Department of Mechanical Engineering
(Established in 2002)

M-TECH (MACHINE DESIGN)

Laboratory Manual

For

M. Tech - II Sem
ADVANCED COMPUTER AIDED MODELLING
LAB (ACAM) - (Code: 83208)

Academic Year 2019-20

Malla Reddy Engineering College
(Autonomous)

MR-18 (83208)   ADVANCED COMPUTER AIDED MODELLING LAB

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Exp: 1 **STUDY OF SYSTEM OF LIMITS, FITS, TOLERANCE**

Limits & Fits: Why we need to study Limits & Fits?

- Exact size is impossible to achieve.

- Establish boundaries within which deviation from perfect form is allowed but still the design intent is fulfilled.

- Enable interchangeability of components during assembly

Definition of Limits:

The maximum and minimum permissible sizes within which the actual size of a component lies are called Limits.

Tolerance:

It is impossible to make anything to an exact size, therefore it is essential to allow a definite tolerance or permissible variation on every specified dimension.

Why Tolerances are specified?

- Variations in properties of the material being machined introduce errors.

- The production machines themselves may have some inherent inaccuracies.

- It is impossible for an operator to make perfect settings. While setting up the tools and workpiece on the machine, some errors are likely to creep in.
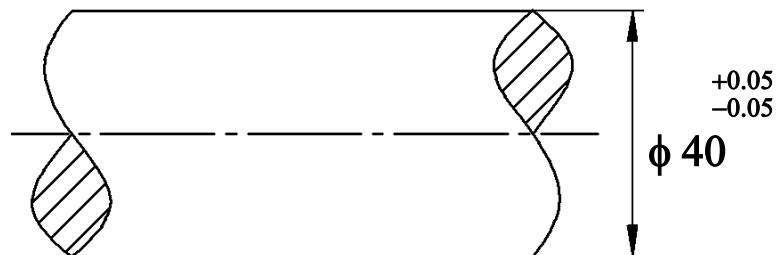
Consider the dimension shown in fig. When trying to achieve a diameter of 40 mm (Basic or Nominal diameter), a variation of 0.05 mm on either side may result.

If the shaft is satisfactory even if its diameter lies between 40.05 mm & 39.95 mm, the dimension 40.05 mm is known as Upper limit and the dimension 39.95 mm is known as Lower limit of size. Tolerance in the above example is (40.05-39.95) =0.10 mm

Tolerance is always a positive quantitative number.

Unilateral Tolerance:

- Tolerances on a dimension may either be unilateral or bilateral.

- When the two limit dimensions are only on one side of the nominal size, (either above or below) the tolerances are said to be unilateral.

- For unilateral tolerances, a case may occur when one of the limits coincide with the basic size.
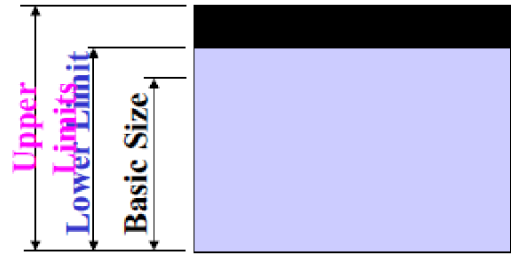
e.g. $\varnothing 25 \, ^{+0.18}_{+0.10}$

Basic Size   = 25.00 mm
Upper Limit = 25.18 mm
Lower Limit = 25.10 mm
Tolerance   = **0.08 mm**
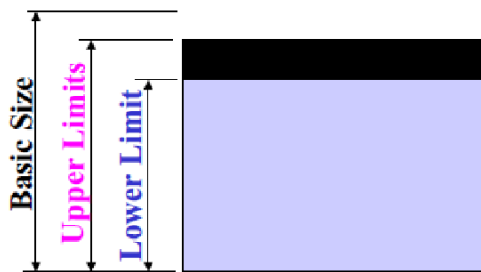
e.g. $\varnothing 25 \, ^{-0.10}_{-0.20}$

Basic Size   = 25.00 mm
Upper Limit = 24.90 mm
Lower Limit = 24.80 mm
Tolerance   = **0.10 mm**

Bilateral Tolerance: When the two limit dimensions are above and below nominal size, (i.e. on either side of the nominal size) the tolerances are said to be bilateral.

Unilateral tolerances, are preferred over bilateral because the operator can machine to the upper limit of the shaft (or lower limit of a hole) still having the whole tolerance left for machining to avoid rejection of parts.

Tolerance zone

Upper limit = $\varnothing$ 28 . 2

Zero line

Lower limit = $\varnothing$ 27. 8

Tolerance = UL – LL
= 28.2 – 27.8
= 0.4
Or ± 0.2

Ø28 ± 0.2
(Basic)

Shaft
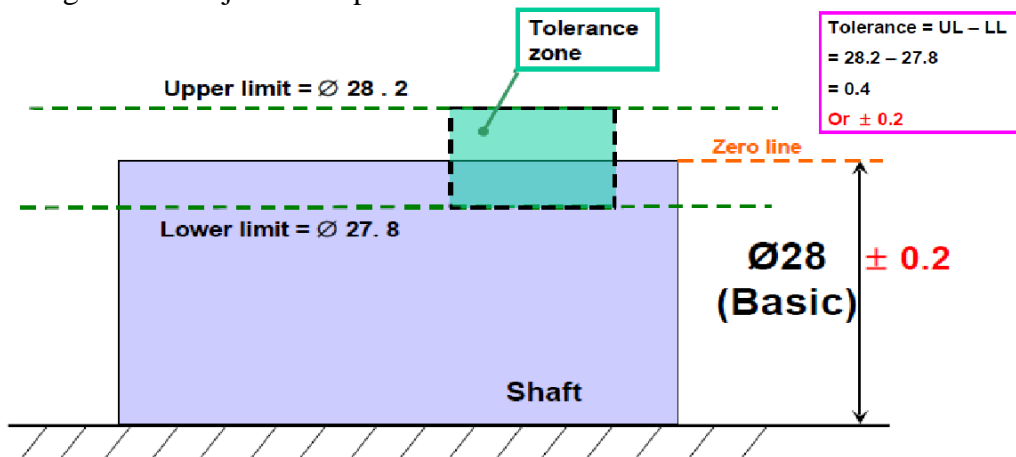
Schematic representation of tolerances:

