Important Instructions to examiners:

1) The answers should be examined by key words and not as word-to-word as given in the model answer scheme.
2) The model answer and the answer written by candidate may vary but the examiner may try to assess the understanding level of the candidate.
3) The language errors such as grammatical, spelling errors should not be given more Importance (Not applicable for subject English and Communication Skills.
4) While assessing figures, examiner may give credit for principal components indicated in the figure. The figures drawn by candidate and model answer may vary. The examiner may give credit for any
equivalent figure drawn.
5) Credits may be given step wise for numerical problems. In some cases, the assumed constant values may vary and there may be some difference in the candidate's answers and model answer.
6) In case of some questions credit may be given by judgement on part of examiner of relevant answer based on candidate's understanding.
7) For programming language papers, credit may be given to any other program based on equivalent concept.

Q.1. a) Attempt any THREE **12 M**

(i) Basic elements of metal cutting (any two with explanation/definitions) **4 M**

1. Cutting Speed: The cutting speed can be defined as the relative surface speed between the tool and the job. It is a relative term since either the tool or the job or both may be moving during cutting. It is expressed in m/min.

2. Feed: It may be defined as the relatively small the cutting tool relative to the work piece in a direction which is usually perpendicular to the cutting speed direction. It is expressed in mm/rev or mm/stroke. It is more complex element as compare to the cutting speed. It is expressed differently for various operations.

3. Depth of cut: The depth of cut is the thickness of the layer of the metal remove in one cut or pass measured in a direction perpendicular to the machine surface. The depth of cut is always perpendicular to the direction feed motion.

(ii) Requirements of tool materials (eight points having ½ M each) **4 M**

1. Hot/Red Hardness, necessary to enable the cutting tool to retail its cutting ability and hardness at the high temperatures developed at the tool-chip interface
2. Wear resistance, necessary to enable the cutting tool to retain its shape and cutting efficiency
3. Toughness, necessary to enable the tool to withstand the forces, to absorb shocks associated with interrupted cuts and to prevent the chipping of the fine cutting edge
4. Mechanical and thermal shock resistance
5. Ability to maintain the above properties at the temperatures occurring during cutting

6. Low friction, in order to have low tool wear and better surface finish, the coeff. of friction between the chip and tool should be as low as possible in the operating range of speed and feed
7. Favorable cost of material
8. Should be easy to regrind and easily weld-able to tool

(iii) Parts of OBI (Open Back Inclinable) press **4 M**

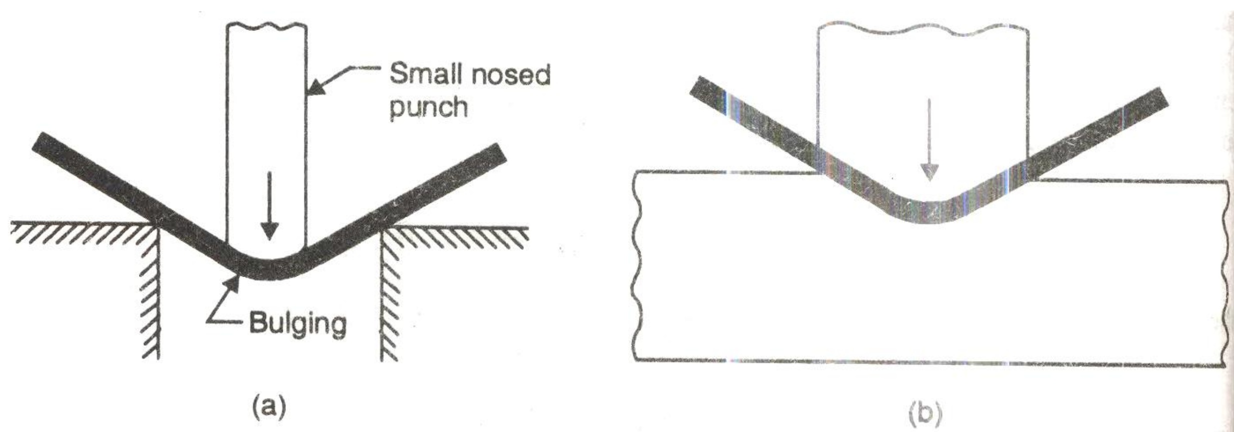
Parts of OBI press (any four) 2m

1. Flywheel	2. Gap frame	3. Main drive gear	4. Bed
5. Bolster plate	6. Die set	7. Clutch	

Applications of OBI press (any four) 2m

1. Blanking of small parts
2. Bending of metallic parts
3. Shallow drawing
4. Punching
5. Shearing of metallic parts, etc.

