Q.1. · Write short notes on the following :- (any four)

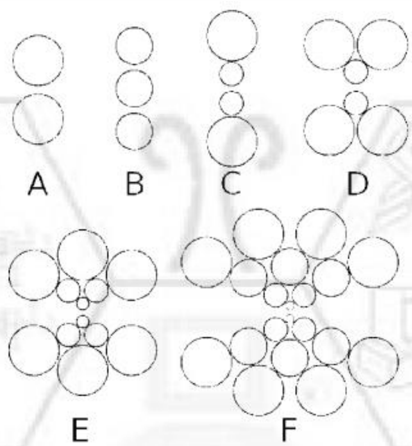
[20]

(a) Centre of Pressure

Ans:- The Centre of Pressure is the centroid of the line perimeter of the blank.

(b) Types of Rolling Mills.

Ans:- A *rolling mill*, also known as a *reduction mill* or *mill*, has a common construction independent of the specific type of rolling being performed



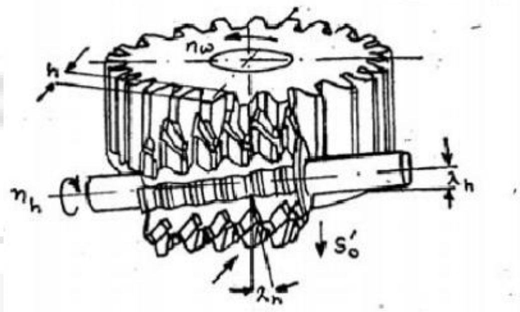
Mills are designed in different types of configurations, with the most basic being a *two-high non-reversing*, which means there are two rolls that only turn in one direction. The *two-high reversing* mill has rolls that can rotate in both directions, but the disadvantage is that the rolls must be stopped, reversed, and then brought back up to rolling speed between each pass. To resolve this, the *three-high* mill was invented, which uses three rolls that rotate in one direction; the metal is fed through two of the rolls and then returned through the other pair. The disadvantage to this system is the work piece must be lifted and lowered using an elevator. All of these mills are usually used for primary rolling and the roll diameters range from 60 to 140 cm (24 to 55 in).[3]

To minimize the roll diameter a *four-high* or *cluster* mill is used. A small roll diameter is advantageous because less roll is in contact with the material, which results in a lower force and energy requirement. The problem with a small roll is a reduction of stiffness, which is overcome using *backup rolls*. These backup rolls are larger and contact the back side of the smaller rolls. A four-high mill has four rolls, two small and two large. A cluster mill has more than 4 rolls, usually in three tiers. These types of mills are commonly used to hot roll wide plates, most cold rolling applications, and to roll foils
Tandem mill

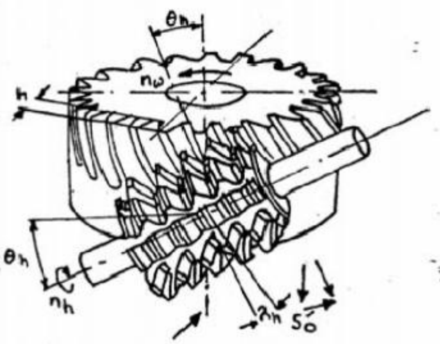
A tandem mill is a special type of modern rolling mill where rolling is done in one pass. In a traditional rolling mill rolling is done in several passes, but in tandem mill there are several *stands* and reductions take place successively. The number of stands ranges from 2 to 18. Tandem mill can be either hot or cold rolling mill type

(c) Gear Hobbing

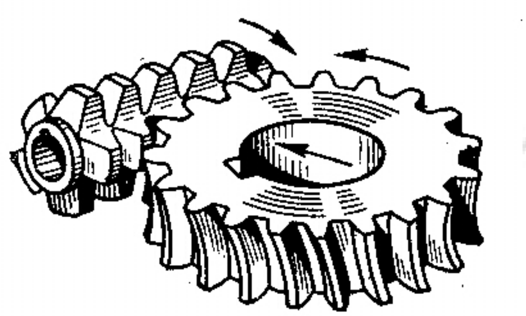
Ans:- The tool-work configuration and motions in hobbing are shown in Fig., where the HSS or carbide cutter having teeth like gear milling cutter and the gear blank apparently interact like a pair of worm and worm wheel. The hob (cutter) looks and behaves like a single or multiple start worms. Having lesser number (only three) of tool – work motions, hobbing machines are much more rigid,strong and productive than gear shaping machine. But hobbing provides lesser accuracy and finish and is used only for cutting straight or helical teeth (single) of external spur gears and worm wheels.



(a)



(b)



(c)

Generation of external gear teeth by Hobbing : (a) straight tooth (b) helical tooth and (c) worm wheel

(d) Turning Fixture

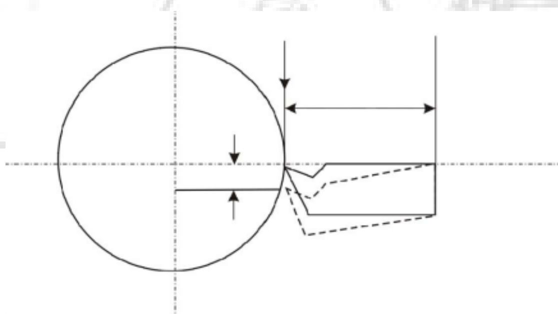
Ans:- A lathe turning fixture for use with a lathe having a three jaw chuck, the fixture including a base member having a flange portion and a work receiving threaded opening, the fixture having a first set of adjusting screws extending through the main body of the base member for engaging the face of the chuck, and a second set of three adjusting screws extending through the flange portion for engaging the edges of the jaws, each set of adjusting screws being 120° apart with respect to the base of the flange, the adjustment of the sets of screws adjusting the axis of rotation of the work piece.

