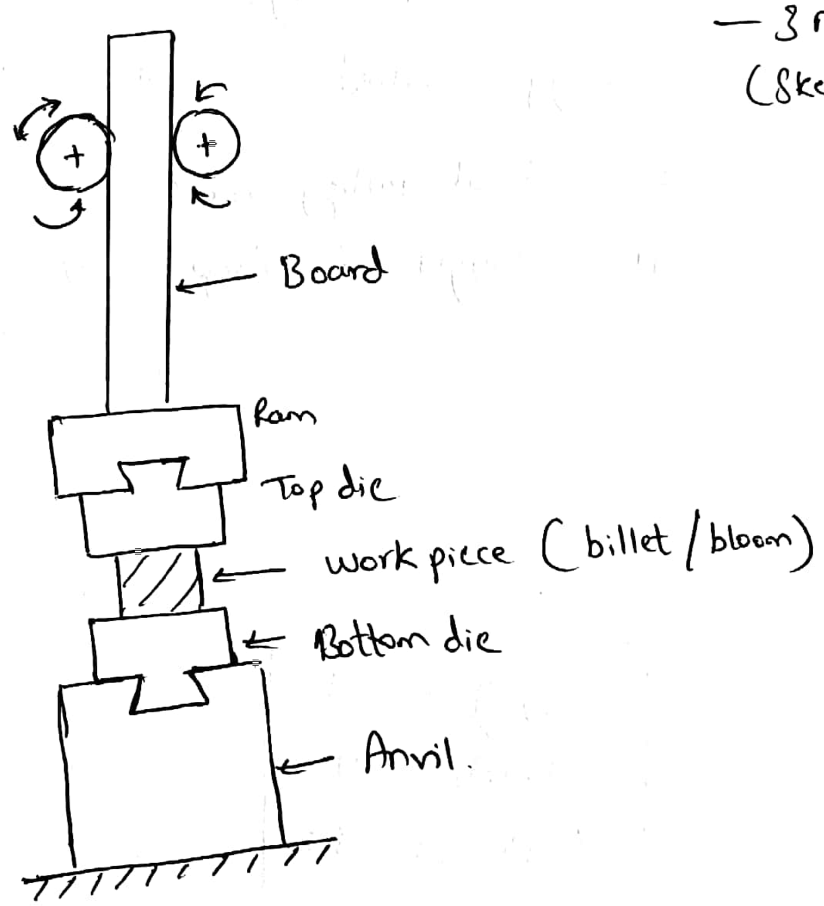
[Atleast 6 differences - 6M]

Q.7.b.

<u>Forging:</u> Forging is a mechanical working process where in deformation in the material is brought by the application of compressive force. It involves shaping of metal through impact hammering, pressing or rolling to produce components with superior strength. — 2M.

<u>Board hammer:</u>

— 3M (Sketch)



- Board hammer consists of board, rollers, ram, die.

- Lower die is fixed on anvil & upper die is fixed to moving ram.

- Board (wooden board) is lifted by rollers (∵ of friction) to certain height and dropped.

Blow due to falling weight of the ram makes the stock to forge.

Energy supplied = $mgH = \frac{1}{2}mv^2$

m = total falling mass

H = height of drop , V = velocity at the end of stroke

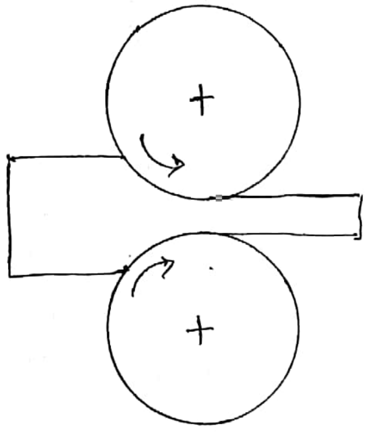
— 3M (explanation)

[Forging : 2M
Sketch : 3M
Explanation : 3M]

Q 7C: ~~[illegible]~~

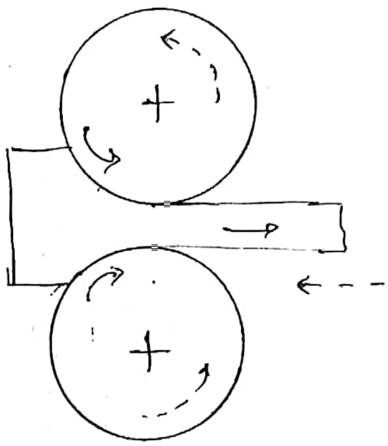
The machine used for rolling (set of rollers) is called rolling mill. The arrangement of rolls in rolling mill varies depending on the application. The names of the rolling mill are generally given by the number of rolls employed.

i) 2-high roll mill



2 rollers are used & is unidirectional

ii) 2-high reversible roll mill.