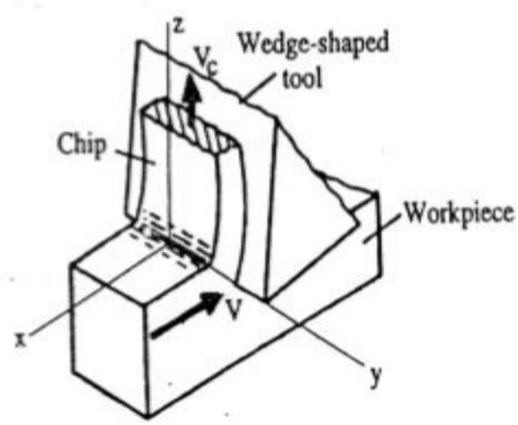
(iv) Spanking (Fig. 2m and explanation 2m) **4 M**



During bending, the area of the sheet under the punch has a tendency to flow and form a bulge on the outer surface (as shown in above fig a). This is prevented by having tool surfaces of sufficient area to restrain metal flow. Thus the nose radius of the punch is gradually blending into the punch faces, fig b. The lower die should be provided with mating surfaces, so that when the punch and die are completely closed on the blank, any bulging developed earlier will be completely pressed or 'spanked' out.

Q.1. b) Attempt any ONE **6 M**

(i) Orthogonal cutting (Fig. 2m and explanation 4m) **6 M**



- The cutting condition when chip is expected to flow along the orthogonal plane is known as orthogonal cutting
- Pure orthogonal cutting is orthogonal cutting when principle cutting angle is 90 degree.
- Cutting edge of the tool is perpendicular to the direction of travel of the tool
- Cutting edge clears the width of the w/p on either ends
- The chip coils are tight and flat spiral
- Only two components of the forces are acting on the tool
- Maximum chip thickness occurs at the middle
- Due to smaller area of the tool, less friction in between work-tool interface therefore tool life is more

(ii) Terms related to Forging Die (1m each) 6 M

1. Scale loss- The outer surface of the hot metal is generally oxidized, and when hammering is done oxidized film is broken and falls down in the form of scale. It is called as scale loss.

2. Draft- It is the angle of taper put on the all sides of the forging to its quick removal from the die cavity after forging. In case of drop and press forging, the usual values of draft angles are- 3^0 to 7^0 for external surfaces and 5^0 to 10^0 for internal surfaces.

3. Fillet- A fillet means the rounding of the apex of an internal angle.

4. Corner radius- Corner radius means the rounding of the apex of the external angle.

5. Parting line- The parting line is the line along the forging where the two halves of a pair of forging dies meet.

6. Mismatch- The forging produced by shifted die will be called as mismatch.

Q.2. Attempt any FOUR 16 M

a) Solution 4 M

From tool designation $\alpha = 10^0$

(i) Chip thickness ratio $r = \frac{t}{tc}$

$r = \frac{0.36}{1.8}$ $r = 0.2$ ……… 2m

(ii) Shear angle $\varphi = tan^{-1}\left(\frac{r\cos\alpha}{1-r\sin\alpha}\right)$

$\varphi = tan^{-1}\left(\frac{0.2\ X\cos 10}{1-r\sin 10}\right)$

$\varphi = 11.53^0$…………………………………………………… 2m

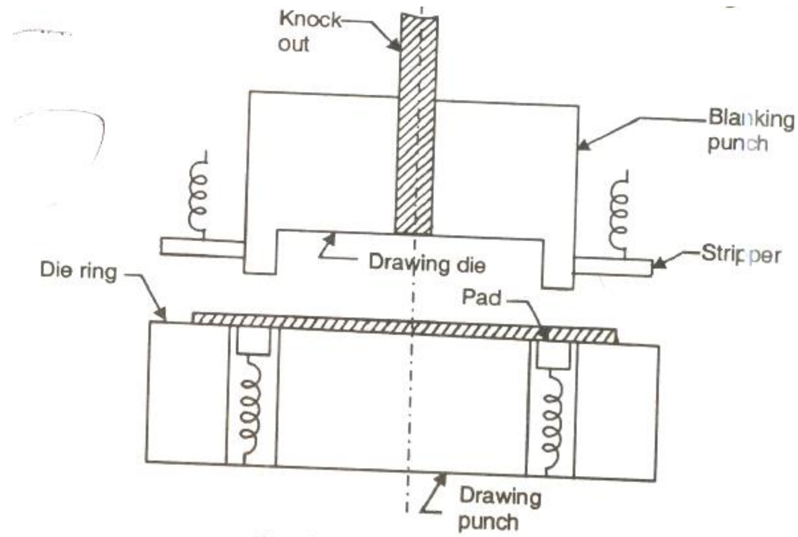
b) Conditions for the effective use of carbide tips (any four) **4 M**

1. Minimum quantity lubrication (MQL) during machining
2. Moderate cutting speeds and feeds
3. Use of effective chip breakers and chip guards
4. Rigidity of tool holder and workpiece
5. Rigidity of machine tool

c) Essential characteristics of cutting fluids (any eight having ½ m each) **4 M**