Unilateral Tolerance

Tolerance

Tolerance

Zero Line

O

(Basic Size)

Bilateral Tolerance
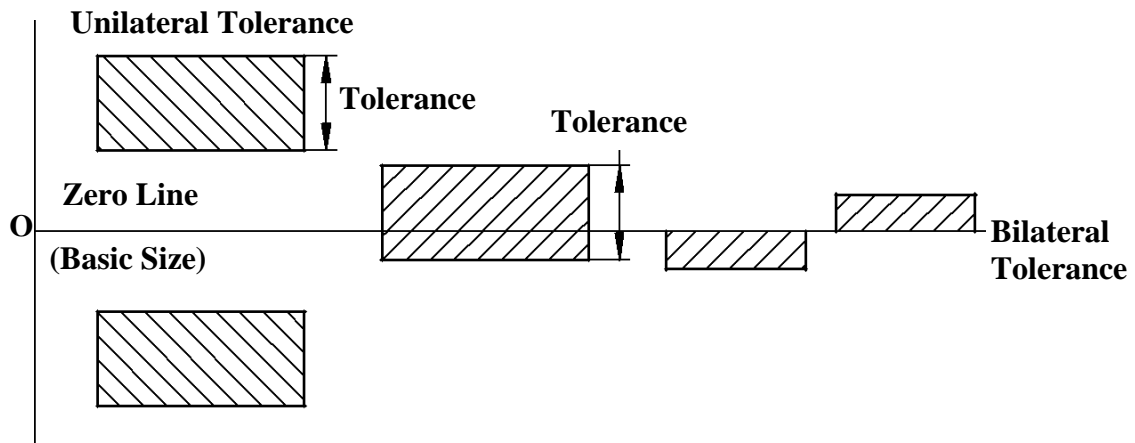
Tolerance Accumulation (or) Tolerance Build up:
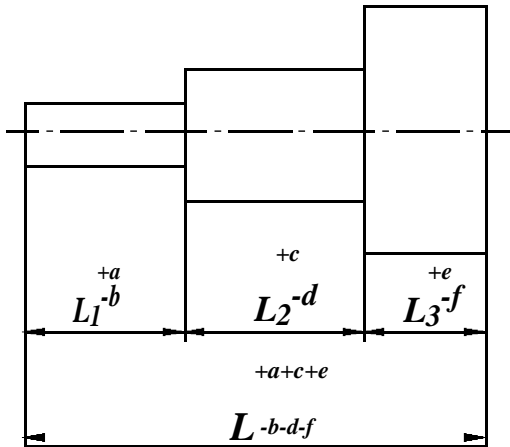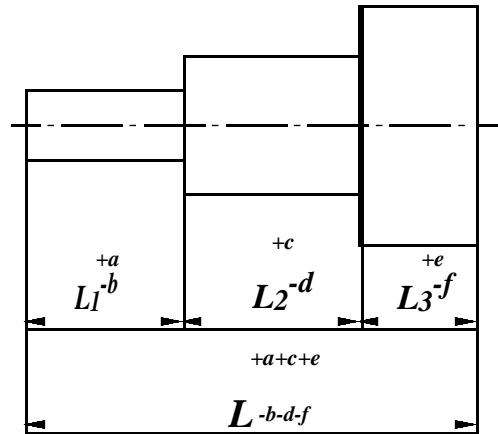

Fig (a)   Fig (b)

If a part comprises of several steps, each step having some tolerance specified over its length, then the overall tolerance on the complete length will be the sum of tolerances on individual lengths as shown in fig (a).

The effect of accumulation of tolerances can be minimized by adopting progressive dimensioning from a common datum as shown in fig (b). Another example of tolerance build up is shown below.