(e) Tool Dynamometer.

Ans:- (a) Measuring deflection caused by the cutting force(s)
Under the action of the cutting force, say P_z in turning, the tool or tool holder elastically deflects
Such tool deflection, δ is proportional to the magnitude of the cutting force, P_z, simply as,

$$\delta = P_Z\left(\frac{L^3}{3EI}\right)$$

where, L = overhang or equivalent projected length of the cantilever type tool (holder)
E = physical property (Young's modulus of elasticity of the beam)
I = size (plane moment of inertia) of the beam section. Since for a given cutting tool and its holder, E and I are fixed and the equation 10.1 becomes,
$\delta \alpha P_z$ or, $\delta = kP_z$ (10.2)
where, k is a constant of proportionality.

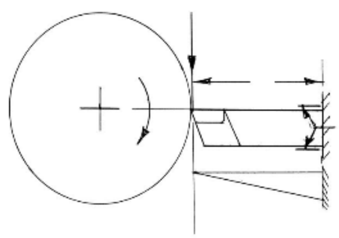


(b) Measuring cutting force by monitoring elastic strain caused by the force.
Increasing deflection, δ enhances sensitivity of the dynamometer but may affect machining accuracy where large value of δ is restricted, the cutting forces are suitably measured by using

the change in strain caused by the force.The principle of force measurement by measuring strain, ε, which would be proportional with the magnitude of the force, F (say P_Z) as,

$$\varepsilon = \frac{\sigma}{E} = \frac{M/Z}{E} = \frac{P_Z.l}{Z.E} = k_1 P_Z$$

where, M = bending moment
Z = sectional modulus (I/y) of the tool section
I = plane moment of inertia of the plane section
y = distance of the straining surface from the neutral plane

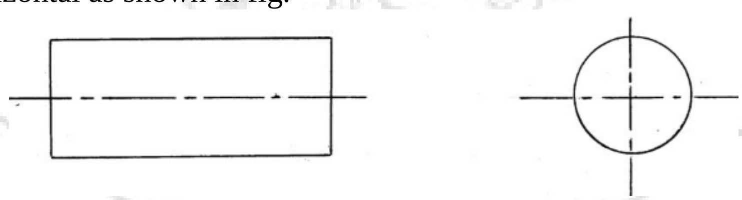


The strain, ε induced by the force changes the electrical resistance, R, of the strain gauges which are firmly pasted on the surface of the tool-holding beam as
G = dR/R
where, G = gauge factor (around 2.0 for conductive gauges)

Q.2.

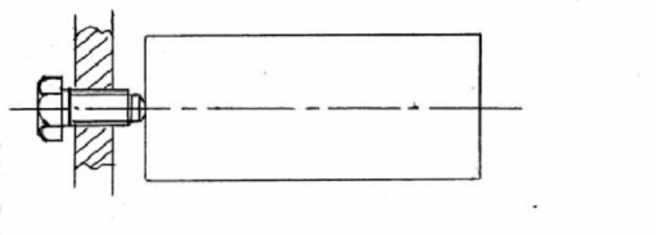
(a) *Explain design principles common to jigs and fixtures*. [10]

Ans:- Design principles common to jigs and fixtures.
-Positioning and orientation
Since a diametric through hole has to be drilled perpendicular to the rod – axis, and the drill – axis in the machine is vertical, the suitable orientation of the job in the jig and against the drill axis will be horizontal as shown in fig.



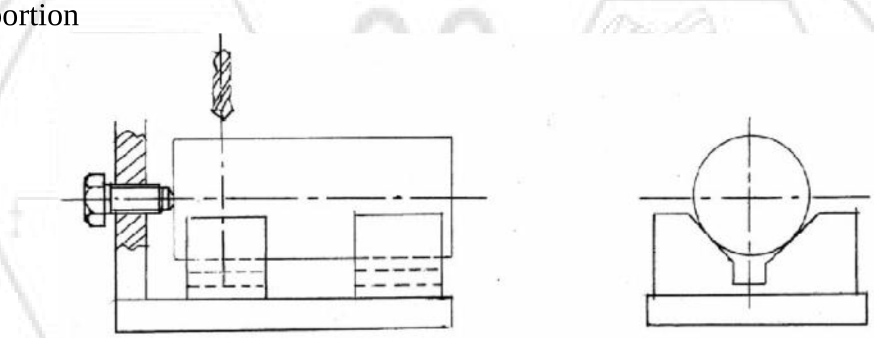
-Locating the blank in the jig and w.r.t. the drill – axis
The facts that
• The blanks are straight cylindrical and pre-machined
• Blank diameter may vary though within a tolerance and
• The blank axis is to be horizontal

clearly justify that the basic locating by V – block will be appropriate as to essentially maintain the desired distance of the hole-axis from one machined face of the block, a pin has also to be used for axial location and it should be adjustable type for likely variation in the part length as indicated in Fig.