1. Good cooling capacity
2. Good lubricating qualities
3. Resistance to rancidity
4. Relatively low viscosity
5. Stability (long life)
6. Rust resistance
7. Nontoxic
8. Transparent
9. Nonflammable

d) Combination die (Fig. 2m and explanation 2m) **4 M**

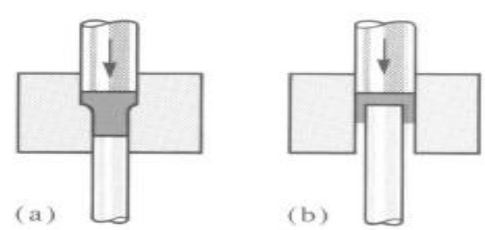


In this die, more than one operation may be performed at one station. It differs from compound die in that, a cutting operation is combined with a bending or drawing operation. Above figure shows working of combination blank and draw die. The die ring which is mounted on the die shoe is counter board at the bottom to allow the flange of a pad to travel up and down. This pad is held flush with the face of the die by a spring. A drawing punch of required shape is fastened to the die shoe. The blanking punch is secured to punch holder. A spring stripper strips the skeleton from the blanking punch. A knockout extending through the centre opening and through the punch stem ejects the part on the upstroke as it comes in contact with the knockout bar on the press.

e) Extrusion and Forward extrusion **4 M**

Definition- Extrusion is the process by which a block/billet of metal is reduced in cross section by forcing it to flow through a die orifice under high pressure. **1 M**

Forward extrusion (Fig. 1m and explanation 2m) **3 M**

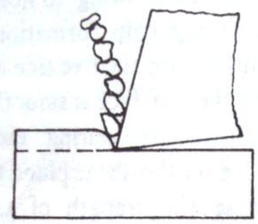


- Metal is forced to flow in the same direction as the punch
- The punch closely fits the die cavity to prevent backward flow of the material
- Examples of the metals that can be extruded are lead, tin, aluminium alloys, copper, titanium, molybdenum, vanadium, steel.

Q.3. Attempt any TWO **16 M**

a) Types of chips (2 m each) **8 M**

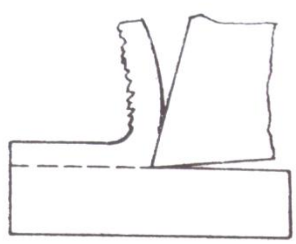
1. Segmental or discontinuous chip



(a) Segmental chips

- Segmental chips consist of separate, plastically deformed segments which either loosely adhere to each other or remain completely unconnected
- Produced by the actual fracture of metal ahead of cutting edge
- Produced in brittle material machining and while cutting ductile material at low speed with high DOC
- For brittle materials such a type chip is associated with fair surface finish, lower power consumption and reasonable tool life

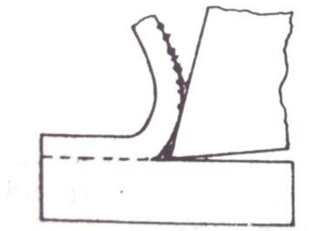
2. Continuous chip



(b) Continuous chip

- Continuous chips are produced when the material ahead of the tool continuously deforms without fracture and flows off the tool face in the form of a ribbon
- In machining most ductile materials at normal cutting speeds
- This type of chip is associated with low friction between the chip and the tool face
- Most desirable form of chip
- Sometimes, chip breaker may become necessary for convenient chip handling and disposal

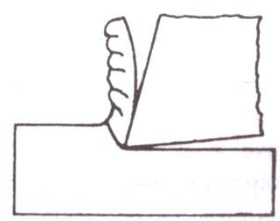
3. Continuous chip with built up edge



(c) Continuous chip with built-up edge

- Similar to continuous chip except a built-up edge is formed on the nose of the tool
- Built-up edge is formed due to the action of welding of the chip material on to the tool face because of high friction between the chip and tool face
- Presence of this welded material further increases the friction, leading to the building up of the edge layer by layer
- Normally occur while cutting ductile materials with high speed steel tools at low cutting speeds
- It is undesirable and result in higher power consumption, poor s/f finish and higher tool wear

4. Non-homogeneous chip



(d) Inhomogeneous chip

- Non-homogeneous chips are produced due to non-uniform strain in the material during chip formation
- They are characterized by notches on the free side of the chip, while the side adjoining the tool face is smooth
- Due to the higher temperature at shear plane a large strain is developed at the tool chip interface
- This type of chip is a typical of materials in which the yield strength decreases with temperature and which have poor thermal conductivity
- They are produced while machining some steels and titanium alloys at medium cutting speeds