A = 65 ±0.15 − 40 ±0.15
  = 25 ±0.3
A max. = 25.3 mm
A min = 24.7 mm

B = 25 ±0.5 + 35 ±0.8 + 20 ±0.5
  = 80 ±1.8
B max. = 81.8 mm
B min = 78.2 mm
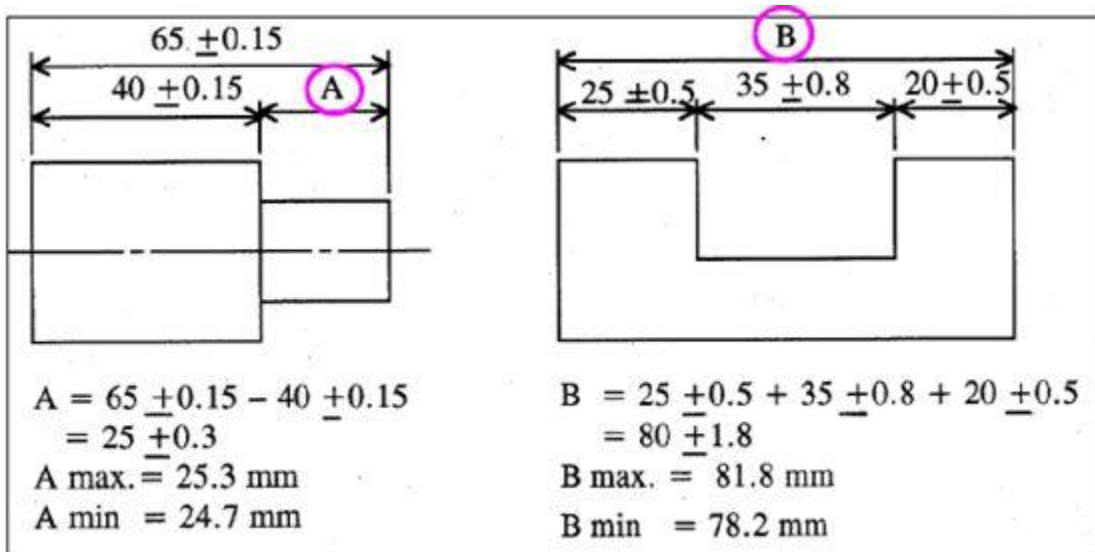
Compound Tolerances: A compound tolerance is one which is derived by considering the effect of tolerances on more than one dimension.
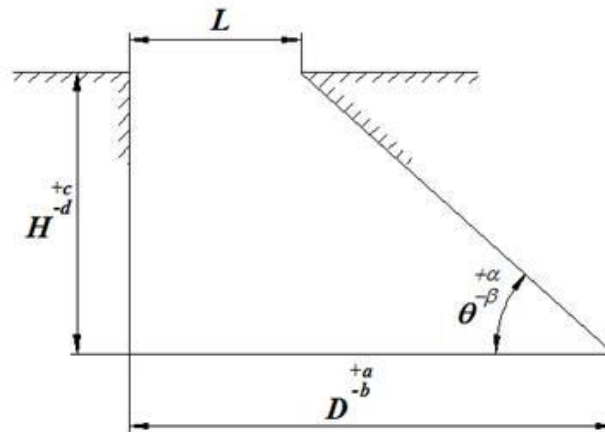
For ex, the tolerance on the dimension L is dependent on the tolerances on D, H & θ.

The dimension L will be maximum when the base dimension is (D+a), the angle is (θ+a), and the vertical dimension is (H-d).

The dimension L will be minimum when the base dimension is (D-b), the angle is (θ-b), and the vertical dimension is (H+c).

LIMITS OF SIZE & TOLERANCE

Terminology of limit systems:

Limits of size: The two extreme permissible sizes of a component between which the actual size should lie including the maximum and minimum sizes of the component.

Nominal size: It is the size of the component by which it is referred to as a matter of convenience.

Basic size: It is the size of a part in relation to which all limits of variation are determined.

Zero Line: It is the line w.r.t which the positions of tolerance zones are shown.
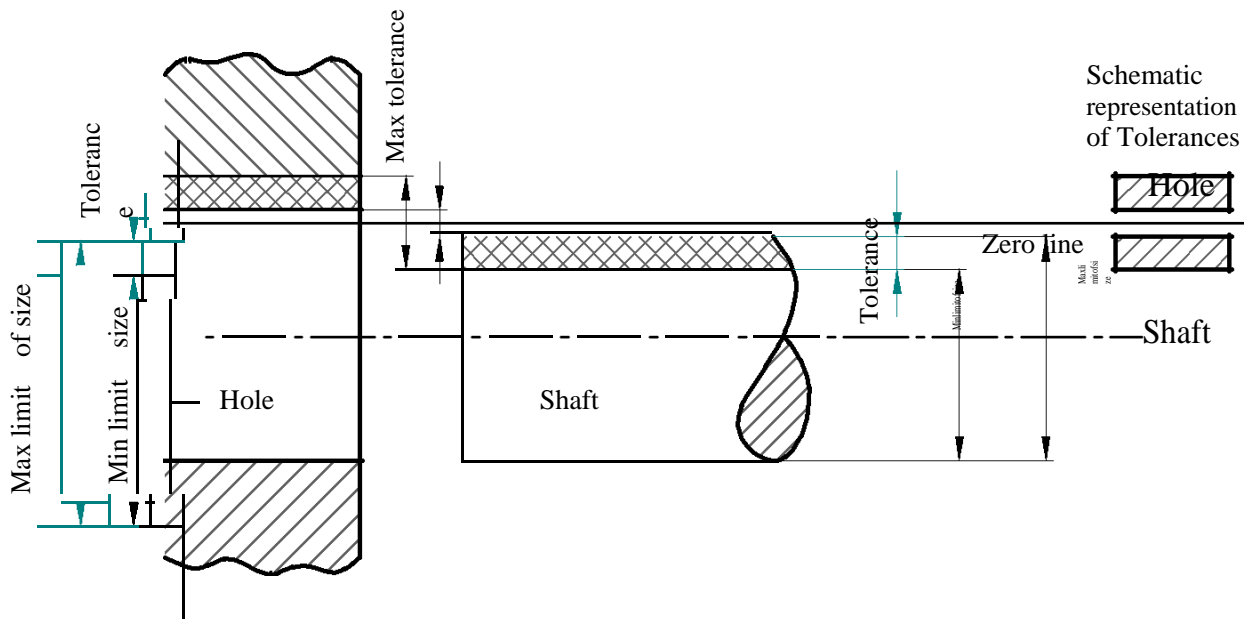
Deviation: It is the algebraic difference between a limit of size and the corresponding basic size.

Upper Deviation: It is the algebraic difference between the maximum limit of size and the corresponding basic size. It is denoted by letters *'ES'* for a hole and *'es'* for a shaft.