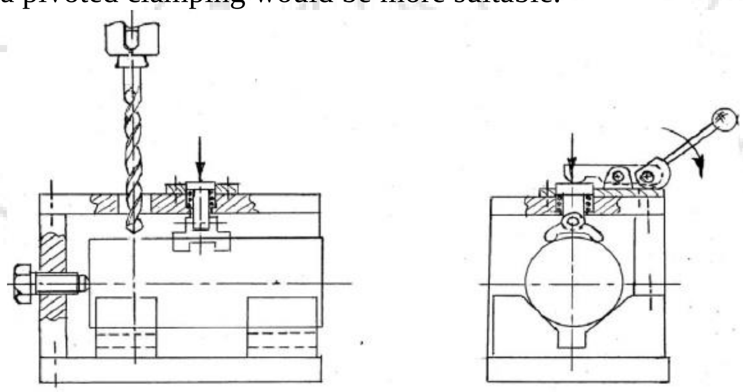
-Supporting the blank against forces

Since the blanks are solid steel rods of favourable L/D ratio and it has been reasonably decided to locate it on V – block, the same V – block can be used for the desired support. In that case the V – block need to be enough strong and rigid and also provided with necessary recess or relief at the central portion



-Clamping

Clamping system should be, as far as possible, simple and quick but also need to be strong, rigid and stable. Clamping should not also obstruct or hamper blank's loading and unloading as well as machining work. Keeping all such factors a cam – clamping may be considered as indicated in Fig. 8.2.3 (d). The clamping plug should retreat sufficiently from the blank for its easier removal and entering of the next blank. A spring can be used. For more effective and stable clamping on cylindrical surface, a pivoted clamping would be more suitable.



-Tool guidance

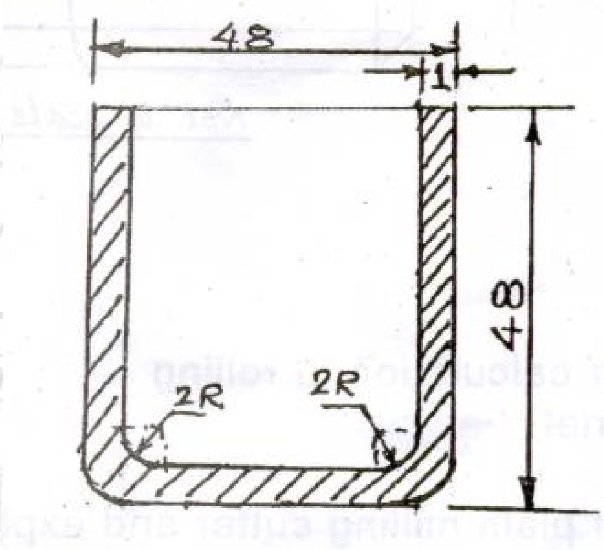
Since it is drilling and over a deep hole, specially on a cylindrical surface, tool guidance must be provided which also shows holding of the slip type bush by a pin for replacement of the bush.
-Consistent effective locating and ejection
It is to be assured that the locating pin is in proper contact with the locating surface and preferably under the same amount of force all the time. This can be done by applying a spring loaded force on the blank and against the locating pin. Such pushing system, again, should not hinder placing and removal of the blank in and from the jig or fixture. One of the possible methods where the swing type lever holding the spring loaded pushing – pin is manually operated with the help of a spring and a stop – pin.
For easy removal of the machined job from the jig or fixture an ejector may be used. An ejector to facilitate unloading of the job after sequentially withdrawing the tool and the clamping unit and shifting the push – lever.

(b) What do you mean by tool life? Explain effect of speed, feed, depth of cut, tool material and geometry on tool life. [10]

Ans:- Definition – Tool life generally indicates, the amount of satisfactory performance or service rendered by a fresh tool or a cutting point till it is declared failed.
Tool life is defined in two ways:
(a) In R & D : Actual machining time (period) by which a fresh cutting tool (or point) satisfactorily works after which it needs replacement or reconditioning. The modern tools hardly fail prematurely or abruptly by mechanical breakage or rapid plastic deformation. Those fail mostly by wearing process which systematically grows slowly with machining time. In that case, tool life means the span of actual machining time by which a fresh tool can work before attaining the specified limit of tool wear. Mostly tool life is decided by the machining time till flank wear, V_B reaches 0.3 mm or crater wear, K_T reaches 0.15 mm.
(b) In industries or shop floor: The length of time of satisfactory service or amount of acceptable output provided by a fresh tool prior to it is required to replace or recondition.
Assessment of tool life
For R & D purposes, tool life is always assessed or expressed by span of machining time in minutes, whereas, in industries besides machining time in minutes some other means are also used to assess tool life, depending upon the situation, such as
• no. of pieces of work machined
• total volume of material removed
• total length of cut.
Wear and hence tool life of any tool for any work material is governed mainly by the level of the machining parameters i.e., cutting velocity, (V_C), feed, (s_o) and depth of cut (t). Cutting velocity affects maximum and depth of cut minimum.
As cutting velocity, (V_C), feed, (s_o) and depth of cut (t) increases tool life decreases.