b) Solution **8 M**

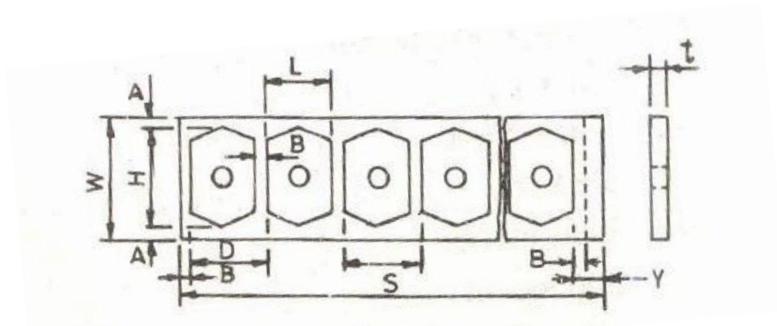


Fig. 6.66

Above figure shows a typical strip/stock layout ……………………… 2 m

S= stock length = 2m

T= thickness of sheet = 3 mm

D= Lead of die

L= Length of part= 60

H= Width of the part= 100

W= Width of strip

A= t + 0.015 x H

= 3 + 0.015 x 100 = 4.5 mm

W= H + 2A

= 100 + 2 x 4.5

= 109 mm

B=t= 3 mm

D= Length of stock to produce one blank

= L + B

= 60 + 3 = 63 mm ……………………………………… 2m

N = Number of blanks which can be made one length of stock

= (S – B)/D = (2000 – 3)/63

= 31.0 ………………………………………………………………….. 2m

Material utilization factor (% stock) = (α/A_1)x 100 where α = Area of component

A = 60 x 100

A_1= Area of strip used to produce a single blanked part = D x W

W = H + A + A

= 100+4.5+4.5

= 109 mm

% stock = (60 x 100)/(63 x 100) X 100

= 87.3 ………………………………………………………………. 2m

c) Factors that affect the metal flow during drawing (any eight 1m each) 8 M

Following are the factors that affect metal flow during drawing operation:

1. Material type
2. Material thickness
3. Blank size and shape
4. Part geometry
5. Press speed (ram speed)
6. Draw radii
7. Draw ratio
8. Die surface finish
9. Die temperature
10. Lubricant
11. Draw bead height and shape
12. Binder pressure
13. Binder deflection
14. Standoff height

Q 4 a) Attempt any THREE of the following

i) State the general rules for using positive and negative rake angles.

Ans:- Using positive rake angles:- (2 Marks)

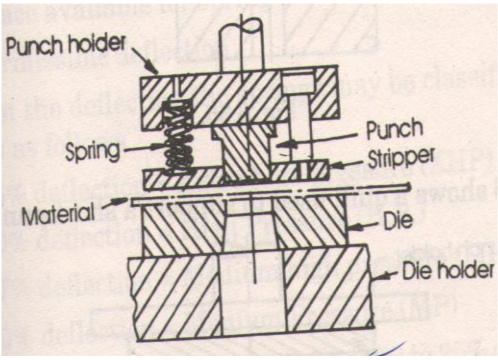
1. When machining low strength ferrous and non-ferrous materials and work-hardening materials.
2. When using low power machines.
3. When machining long shafts of small diameters.
4. When the set up lacks strength and rigidity.
5. When cutting at low cutting speeds.

Using Negative rake angles :- (2 Marks)

1. When machining high strength alloys.
2. When there are heavy impact loads such as in interrupted machining.
3. For rigid set ups and when cutting at high speeds.

ii) Explain the spring loaded stripper with neat sketch.

Ans:- Spring loaded stripper plate is preferred as it holds the strip in a flat position before the punch contacts the strip. This is necessary where very accurate blanks are needed and when very thin material is to be punched as shown in following figure.



(2+ 2 Marks)

The strippers are usually of the same length and width as die block. The stripper thickness should be sufficient to withstand the force required to strip the punch from the stock. The stripper thickness usually varies from 5 to 6 mm. The force required to strip the stock material from the punch called stripping force varies from 5 to 20 % of the cutting force. The punches with polished side walls tends to strip easier than those with rough surface. More force is also required to strip punches that are close together. Selection of stripper depends on stripping force and space available. The force (F) for which springs operated stripper plate is calculated F = 1500 L x t, where L= cut perimeter (cm) t= stock thickness (cm).

Choice of the method of applying springs to the stripper plate depends on the following:

Required pressure, Stage limitation, Shape of die and Nature of work.

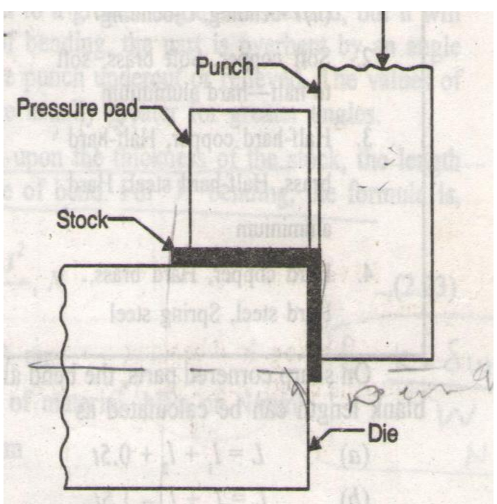
iii) What are the methods of bending? Explain any one with neat sketch.