Lower Deviation: It is the algebraic difference between the minimum limit of size and the corresponding basic size. It is denoted by letters *'EI'* for a hole and *'ei'* for a shaft.

Fundamental Deviation: It is the deviation, either upper or lower deviation, which is nearest to the zero line for either a hole or a shaft. It fixes the position of the tolerance zone in relation to the zero line.

Allowance: It is the intentional difference between the hole dimensions and shaft dimension for any type of fit.

Size of tolerance: It is the difference between the maximum and minimum limits of size.

SYSTEM OF FITS

Fit is an assembly condition between 'Hole' & 'Shaft'

Hole: A feature engulfing a component.

Shaft: A feature being engulfed by a component.
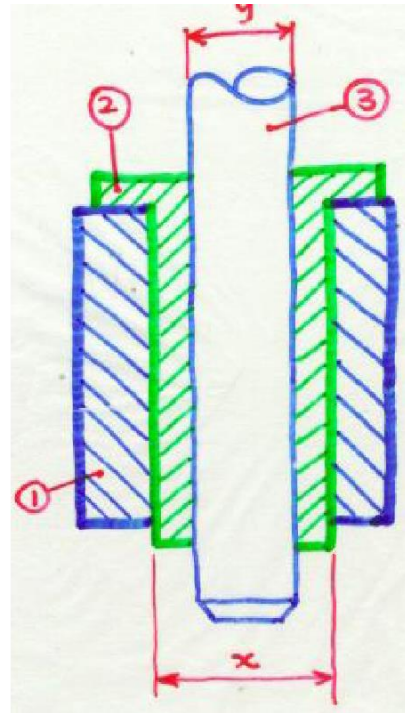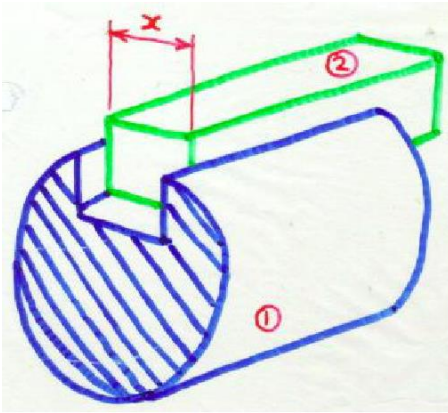
Clearance fit: In this type of fit, the largest permitted shaft diameter is less than the smallest hole diameter so that the shaft can rotate or slide according to the purpose of the assembly.
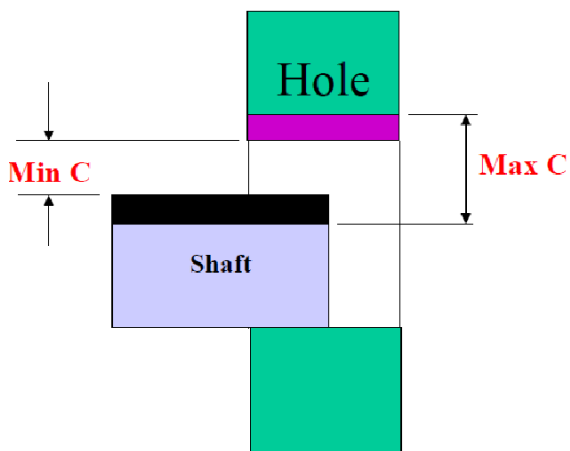
Tolerance zones never meet

Max. C = UL of hole - LL of shaft
Min. C = LL of hole - UL of shaft

Interference Fit:

It is defined as the fit established when a negative clearance exists between the sizes of holes and the shaft. In this type of fit, the minimum permitted diameter of the shaft is larger than the maximum allowable diameter of the hole. In case of this type of fit, the members are intended to be permanently attached. *Ex:* Bearing bushes, Keys & key ways
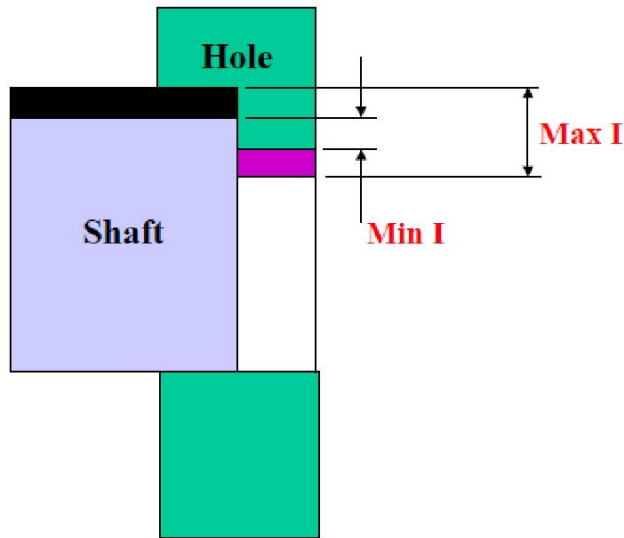
Tolerance zones never meet but crosses each other

Max. I = LL of hole - UL of shaft
Min. I = UL of hole - LL of shaft

Transition Fit: In this type of fit, the diameter of the largest allowable hole is greater than the smallest shaft, but the smallest hole is smaller than the largest shaft, such that a small positive or negative clearance exists between the shaft & hole.