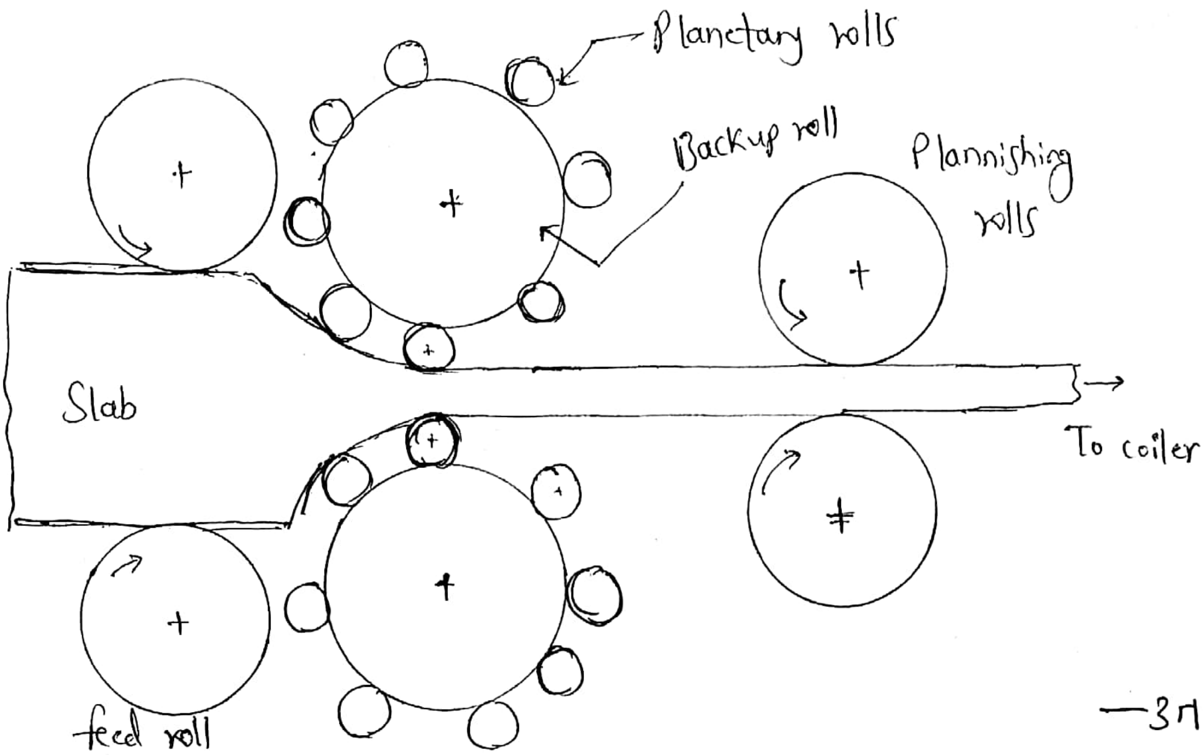


Bidirectional, centre distance of rollers changes after one pass allowing for further reduction in thickness after one pass.

* The term 'high' signifies that rolls are placed above ground level.

— 3M

ii) Planetary rolling mill



—3M .

Here small rolls surround the bigger back up roll. working is done by small rolls (arranged in planetary fashion around the backup roll).

- Feed rolls help for feeding the work in b/w planetary rolls.
- Very high reduction (Slab to Sheet) takes place in one pass.
- Plannishing rolls at the exit help to maintain surface flatness & surface finish.

[2 high roll mill — 3M
Planetary roll mill — 3M]

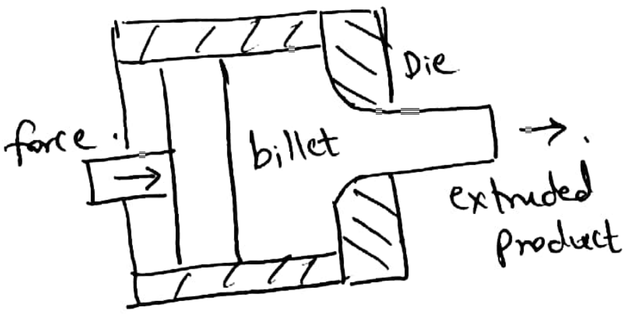
Q8. a.