Ans:- Methods of bending (1 Mark)

1) Edge bending
2) V- bending
3) U-bending

In edge bending as shown in fig 1 the material is bent at one edge with the help of a punch. The work piece is clamped to the die block by a spring loaded pad. The punch presses the metal into die during downward stroke. The bend axis is parallel to the edge of the die and the stock is subjected to cantilever loading. The metal gets distorted plastically within the bend area. Metal towards inner bend surface is under compression and metal towards outer surface is in tension. To prevent the movement of the stock during bending, it is held down by a pressure pad before the punch contacts it. Bending can be successfully applied to materials which are ductile and strong but no hard.

V bending also called air bending uses V shaped punch to press the work metal as shown in fig 2. bend angle may be acute,90^0 ,or obtuse. As the punch descends, the contract forces at the die corner produce a sufficiently large bending moment at the punch corner to cause the necessary deformation. To maintain the deformation to be plane-strain, the side creep of the part during its bending is prevented or reduced by incorporating a spring loaded knurled pin in the die. Whereas the U bending uses a U shaped punch to give the required shape to the metal as shown in fig 3.



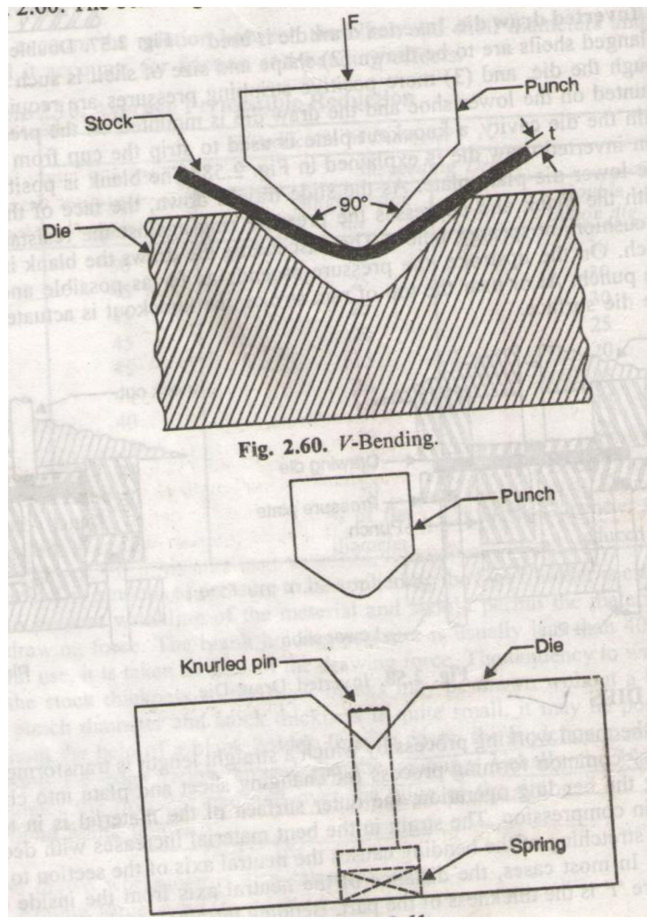
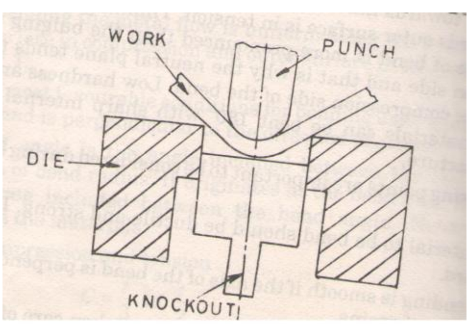


Fig. 2.60. V-Bending.



(any one 1+ 2 Marks)

iv) What is forging? Discuss press and up-setting forging.

Ans:- Forging is the process of shaping heated metal by the application of sudden blows or steady pressure and makes use of characteristic of plasticity of the material.

OR

Forging process may be defined as a metal working process by which metals or alloys are plastically deformed to the desired shapes by a compressive force applied with the help of a pair of dies. (2 Marks)

Up-Setting forging :- it is used to increase the cross sectional area usually be pressing or hammering. Upset forging forces the end of a heated bar into a desired shape. The bar is heated, clamped and up set into the die opening.

Press Forging :-The various forging presses employed for the forging process are power driven presses and hydraulic presses. (1 mark each)

b) Attempt any one of the following

i) What are the types of tool material? State at least two applications of each.