Ex: Coupling rings, Spigot in mating holes, etc.
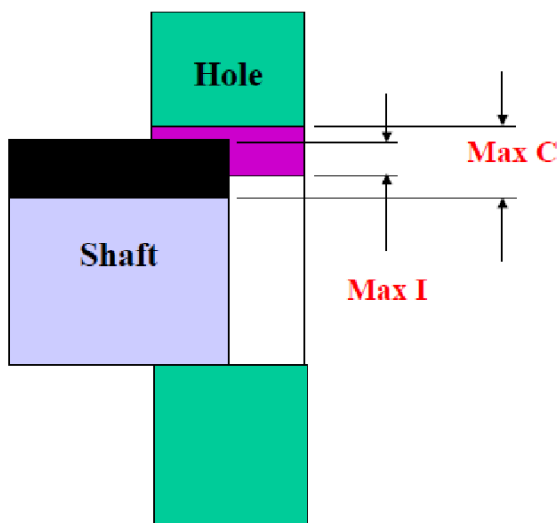
Tolerance zones always overlap

Max. C = UL of hole - LL of shaft
Max. I = LL of hole - UL of shaft

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Interchangeability:

Interchangeability occurs when one part in an assembly can be substituted for a similar part which has been made to the same drawing. Interchangeability is possible only when certain standards are strictly followed.

Universal interchangeability means the parts to be assembled are from two different manufacturing sources.

Local interchangeability means all the parts to be assembled are made in the same manufacturing unit.

Selective Assembly:

In selective assembly, the parts are graded according to the size and only matched grades of mating parts are assembled. This technique is most suitable where close fit of two components assembled is required.

Selective assembly provides complete protection against non-conforming assemblies and reduces machining costs as close tolerances can be maintained.

Suppose some parts (shafts & holes) are manufactured to a tolerance of 0.01 mm, then an automatic gauge can separate them into ten different groups of 0.001 mm limit for selective assembly of the individual parts. Thus high quality and low cost can be achieved.

Selective assembly is used in aircraft, automobile industries where tolerances are very narrow and not possible to manufacture at reasonable costs.

Geometrical Tolerances:

It is necessary to specify and control the geometric features of a component, such as straightness, flatness, roundness, etc. in addition to linear dimensions. Geometric tolerance is concerned with the accuracy of relationship of one component to another and should be specified separately.

 Geometrical tolerance may be defined as the maximum possible variation of *form*, or *position of form* or *position of a feature.*

Geometric tolerances define the shape of a feature as opposed to its size. There are three basic types of geometric tolerances:

Form tolerances:

Straightness, flatness, roundness, cylindricity
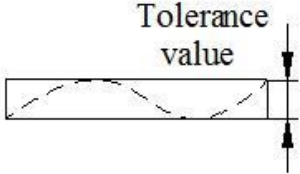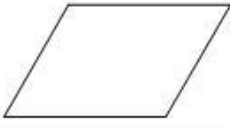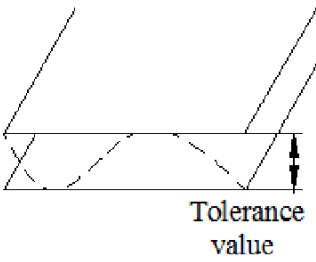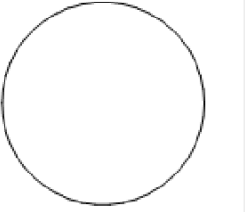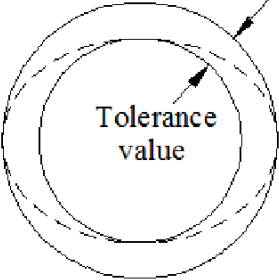
Orientation tolerances:

Perpendicularity, parallelism, angularity

Position tolerances:

Position, symmetry, concentricity

FORM TOLERANCES

Characteristic or symbol	Function of geometric tolerance	Tolerance zone	Typical example
Straightness ─────────	To control the straightness of the line on a surface.	Area between two parallel straight lines in the plane containing the considered line or axis, Tolerance value is the distance between them.	
Flatness	To control the flatness of a surface.	Area between two planes. Tolerance value is the distance between them.	
Roundness	To control the errors of roundness of a circle in the plane in which it lies.	Area between two concentric circles. Tolerance value is the radial distance between them.	
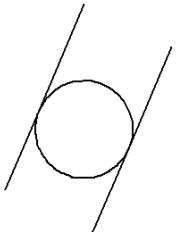
Cylindricity	To control combination of roundness, straightness, and parallelism of a cylindrical surface.	Annular space between two cylinders that are co axial. Tolerance value is the radial distance between them.	
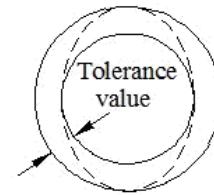
ORIENTATION TOLERANCES

Parallelism	To control the parallelism of a line or surface w.r.t some datum.	Area between two parallel lines or space between two parallel lines which are parallel to the datum	
Squareness	To control the perpendicularity of a line or surface w.r.t a datum.	Area between two parallel lines or space between two parallel lines which are perpendicular to the datum.	
Angularity	To control the inclination of a line or surface w.r.t a datum.	Area between two parallel lines or space between two parallel lines which are inclined at a specified angle to the datum.	
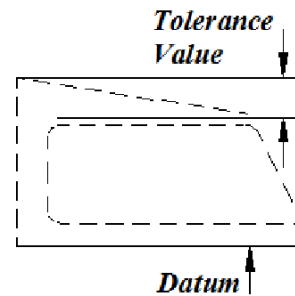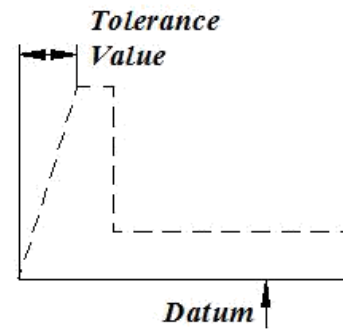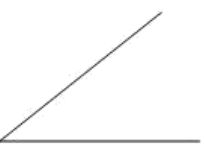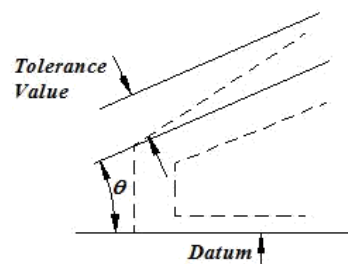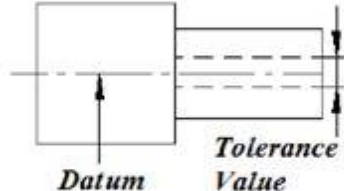
POSITIONAL TOLERANCES