Classification of extrusion processes:

- Extrusion
  - Hot extrusion
    - Direct extrusion
    - Indirect extrusion
  - Cold extrusion
    - Direct
      - Hydrostatic extrusion
    - Indirect
      - Impact extrusion
      - Cold extrusion forging

—(2M)

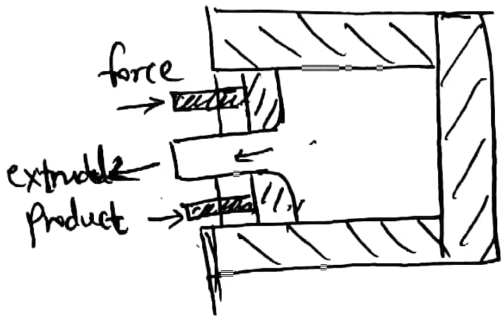
Direct extrusion



- Product comes out of the die in the same direction of applied force

- More friction, ∵ of relative movement b/w cylinder & billet.

Indirect extrusion



- Product comes out in the opposite direction of applied force

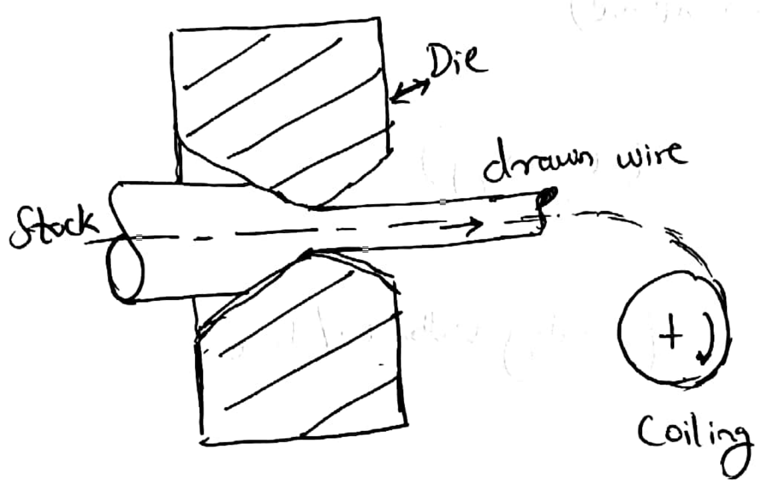
- Less friction

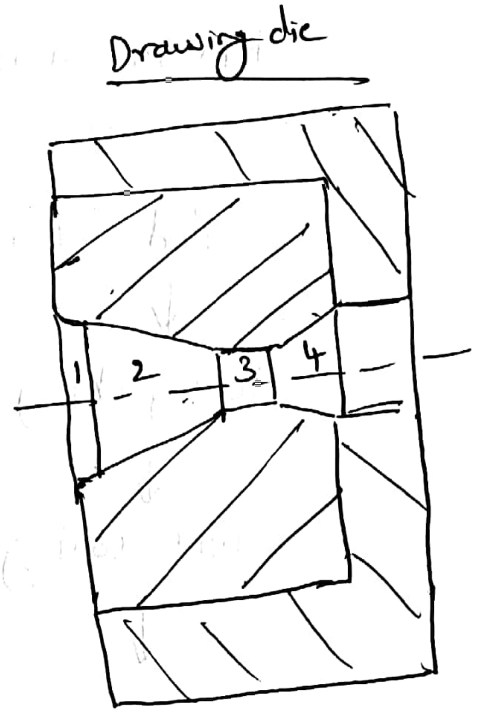
Direct extrusion	Indirect extrusion
- Amount of reduction possible in extrusion is more.	Amount of reduction possible is less.

— (4M)

[Classification — 2M.
Differences — 4M.]

Q8. b. **Wire drawing process:**





- Wire drawing is metal working process to obtain wires from rods of bigger diameter by pulling it through die.
- It is always a cold working process.
- The die is of conical shape. The end of the rod to be drawn is made pointed by hammering or swaging and then inserted in the die.
- The end is then gripped on the other side with a gripper & then wire is pulled through the die & next coiled over a reel.