Ans:- 1. Carbon tool steels :- rolled products i e bars, squares, special item i e wheels,axles

2. High speed steel :- milling cutters, reamers ,punches, dies, taps

3. Cemented carbides:- tips of cutting tools, mechanical fasteners

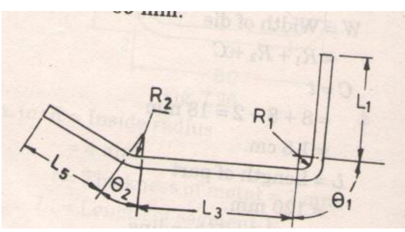
4. Ceramics:-clamp tips, inserts

5. Diamonds :- wire drawing dies, abrasive in polishing and grinding

(any 4 materials 2 marks & applications 1 mark each)

ii) Calculate the blank length to make the part as shown in fig. no. 2

Ans :- As shown in fig



t=Thickness of metallic sheet = 2 mm

R1 = Internal radius = 5 – t = 5 -2 = 3 mm.

R2 = Internal radius = 3 –t = 3 – 2 = 1 mm.

L1 = Length of leg 1 = 64 – (t+R1) = 64 – (2+3)= 59 mm.

$\Theta1 = 90^0$

L2 = Length of leg 2 = Bend allowance = $\frac{2\,\Pi\theta1}{360}[R1 + K1\,t]$

Where K1 = 1/3 as R1 < 2t $= \frac{2\,\Pi\,x90}{360}[3 + 1/3x2]$

= **5.76 mm** .----2 Marks

L3= 96-(R1+t) = 96-[3+2] = 91 mm

$\Theta2 = 30^0$

L4 = Length of leg 4 = Bend allowance = $\frac{2\,\Pi\theta2}{360}[R2 + K2\,t]$

$= \frac{2\,\Pi x30}{360}[1 + 1/4x2]$

Where K2 = ¼ as R2 < t = **0.785 mm** -----2 Marks

L5 = Length of segment 5 = 80 mm.

The developed length is the summation of all these lengths along the neutral bending line

L = Total length 5 = L1 + L2 + L3 + L4 + L5 = 59 + 5.76 + 91 + 0.785 + 80 = **236.54 mm** –2 Marks

Q 5. Attempt any four of the following.

a) What are the types of cutting fluids? State its applications.

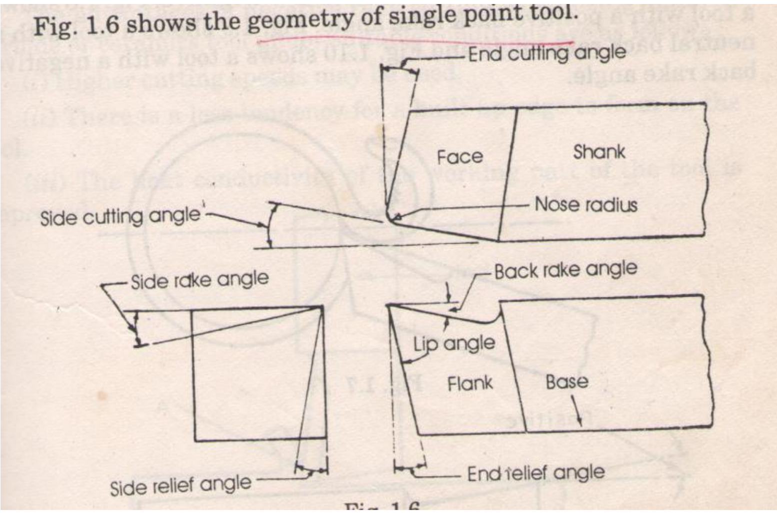
Ans:- Types :- 1. Water based cutting fluids

2. Straight or neat oil based cutting fluids :- Mineral oils, straight fatty oils, compounded or blended Oils, sulphurised oils and chlorinated oils.

Applications :- Turret and capstan lathes, CNC lathes, thread cutting machine, thread milling machine, automatic lathes, gear cutting machine etc. (2+ 2 Marks)

b) Draw a neat sketch of nomenclature of single point cutting tool.

Ans:- (2+2 Marks)



c) What is meant by notching, cropping, lancing and coining?

Ans:- (1 Mark each)

Notching :- This operation is used to remove small amount of metal from the edges of the metallic strip.

Lancing :- It is combined bending and cutting operation.

Cropping:- refers to the removal of the outer parts of an image to improve framing, accentuate subject matter or change aspect ratio.

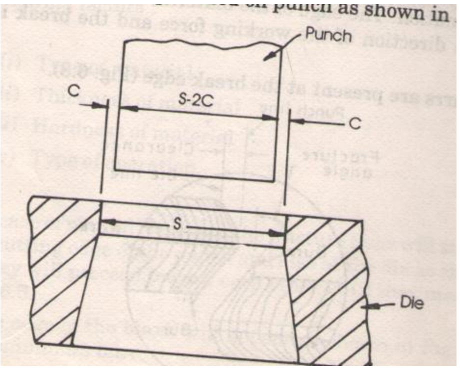
Coining :- is a form of precision stamping in which a workpiece is subjected to a sufficiently high stress to induce plastic flow on the surface of the material.

d) Which member should be given clearance? Explain

Ans:- Whether the clearance should be provided on punch or die depends upon type of cutting such as

1.Blanking 2. Piercing.