Q.3.
(a) A circular cup shown in figure is manufactured using deep drawing process [14]

has a height of 48 mm and a diameter of 48 mm. The corner radius in 2 mm and work piece material is medium carbon steel and is 1mmthick. Determine the following parameters. (i) Blank Size (ii) Percent deduction (iii) No. of draws required (iv) Punch and die radius (v) Die clearance (vi) Drawing force (Viii) Blank holding force.
(yield strength= 427 N/ mm2)



Ans:-

(i)Blank Size

d/r = 48/2 =24

$D = (d^2 + 4*d*h)^{1/2}$, d=48 mm, h=48 mm

$D = (48^2 + 4*48*48)^{1/2}$

D = 107.33 mm

By considering trimming allowance

D =107.33 + 6.4 = 113.73 mm

(ii) Percent reduction

= 100*(1-d/D)

= 100*(1-48/113.73)

= 57.79%

(iii) No. of draws required

Height to diameter ratio =48/48 =1

No. draws =2

First reduction 45%

d1 = 113.73 – 0.45*113.73= 62.552 mm

second reduction= 100*(1-48/62.552) = 23.26%

(iv) Punch and die radius

Punch diameter for first draw = 4*t = 4*1 = 4 mm

Punch diameter for second draw = 2*t = 2*1 = 2 mm

die radius = 6*t = 6 mm

(v) Die clearance

For first draw = 1.08t to 1.1t
= 1.09*1=1.09 mm
For second draw = 1.09t to 1.12t
= 1.05*1=1.05mm
Punch diameter for second draw = 48-2*1=46 mm
Die diameter for second draw = 46 + 2*1.105=48.21 mm
Punch diameter for second draw = 62.551-2*1=60.551 mm
Die diameter for second draw = 60.551 + 2*1.09 = 62.731 mm

(vi) Drawing force

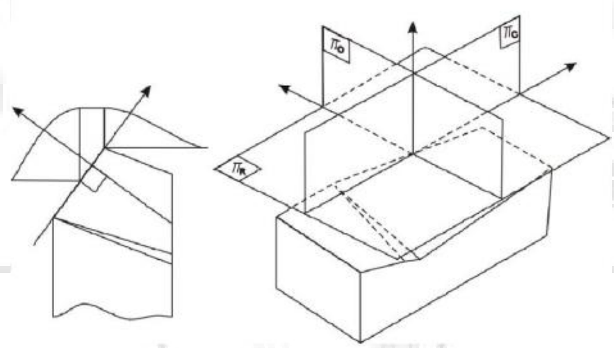
$F= \pi*d*t*\sigma_{yt}*(D/d -C)$
$= \pi*48*1*427*(113.73/48 -0.65)$
$= 110.71*10^3$ N

(Viii) Blank holding force may be considered as 1/3 of drawing force.

(b) *Explain with a neat sketch the orthogonal rake system (ORS) of describing a single point cutting tool geometry.* . [10]

Ans:-

Orthogonal Rake System – ORS This system is also known as ISO – old.
The planes of reference and the co-ordinate axes used for expressing the tool angles in ORS are:
π_R - π_C - π_O and X_o - Y_o - Z_o
which are taken in respect of the tool configuration as indicated in Fig.

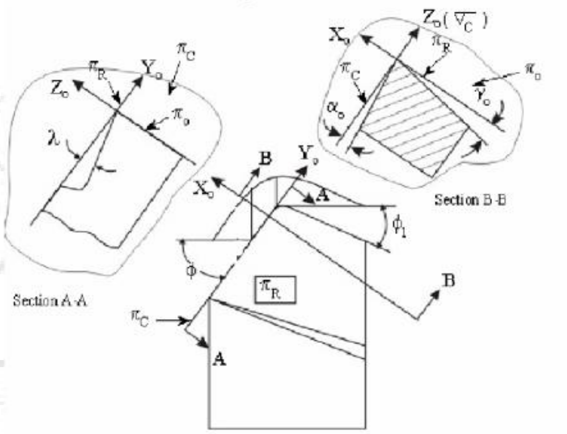


where,
π_R = Refernce plane perpendicular to the cutting velocity vector, CV
π_C = cutting plane; plane perpendicular to π_R and taken along the principal cutting edge
π_O = Orthogonal plane; plane perpendicular to both π_R and π_C and the axes;
X_o = along the line of intersection of π_R and π_O

Y_o = along the line of intersection of π_R and π_C

Z_o = along the velocity vector, i.e., normal to both X_o and Y_o axes.

The main geometrical angles used to express tool geometry in Orthogonal Rake System (ORS) and their definitions will be clear from Fig



Definition of –

• Rake angles [Fig.] in ORS

γ_o = orthogonal rake: angle of inclination of the rake surface from Reference plane, π_R and measured on the orthogonal plane, π_o

λ = inclination angle; angle between π_C from the direction of assumed longitudinal feed [π_X] and measured on π_C

• Clearance angles [Fig.]

α_o = orthogonal clearance of the principal flank: angle of inclination of the principal flank from π_C and measured on π_o

α_o' = auxiliary orthogonal clearance: angle of inclination of the auxiliary flank from auxiliary cutting plane, π_C' and measured on auxiliary orthogonal plane, π_o' as indicated in Fig. 3.8.

• Cutting angles [Fig.]