Drawing die:

1: entry zone

2: Conical working zone

3: bearing surface (guiding)

4: exit zone (relief)

Steps in wire drawing

Rod (raw material)

↓

Acid pickling (cleaning)

↓

Wire coating (coating with Cu/ lime)

↓

Swaging or hammering of tip

↓

Passing through die & draw

↓

Annealing (to restore ductility)

↓

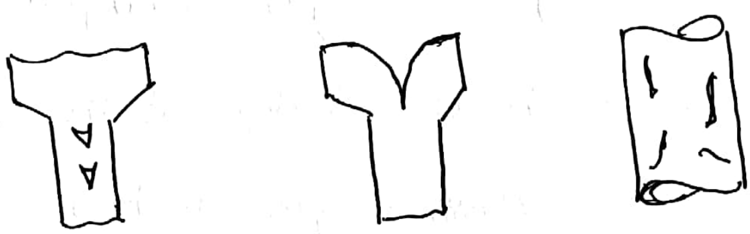
next stage of draw (till final diameter is reached).

[Sketch – 3M

Explanation – 5M]

Q8. C. **Defects in extruded products:**

Owing to considerable deformation associated with extrusion operations, a number of defects can occur in extruded products.



(i) (ii) (iii)

i) Centreburst: This defect is an internal crack that develops as a result of tensile stresses along the centreline of the work part during extrusion. The significant material movement in the outer region stretches the material along the centre of the work. If the stresses are high bursting occurs. This is centreburst. Conditions are: high die L/e, low extrusion ratios, impurities in the work metal etc.

ii) Piping is the defect associated with direct extrusion. It is the formation of

Sink hole in the end of billet. The use of lesser diameter dummy block helps to overcome piping defect.

iii) Surface cracking : Higher workpart temperatures can cause cracks to develop at the surface. These occur when extrusion speed is high — leading to high strain rate associated with heat generation.

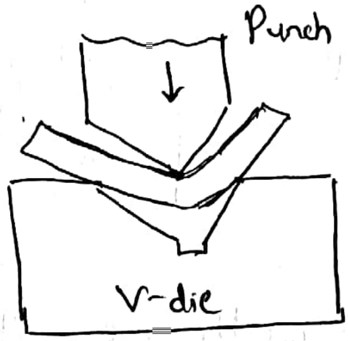
(Explanation of 3 defects × 2M = 6M)

Module -5

Q9. a.

V-bending:

— (3M)

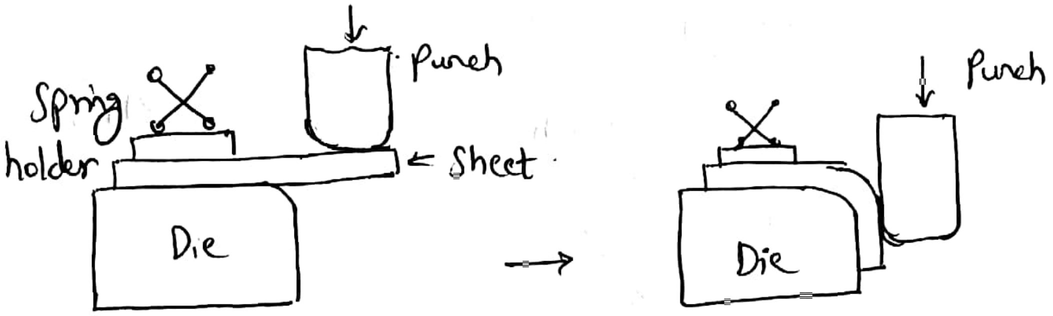


In V-bending, both punch & die are of V-shape. Flat sheet is kept on the die & with the downward movement of the punch, bending operation is done.

i) Air bending: Stroke of punch is limited. There will be gap left b/w bent part & die. Variety of included ∠les can be formed with same die.

ii) Bottoming type: At the end of stroke, no gap is left b/w bent part & die. Angle of bend & shape are controlled by full downward movement of the punch.