Concentricity	To control the deviation of the position of the position of the center or axis of the toleranced circles or cylinders.	Center or axis to lie within the circle or cylinder. Tolerance value is the diameter of such a circle or cylinder.	

Feature Control Frame:

A geometric tolerance is prescribed using a feature control frame. It has three components:

- The tolerance symbol,
- The tolerance value,
- The datum labels for the reference frame.
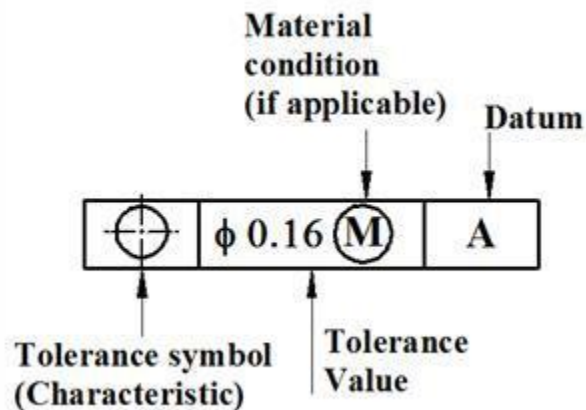
Material Conditions:

Maximum Material Condition (MMC): The condition in which a feature contains the maximum amount of material within the stated limits.   e.g. minimum hole diameter, maximum shaft diameter.

 Least Material Condition (LMC): The condition in which a feature contains the least amount of material within the stated limits. e.g. maximum hole diameter, minimum shaft diameter.

Regardless of Feature Size (RFS): This is the default condition for all geometric tolerances.

Example: **STRAIGHTNESS**

This cylinder must be straight within 0.03 mm.

What it means -

0.03 Tolerance Zone
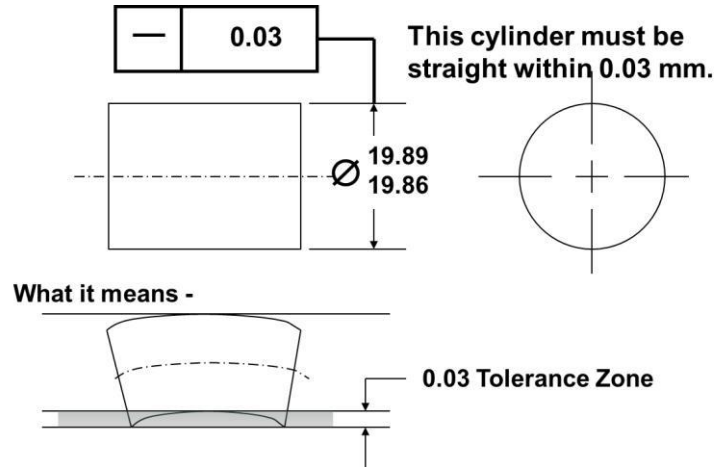
ROUNDNESS:
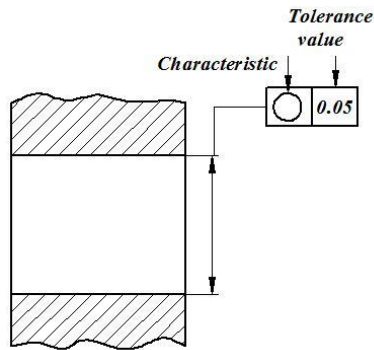
SQUARENESS:

PARALLELISM:

Geometric Characteristic Symbol

Tolerance

Datum Reference

| // | ⌀ .007 Ⓜ | B |

Material condition

.007
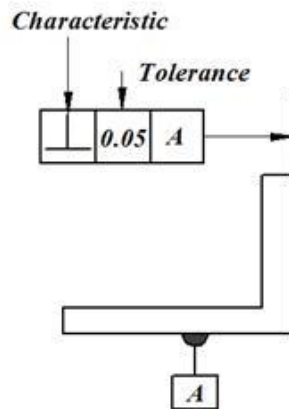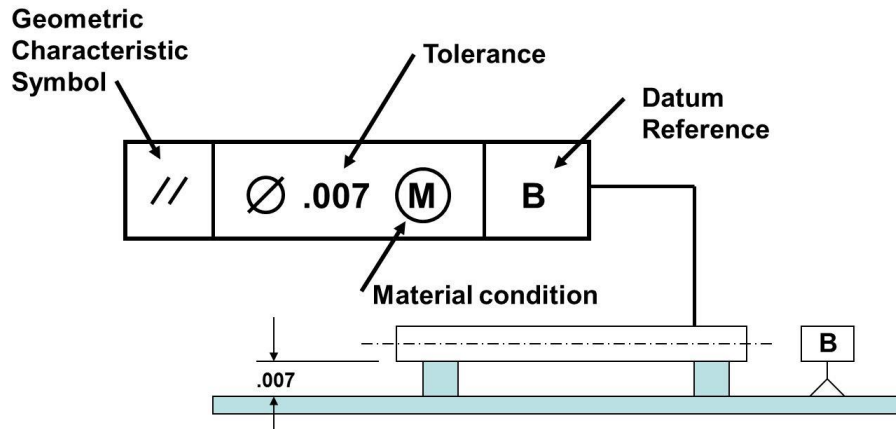
This feature must be parallel to Datum B within .007 at MMC (largest cylinder) as measured on the diameter