φ = principal cutting edge angle: angle between π_C and the direction of assumed longitudinal feed or π_X and measured on π_R

φ_1 = auxiliary cutting angle: angle between π_C' and π_X and measured on π_R

• Nose radius, r (mm)

r = radius of curvature of tool tip

Q. 4

(a) The following data relate to orthogonal cutting of mild steel part:
Cutting speed = 200 m/ min; Tool rake angle = 12°;
Width of cut = 1·8 mm; Uncut thickness = 0·2 mm.
Average value of the coefficient of friction between the tool and the chip = 0·55 ; shear stress of work material 390 N/mm2.
Calculate: (i) Shear angle ii) Cutting force (iii) Shear force
(iv) Feed force OR Thrust force. . [10]

Ans:-

Calculate:

(i) Shear angle

$\beta = \tan^{-1}(\mu)$

$\beta = \tan^{-1}(0.55) = 28.81^0$

$\varphi = 45 - \beta/2 + \alpha/2$

$\varphi = 45 - 14.40 + 6 = 36.6^0$

(iii) Cutting force

$F_c = (\tau_s * b * t)/[\mathrm{Sec}(\beta - \alpha) * \mathrm{Cos}(\varphi + \beta - \alpha) * \mathrm{Sin}(\varphi)]$

$F_c = (390*1.8*0.2)/[\mathrm{Sec}(28.81 - 12)*\mathrm{Cos}(36.6 + 28.81 - 12)*\mathrm{Sin}(36.6)]$

$F_c = 378.16$ N

(ii) Shear force

$Fs = Fc * \mathrm{Cos}(\varphi) - Ft * \mathrm{Sin}\ \varphi$

$Fs = 378.16 * \mathrm{Cos}(36.6) - 114.28 * \mathrm{Sin}(36.6)$

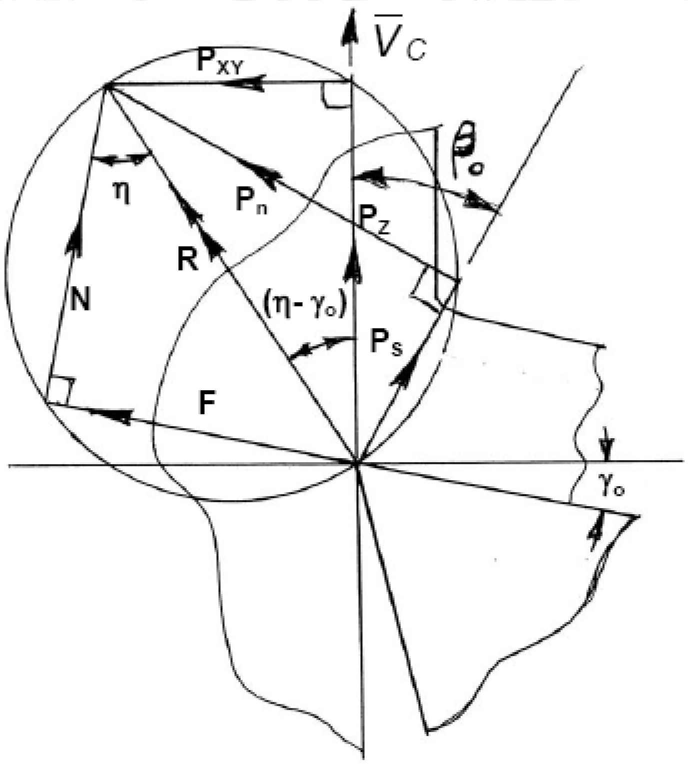
Fs = 235.45 N

(iii) Feed force OR Thrust force.
Ft = Fc* tan((β- α))
Ft = Fc* tan*((28.81-12))
Ft = 114.28 N

(b) Clearly stating the assumption derive the relationship 2φ +β-γ =π/2 in Merchant's original theory. [10]

Ans:- Tangential or main component, P_z

This can be very conveniently done by using Merchant's Circle Diagram, MCD, as shown in Fig.



From the diagram in Fig. 9.1,

$$P_Z = R\cos(\eta - \gamma_o) \quad (9.1)$$

$$P_s = R\cos(\beta_o + \eta - \gamma_o) \quad (9.2)$$

Dividing Eqn. 9.1 by Eqn. 9.2,

$$P_Z = \frac{P_s \cos(\eta - \gamma_o)}{\cos(\beta_o + \eta - \gamma_o)} \quad (9.3)$$

It was already shown that,

$$P_s = \frac{ts_o\tau_s}{\sin\beta_o} \quad (9.4)$$

where, τ_s = dynamic yield shear strength of the work material.

$$\text{Thus, } P_Z = \frac{ts_o\tau_s\cos(\eta - \gamma_o)}{\sin\beta_o\cos(\beta_o + \eta - \gamma_o)} \quad (9.5)$$