Edge bending operation: —(3M)



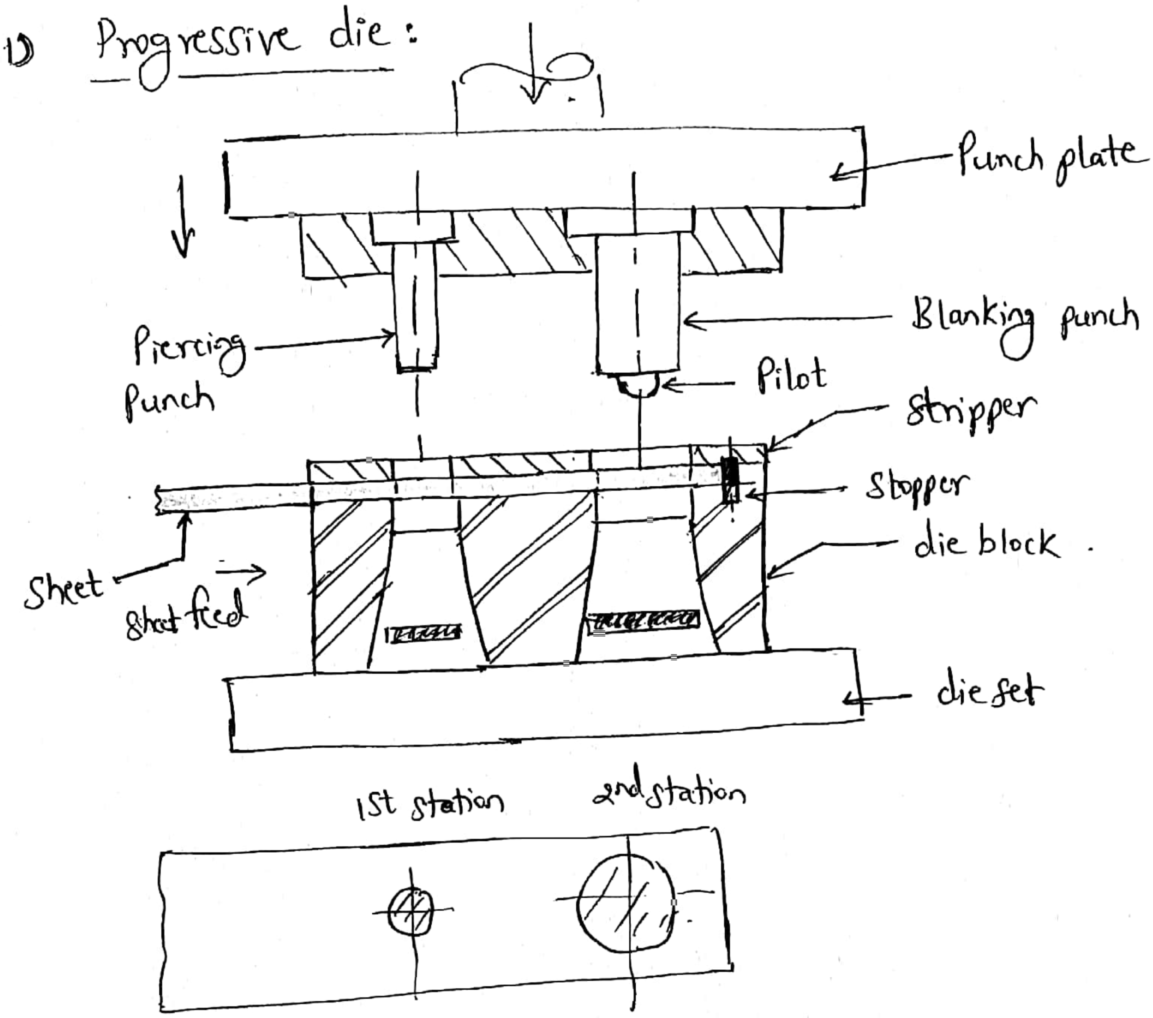
The flat sheet is kept on the die. It is 1st held by spring force on one end & the other side the punch forces the sheet to bend around the corner. It is also called as wiping die operation (∵ of wiping action by the punch.

[3M+3M]

Q9. b: Die: The die, also called as stamping die is a tool / set of tools used to cut or form the sheet metal parts. The dies are mounted on the press & sheet metal is fed through them, with each action of the press, sheet metal components are produced. It essentially consists of punch, die block and other accessories.