CONCENTRICITY:

| ◎ | ⌀ .007 | A |

A

XX

YY
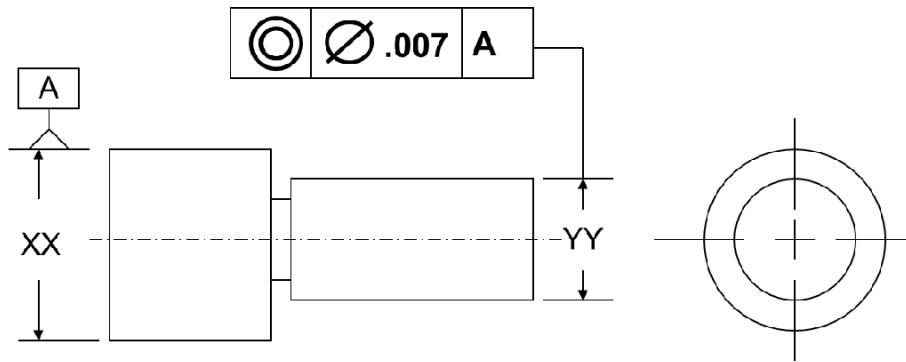
This cylinder (the right cylinder) must be concentric within .007 with the Datum A (the left cylinder) as measured on the diameter

⌀ .007 Tolerance Zone
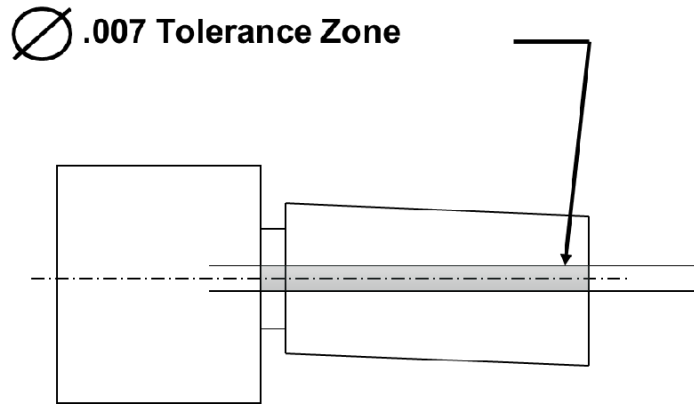
IS 919-1965 SYSTEM OF TOLERANCES

Holes are designated by capital letter:
Letters A to G - oversized holes
Letters P to ZC - undersized holes
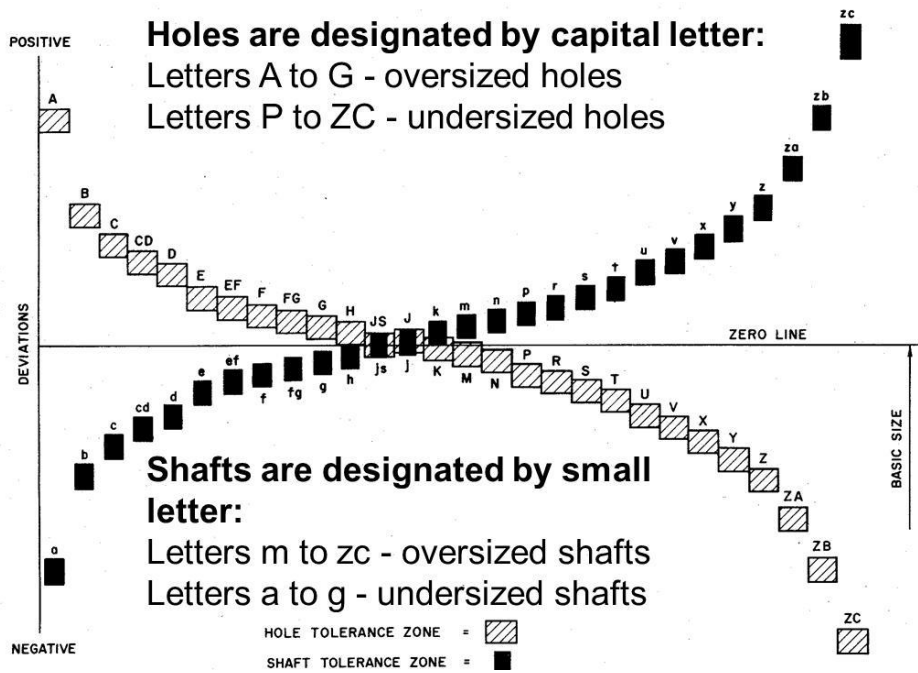
'H' is used for holes and 'h' is used for shafts whose fundamental deviation is zero.

Shafts are designated by small letter:
Letters m to zc - oversized shafts
Letters a to g - undersized shafts

HOLE TOLERANCE ZONE = ▨
SHAFT TOLERANCE ZONE = ■

Terms & symbols used:

Basic shaft: It is a shaft whose upper deviation is zero. i.e. the maximum limit of shaft coincides with the nominal size.(zero line). *Eg:* shaft 'h'

Basic hole: It is a hole whose lower deviation is zero. i.e. the minimum limit of hole coincides with the nominal size.(zero line). *Eg*: shaft 'H'

STUDY OF FUNDAMENTAL CALCULATIONS OF SHAFT DEVIATIONS

Basis of Fits

Hole Basis: In this system, the basic diameter of the hole is constant while the shaft size is varied according to the type of fit.