For brittle work materials, like grey cast iron, usually, $2\beta_o + \eta - \gamma_o = 90^\circ$ and τ remains almost unchanged.
Then for turning brittle material,

$$P_Z = \frac{ts_o\tau_s\cos(90^\circ - 2\beta_o)}{\sin\beta_o\cos(90^\circ - \beta_o)}$$

$$\text{or, } P_Z = 2ts_o\tau_s\cot\beta_o \quad (9.6)$$

$$\text{where, } \cot\beta_o = \zeta - \tan\gamma_o \quad (9.7)$$

$$\zeta = \frac{a_2}{a_1} = \frac{a_2}{s_o\sin\phi}$$

It is difficult to measure chip thickness and evaluate the values of ζ whil machining brittle materials and the value of τ_s is roughly estimated from

$$\tau_s = 0.175\ \text{BHN} \quad (9.8)$$

where, BHN = Brinnel Hardness number.
But most of the engineering materials are ductile in nature and even som semi-brittle materials behave ductile under the cutting condition.
The angle relationship reasonably accurately applicable for ductile metals is

$$\beta_o + \eta - \gamma_o = 45^\circ \quad (9.9)$$

Q.5. (a) Design and sketch around pull type broach for machining a cylindrical hole 10 of diameter 40H7, length 50mm in a work piece of carbon steel. Assume rise· per tooth in the range of 0·02 to 0·06mm. and broaching force required per mm. cutting edge length to be 12kgf. Broach is of HSS and permissible shear stress not to exceed 30kgf/mm2. . [10]

Ans:- Design of broach

Pitch $p = 1.75*(\text{hole length})^{1/2}$
$p = 1.75*(50)^{1/2}$
p = 12.37 mm
Approximately p = 12.50 mm
Face angle = 10^0
Relief angle = 1.5^0 for roughing

= 1.0^0 for finishing
Depth of cut per tooth s= 0.05 mm
Width of the land w=0.3*p
= 0.3*12.5
= 3.75 mm
Depth of cutting teeth h = 0.4*12.5
= 5 mm
Tooth fillet radius = r = 0.3*12.5
= 3.75 mm
Length of toothed portion of broach l is = l
No of cutting teeths = 0.0282/0.05 = 0.5
Approximately 3 minimum no of teeth
L = (p*T/S) + (5 to 12)*p
= p * (3 + 7)
= 10 * 12.5
= 12.5 mm

(b) *Discuss the following; -* [10]

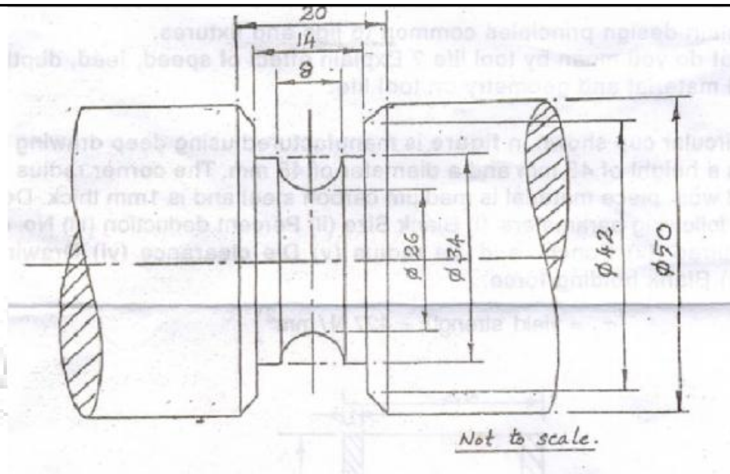
(i) *Types of bending dies.*

Ans:- Types of bending dies.
(a) V bending
(b) Edge bending

(ii) *Methods of reducing cutting force in cutting tool.*

Ans:- (a) Shear-The working faces of the punch or die are ground off so that these don't remain parallel to the horizontal plane but incline to it. This angle of inclination is called shear.
(b) Staggering of punches- The punches are arranged so that one does not enter the material until one before it has penetrated through.

Q.6. *(a) Design a circular form tool graphically for the component given in figure. Rake and clearance angle are 12° and 8° respectively. .* [10]



Ans:- A form tool is precision-ground into a pattern that resembles the part to be formed. The form tool can be used as a single operation and therefore eliminate many other operations from the slides (front, rear and/or vertical) and the turret, such as box tools. A form tool turns one or more diameters while feeding into the work. Before the use of form tools, diameters were turned by multiple slide and turret operations, and thus took more work to make the part. For example, a form tool can turn many diameters and in addition can also cut off the part in a single operation and eliminate the need to index the turret. For single-spindle machines, bypassing the need to index the turret can dramatically increase hourly part production rates.On long-running jobs it is common to use a *roughing tool* on a different slide or turret station to remove the bulk of the material to reduce wear on the form tool.

There are different types of form tools. Insert form tools are the most common for short- to medium-range jobs (50 to 20,000 pcs). Circular form tools are usually for longer jobs, since the tool wear can be ground off the tool tip many times as the tool is rotated in its holder. There is also a skiving tool that can be used for light finishing cuts. Form tools can be made of cobalt steel, carbide, or high-speed steel. Carbide requires additional care because it is very brittle and will chip if chatter occurs.

A drawback when using form tools is that the feed into the work is usually slow, 0.0005" to 0.0012" per revolution depending on the width of the tool. Wide form tools create more heat and usually are problematic for chatter. Heat and chatter reduces tool life. Also, form tools wider than 2.5 times the smaller diameter of the part being turned have a greater risk of the part breaking off. [1] When turning longer lengths, a support from the turret can be used to increase turning length from 2.5 times to 5 times the smallest diameter of the part being turned, and this also can help reduce chatter. Despite the drawbacks, the elimination of extra operations often makes using form tools the most efficient option.