└ 1M

1) Progressive die:



- 3.5 M

→ Progressive die is the one in which sheet is fed from one end and the operations happen at multiple stations one after the other (when the press ram moves down)

→ Punch is fixed to moving member (ram) of the press and die block is fixed in the bottom.

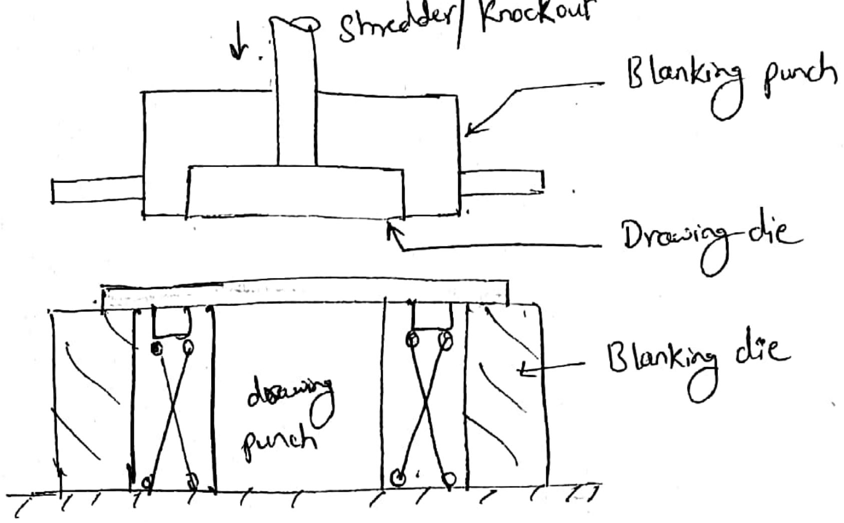
→ Each station will have stopper to locate the sheet.

→ Figure shows 2 station die - In the 1st station piercing takes place & in the 2nd station blanking operation takes place. A pilot is used to guide the previously pierced hole.

→ ~~When~~ During the operation sheet is wrapped around the punch and when punch goes back sheet is stripped off with stripper. Cut pieces (slug & blank) fall through opening provided in the die block.

→ Progressive dies may also contain forming operations.

2) Combination die:



—3.5M

→ Combination die combines one cutting and one forming operation.

→ In the figure shown blanking and drawing operations are combined.

→ Blanking die & drawing punch are fixed in the bottom while blanking punch (which also contains aperture for drawing) is fixed to moving ram.

→ When the ram moves downwards, first the blanking operation takes place followed by drawing.

→ The component is ejected out with the help of shredder or knockout rod.

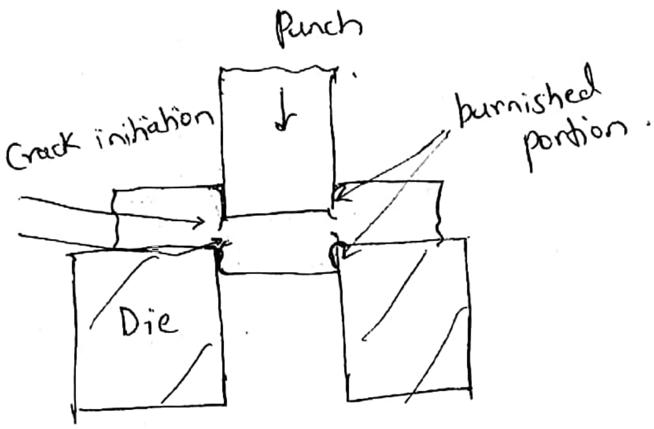
(Note: Simple sketches of the die is sufficient)