1.Blanking:- In blanking the cut out piece is the desired part. In this case punch is made smaller in size and the die is made of exact size clearance is thus provided on punch as shown in following fig.



S= Size of work piece

C=Clearance

Die Size = S =Size of work piece

Punch Size = S-2C

2.Piercing:- In piercing the cut out part is waste and left out piece is of importance. In piercing the punch is made of exact size and die is made of bigger size as shown in following fig.

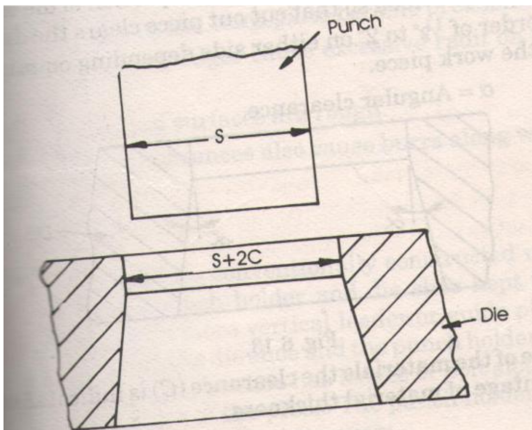


Fig 6.11.

Punch Size = Size

Die Size = Size + 2C

Thus clearance is given on die.

Hard materials require more clearance than soft materials. (2 Marks each)

e) What do you understand by set back and bend allowance?

Ans:- Set Back :- In bending after the applied force is withdrawn the metal tries to resume its original position causing a decrease in bend angle(as well as an increase in the included angle between bent portions). Such a metal movement is called set back . It is caused by the elastic stresses remaining in the bend area. After bending pressure on metal is released, the elastic stresses are also released, and cause metal movement spring back varies from ½ to 5^0 in steel whereas in phosper bronze it may be 10-15^0.

Spring back depends upon material type, thickness, hardness and bend radius.

Bend allowance :- To calculate the blank length for bending, the length of material in the curved section or bend area has to be calculated. This length in the bend area which will be more than the corresponding length of blank before bending is called bend allowance. The bend allowance added to the lengths of the straight legs of the part will give the length of blank. The bend allowance varies with the distance of the neutral axis from the inside surface of the bend. Bend allowance can be calculated from the following formula.

$B=\alpha/360\ 2\pi(r + k)$

B = Bend allowance along neutral axis ,cm.

α = Bend angle in degrees.

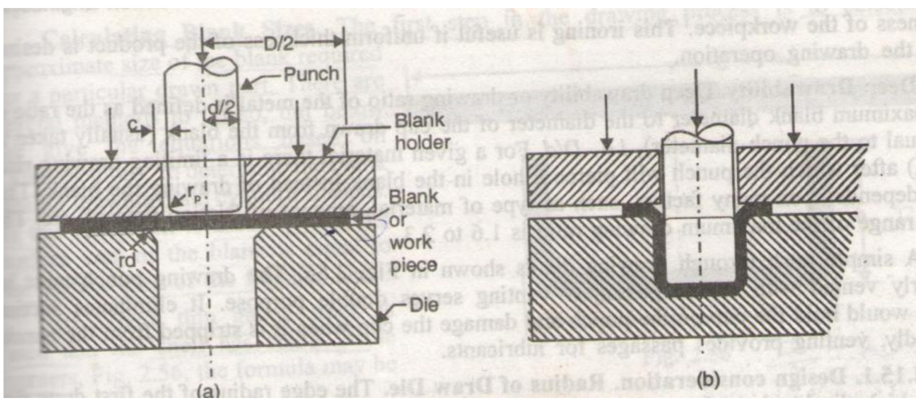
r = Inside radius of bend, cm.

k = Distance of neutral axis from the inside surface of the bend cm.

(2 Marks each)

f) Draw the diagram of drawing operation. State the function of pilot and knock out.

Ans :- (2+1+1 Marks)



Pilot :- The function of a pilot is to position the work piece or stock strip accurately. When establishing the sequence of operations for progressive dies, piercing operations are carried out first.

Knock out :- The function of the knock out is to remove the work piece which adhere to the die opening.

Q 6.Attempt any TWO of the following

a) What is tool life? Write its equation. Explain the factors affecting tool life.

Ans:- Tool Life :- It is defined as the time elapsed between two successive grindings of the tool.During this period the tool cuts efficiently and effectively. It is one of the most important economic considerations in metal cutting. (2 Marks)

$$VT^n = C$$

V= Cutting speed in Metre / Min.

T = Tool Life in Minutes.