(b) *Explain the following;-* . [10]

(i) Torque and power calculation in rolling

Ans: - The Mill Load application is specifically developed for mill design/operation engineers to calculate roll separating force, rolling torque and power, etc. Typically, load calculation is needed for an existing mill when a new rolling process is applied either with higher reduction or in lower temperature or higher speed, or for a stronger material. This is to make sure the force, torque, etc. are not over equipment capacity. In building a new mill, motor selection, mill size determination and transmission system design, etc. are all based on mill load calculation

(ii) Cutting tool material.

Ans: - (a) High Speed Steel (HSS)

Advent of HSS in around 1905 made a break through at that time in the history of cutting tool materials though got later superseded by many other novel tool materials like cemented carbides and ceramics which could machine much faster than the HSS tools.

(b) Stellite

This is a cast alloy of Co (40 to 50%), Cr (27 to 32%), W (14 to 19%) and C (2%). Stellite is quite tough and more heat and wear resistive than the basic HSS (18 – 4 – 1) But such stellite as cutting tool material became obsolete for its poor grindability and specially after the arrival of cemented carbides.

(c) Sintered Tungsten carbides

The advent of sintered carbides made another breakthrough in the history of cutting tool materials.

• Straight or single carbide First the straight or single carbide tools or inserts were powder metallurgically produced by mixing, compacting and sintering 90 to 95% WC powder with cobalt. The hot, hard and wear resistant WC grains are held by the binder Co which provides the necessary strength and toughness. Such tools are suitable for machining grey cast iron, brass, bronze etc. which produce short discontinuous chips and at cutting velocities two to three times of that possible for HSS tools.

• Composite carbides

The single carbide is not suitable for machining steels because of rapid growth of wear, particularly crater wear, by diffusion of Co and carbon from the tool to the chip under the high stress and temperature bulk (plastic) contact between the continuous chip and the tool surfaces.

For machining steels successfully, another type called composite carbide have been developed by adding (8 to 20%) a gamma phase to WC and Co mix. The gamma phase is a mix of TiC, TiN, TaC, NiC etc. which are more diffusion resistant than WC due to their more stability and less wettability by steel.

• Mixed carbides

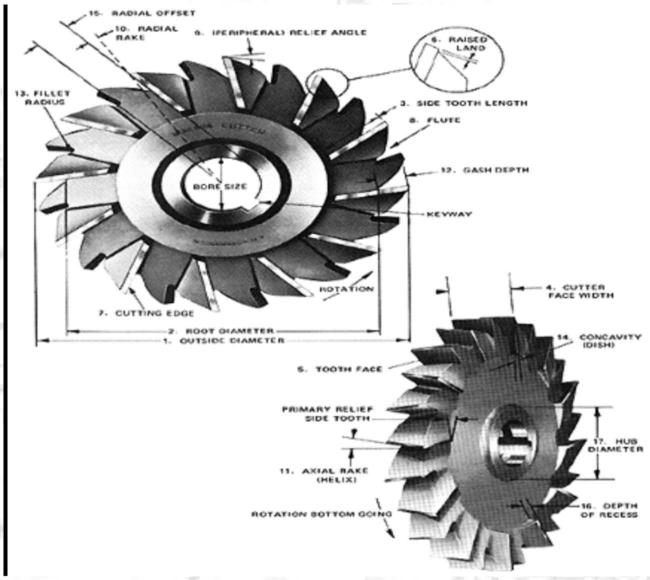
Titanium carbide (TiC) is not only more stable but also much harder than WC. So for machining ferritic steels causing intensive diffusion and adhesion wear a large quantity (5 to 25%) of TiC is added with WC and Co to produce another grade called Mixed carbide. But increase in TiC content reduces the toughness of the tools. Therefore, for finishing with light cut but high speed, the harder grades containing upto 25% TiC are used and for heavy roughing work at lower speeds lesser amount (5 to 10%) of TiC is suitable.

(d) Plain ceramics

Inherently high compressive strength, chemical stability and hot hardness of the ceramics led to powder metallurgical production of indexable ceramic tool inserts since 1950. Table 3.3.4 shows the advantages and limitations of alumina ceramics in contrast to sintered carbide. Alumina (Al_2O_3) is preferred to silicon nitride (Si_3N_4) for higher hardness and chemical stability. Si_3N_4 is tougher but again more difficult to process. The plain ceramic tools are brittle in nature and hence had limited applications.

Q.7.
(a) *Draw the nomenclature of plain milling cutter and explain the procedure of 10 designing a plain milling cutter. .* [10]

Ans:-



1. outside diameter. The outside diameter is the diameter of the cylinder passing through the peripheral cutting edges.
2. Root diameter. The root diameter is the diameter of the circle passing tangent to the bottom of the fillet.
3. Side tooth length. Length of the raised land along the side tooth. Required to calculate the number of resharpenings available and the modification possibilities.
4. Cutter faces width. The cutter face is the surface at the side or end of the cutter body which is perpendicular to the axis of the cutter. The distances between the two faces of plain, helical and side milling cutters or the length of the outside diameter cylinder is the cutter width, if small, or cutter length, with respect to the diameter.
5. Tooth face. The tooth face is that surface of the cutting tooth against which the chip is forced in the metal cutting operation.
6. Land. The land is that part of the back of the tooth adjacent to the cutting edge which is relieved to avoid interference between itself and the surface being machined. A raised land permits numerous resharpenings before a secondary clearance has to be ground.
7. Cutting edge. The cutting edge is the intersection of the face of the tooth with the leading edge of the land.
8. Flute. The flute is the chip space between the back of one tooth and the face of the following tooth.
9. Relief angle. The peripheral relief angle is the angle between the surface formed by the land and a tangent to the cutter outside circle passing through the cutting edge in a diametral plane. It is to prevent the land from rubbing on the surface of the work being cut. Relief and clearance are measured in degrees or in radial fall in inches at a certain specified distance back of the cutting

edge on the land. For this latter measurement, a dial indicator may be used to measure the radial fall in thousandths of an inch from the outside or cutting edge diameter back of the cutting edge.