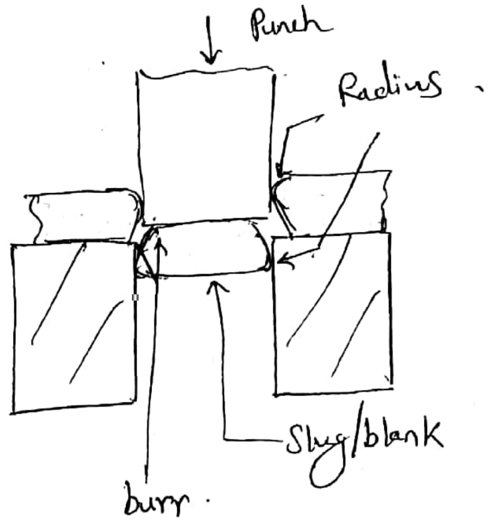
[Die defn : 1M

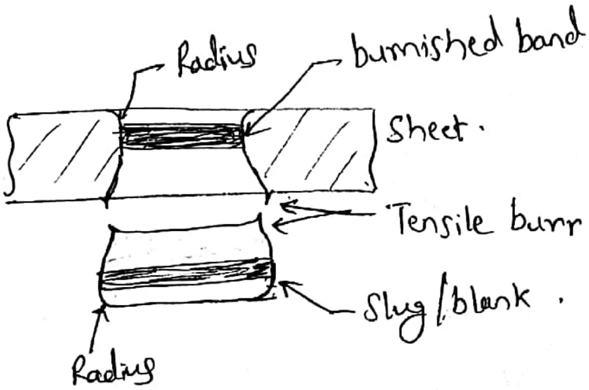
Progressive die: 3.5M

Combination die: 3.5M]

Q9.c: Shearing action in punch & die operations







— (Sketch 3M)

With the downward movement of the punch, pressure on the sheet builds up & when elastic limit of the material is exceeded, the material starts flowing plastically. Radius is formed at the top edge of the hole & bottom side of slug/blank.

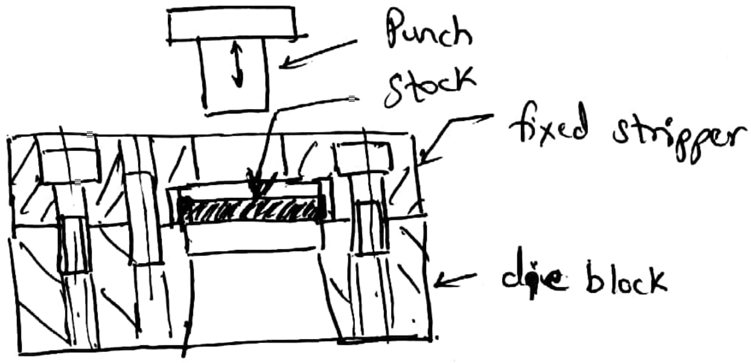
Because of heavy rubbing of sheet with the punch and that of slug with the die, a bright-burnished band can be observed. —(3M)

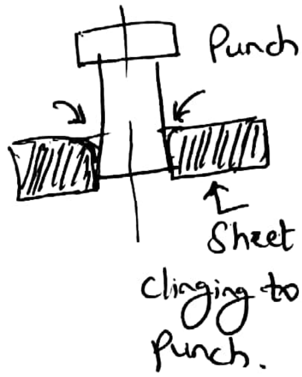
With further downward movement of the punch, cracks initiate from bottom corner of the punch & top corner of the die which eventually meet — which displaces the cut portion from the sheet. Proper (optimum) clearance is very much essential b/w punch & die for cracks to meet.

Tensile burrs are formed at the bottom of hole & topside of slug/blank.

Q10. a. <u>Stripper:</u> Stripper is a part in stamping die used to remove the sheet (stock) from the punch after blan-king or piercing operation. The sheet will cling to the punch because of material flow during shearing action & will try to go along with punch while retracting & stripper avoids that.