C = Constant (2 Marks)

Factors:- (any four 1 Mark each)

1. Machining variables:- Cutting speed, Feed and Depth of Cut.
2. Type of cutting such as continuous and intermittent cutting.
3. Tool geometry.
4. Tool Material.
5. Machining Conditions :- Temperature of the work and tool and type of cutting fluid used.
6. Properties of material being cut : Microstructure of work piece materials, tensile strength and hardness of the material and degree to which the material cold works.

b) Ans :-

i) To find Blank diameter (2 Marks)

h = height of shell = 48 mm.

d = Diameter of shell = 48 mm.

r = Radius of corner = 2 mm.

t = Thickness of shell material = 1 mm.

d/r = 48/2 = 24

Then the formula for calculating size of blank will be as follows;

$$D = \sqrt{(d^2 + 4dh)} \quad = \sqrt{(48^2 + 4x48x48)} \quad = \mathbf{107.3\ mm.}$$

This is the theoretical value of blank size. In order to take into account trimming extra metal of about 3 mm is to be added to blank diameter for each 25 mm of cup diameter.

Blank diameter = D + 3/25 x 48 = 107.3 + 5.7 = 113 mm.

Ii) To find percentage reduction (2 Marks)

P = percentage reduction = 100 (1- d/D) = 100 (1-48/113) = **58 %**

Now for one draw the percentage reduction permissible is about 50 %.Therefore it is obvious that the cup not be drawn in one operation.

iii) To find number of draws (2 Marks)

Draw ratio = h/d = 48/48 = 1.

As the reduction ratio is more than 0.75 therefore the shell may be drawn

In two stages with 40 % reduction for first draw and 25 % reduction for second draw.

For first draw p = per cent reduction

40 = 100 (1-d1/D) where D = Blank diameter

40 = 100 (1-d1/113) d1 = 67.8 mm.

For second draw

P = 100 (1- d/d1) = 100 (1-48/67.8) = 29%

Since per cent reduction is 29 % and allowable per cent reduction is 25 % therefore the cup should be **drawn in three stages**

For second stage p = 100 [1-d2/d1] 25 = 100 [1-d2/678] d2 = 50.85 mm

For third stage p = 100 [1-48/50.85]

= 6 %

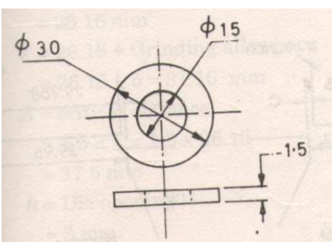
This is within permissible per cent reduction of 15% for third stage.

Iv) To determine radius on punch and die (2 Marks)

R1 = Radius on punch = 4xt = 4x1 =4 mm

R2 = Radius on die = 5t = 5x1 = **5 mm.**

c) Ans :- Fig. shows the washer



D = outside diameter = 30 mm

d = inside diameter = 15 mm

t = sheet thickness = 1.6 mm

A= Area to be sheared = $A = \pi(D + d).t$ $= \pi(30 + 15)x\ 1.6$ = 226.1 mm^2

Fs = shear stress = 32 kg/ mm^2

P = Cutting force = A x fs = 226.1 x 32 =7235.2 kg =7.235 tonnes

Assuming 70 % efficiency, Press Capacity = 7.235/0.7 = 10.335 tons

Piercing punch size = size of hole + shrinkage of hole

= 15 + 0.05 = 15.05 mm (2 Marks)

C = clearance = 6% of material thickness

Piercing die size = Punch size + 2C

= 15.05 + 2 x 6/100 x1.6

= 15.05 + 0.192 = 15.242 mm (2 Marks)

In blanking size of blank is determined by the size and the washer will expand approximately by 0.05 mm.

Size of blanking die = Blank dia – 0.05

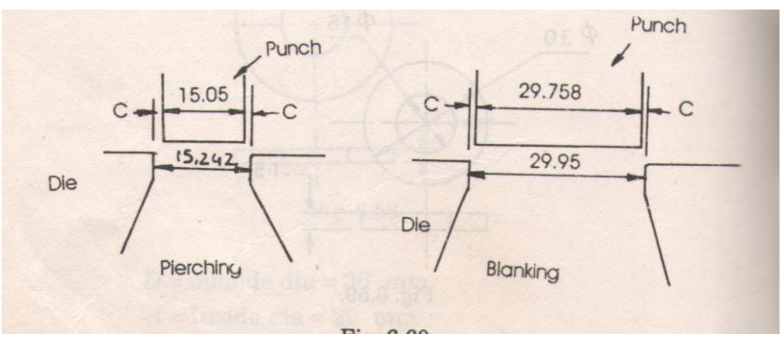
= 30-0.05 = 29.95 mm (2 Marks)

Size blanking punch = size of blanking die -2C

= 29.95 – 2 x 6/100 x1.6

= 29.758 mm (2 Marks)

Dimensions of punches and dies are shown in following fig.



The End