10. Radial rake angle. The radial rake angle of a milling cutter is the angle formed in a diametral plane between the face of the tooth and a radial line passing through the cutting edge. This may be positive, negative, or zero degree.

11. Axial rake angle or helical rake. When a milling cutter has helical teeth, that is, when its cutting edge is formed along a helix about the cutter axis, the resulting rake is called helicall rake. If the cutting edge is straight, its rake is axial rake. The axial rake or helical rake angle is the angle formed between the line of the peripheral cutting edge and the axis of the cutter, when looking radially at the point of intersection. This applies in the case of helical mills, half-side mills, staggered tooth mills, face mills, and metal slitting saws having face cutting edges.

12. Gash depth. Gash depth is the distance from the outside diameter of the cutter to the fillet radius or root diameter.

13. Fillet radius. The fillet radius is the curved surface at the bottom of the flute which joins the face of one tooth to the back of the tooth immediately ahead.

14. Dish or concavity. The progressive decrease in cutter width from the periphery toward the center.

15. Radial offset. The radial offset of a milling cutter is the physical dimension that a tooth is behind (for positive rake) or ahead (for negative rake) of a center line drawn parallel with flat, tooth face. It is calculated by multiplying the sine function of the radial rake angle times the radius of the milling cutter.

16. Depth of recess. The distance from the cutting edge on the land of the side tooth (or the hub which is the same width as the cutter) to the recess is the depth of recess. This dimension is required to determine width and angle modification limits.

17. Hub diameter. The hub is the raised ground section between the bore and recess. It is the same width as the cutter. Collar spacers butt adjacent to the hub for holding and spacing of the cutter on the arbor. The hub diameter dimension is required to determine the allowable depth or cut and clearance between cutter and workpiece.

(b) *Explain the following ;-* . [10]

(i) *'C'-clamp and captive "c' clamp*

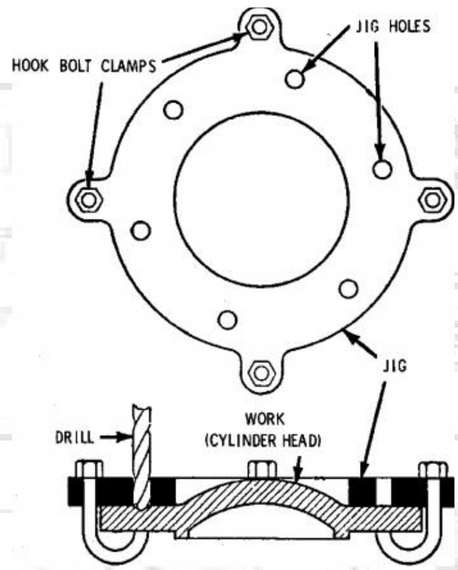
Ans:- C-clamps are typically made of steel or cast iron, though smaller clamps may be made of pot metal. At the top of the "C" is usually a small flat edge. At the bottom is a threaded hole through which a large threaded screw protrudes. One end of this screw contains a flat edge of similar size to the one at the top of the frame, and the other end usually a small metal bar, perpendicular to the screw itself, which is used to gain leverage when tightening the clamp. When the clamp is completely closed, the flat end of the screw is in contact with the flat end on the frame.[2] When the clamp is actually used, it is very rare that this occurs. Generally some other object or objects will be contained between the top and bottom flat edges.

A C-clamp is used by turning the screw through the bottom of the frame until the desired state is reached. In the case that the clamp is being tightened, this is when the objects being secured are satisfactorily secured between the flat end of the screw and the flat end of the frame. If the clamp is being loosened, this is when a sufficient amount of force has relieved to allow the secured objects to be moved.

(ii) *Open type jig and channel type jig.*

Ans:- Open type jig

This device derives its name from the fact that it usually resembles some form of clamp. It is adapted for use on work pieces on which the axes of all the holes that are to be drilled are parallel. Clamp jigs are sometimes called *open jigs*. A simple example of a clamp jig is a design for drilling holes that are all the same size—for example, the stud holes in a cylinder head (Figure), the jig consists of a ring with four lugs for clamping and is frequently called a *ring jig*. It is attached to the cylinder head and held by U-bolt clamps. When used as a



guide for the drill in the drilling operation, the jig makes certain that the holes are in the correct locations because the holes in the jig were located originally with precision. Therefore, laying out is not necessary. A disadvantage of the simple clamp jig is that only holes of a single size can be drilled. Either *fixed* or *removable* bushings can be used to overcome this disadvantage. Fixed bushings are sometimes used because they are made of hardened steel, which reduces wear. Removable bushings are used when drills of different sizes are to be used, or when the drilled holes are to be finished by reaming or tapping.

channel type jig

Another simple clamp jig is called a *channel jig* and derives its name from the cross-sectional shape of the main member, as shown in Figure. They can be used only with parts having fairly simple shapes.