<u>Fixed Stripper:</u>



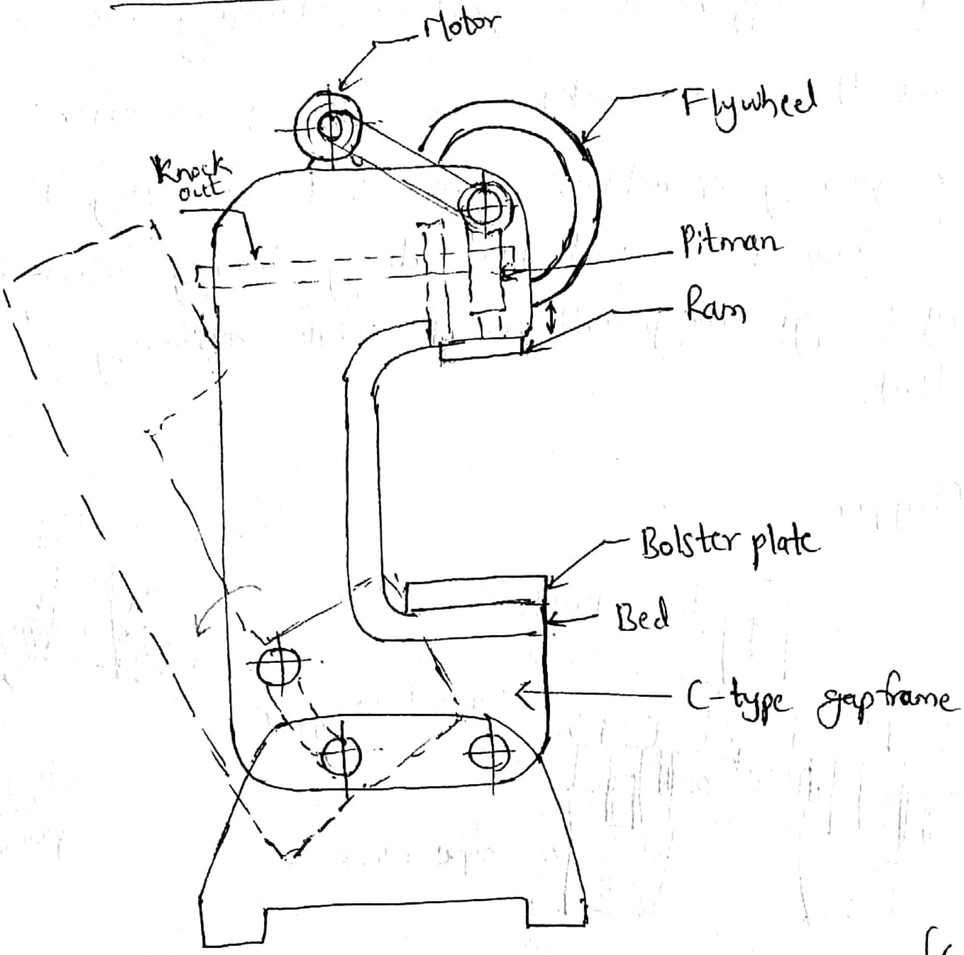


- Fixed strippers are solidly attached to the die block using screws & dowels.
- These are also called as channel strippers, since a channel / groove is machined on the plate.

- Height of the channel ≃ 1.5 × Sheet thickness
  width of channel → more than width of sheet to allow for easy movement of sheet.

[Stripper definition – 1M.
Sketch – 2.5M
Explanation – 2.5M.]

Q 10. b) Open Back Inclinable (OBI) Press :



(Sketch – 4M)

(Explanation) – 4M

– OBI press is a type of gap frame press [C-shaped] which allows feeding of sheet metal strip from left to right or vice versa.

It consists of :

1) A rectangular steel bed which is stationary and serves as table to which bolster plate is mounted.

2) A bolster plate consisting of flat steel plate 2 to 5 inch thick which is ment for mounting the die

3) Ram – also called as slide which reciprocates in the press frame. Upper portion of die (punch) is fastened to ram.

4) A Knock out – It consists of cross bar which is used to eject the workpiece

5) A Flywheel which absorbs energy from motor continuously & delivers the stored energy to workpiece through ram.

6) Pitman – consists of connecting rod to convey motion & pressure from main shaft to ram.

Q 10: c) Calculate the bending force for 90° bend part from the steel sheet with air bending. The bend length is 30 cm, the material thickness is 2.5 mm and beam length is 25 mm. The tensile strength of the material is 32 KN/cm². Die opening factor = 1.33. (6M)

Soln: Data: Type of bending: air bending

Angle = 90°

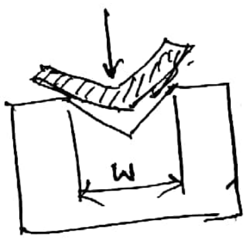
Bend length, L = 30 cm = 300 mm.

Sheet thickness, t = 2.5 mm.

× 10³ → KN to N
&
÷ 10² → cm to mm

Tensile Strength, $S = 32\,kN/cm^2 = \frac{32 \times 10^3}{10^2}\,N/mm^2$

$= 320\,N/mm^2$



Die opening factor constant, K = 1.33 — 2M.

beam length, W = 25 mm.

Bending force, $F = \frac{KLSt^2}{W}$ — 1M.

$= \frac{1.33 \times 300 \times 320 \times (2.5)^2}{25}$

$= 31{,}920\,N$

$= 31.92\,KN$ — 3M.

[Steps: 2M + 1M + 3M]

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