Significance of Hole basis system: The bureau of Indian Standards (BIS) recommends both hole basis and shaft basis systems, but their selection depends on the production methods. Generally, holes are produced by drilling, boring, reaming, broaching, etc. whereas shafts are either turned or ground.

If the shaft basis system is used to specify the limit dimensions to obtain various types of fits, number of holes of different sizes are required, which in turn requires tools of different sizes.

HOLE BASIS SYSTEM OF FITS
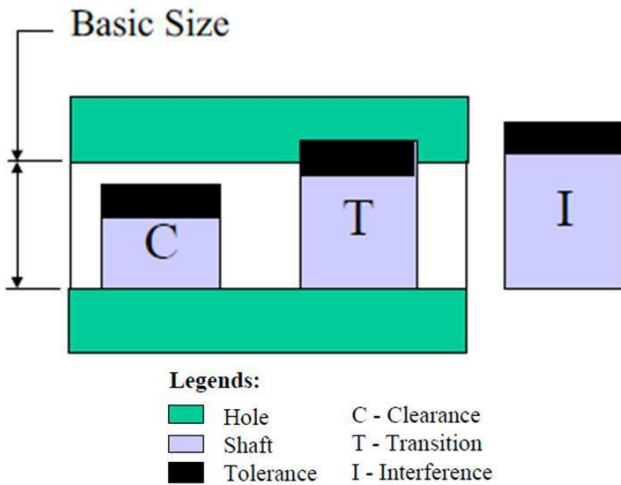
If the hole basis system is used, there will be reduction in production costs as only one tool is required to produce the ole and the shaft can be easily machined to any desired size. Hence hole basis system is preferred over shaft basis system.

Shaft Basis system:

In this system, the basic diameter of the shaft is constant while the hole size is varied according to the type of fit.
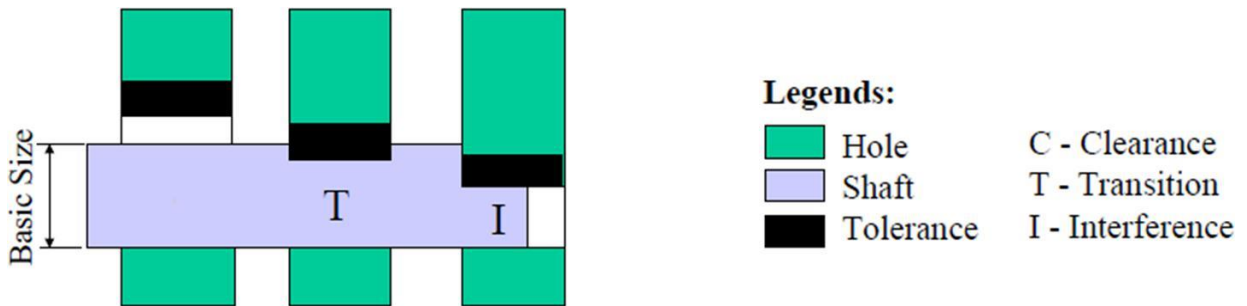
It may, however, be necessary to use shaft basis system where different fits are required along a long shaft.

For example, in the case of driving shafts where a single shaft may have to accommodate to a variety of accessories such as couplings, bearings, collars, etc., it is preferable to maintain a constant diameter for the permanent member, which is the shaft, and vary the bore of the accessories.

GRADES OF TOLERANCES

Grade is a measure of the magnitude of the tolerance. Lower the grade the finer the tolerance. There are total of 18 grades which are allocated the numbers IT01, IT0, IT1, IT2..... IT16.

Fine grades are referred to by the first few numbers. As the numbers get larger, so the tolerance zone becomes progressively wider. Selection of grade should depend on the circumstances. As the grades get finer, the cost of production increases at a sharper rate.
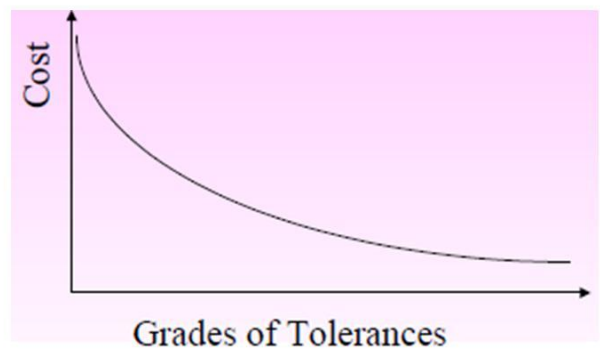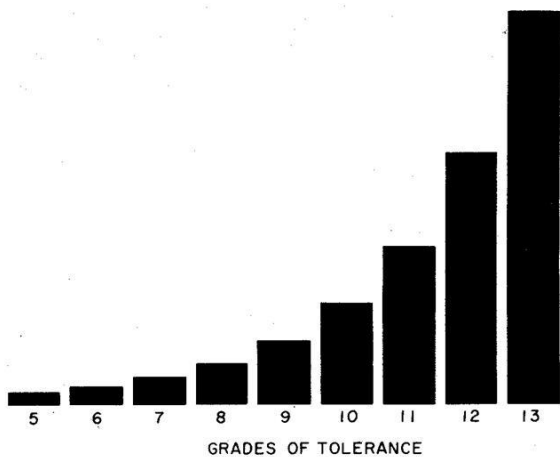
TOLERANCE GRADE

The tolerance grades may be numerically determined in terms of the standard tolerance unit 'i' where i in microns is given by $\overline{}$ (for basic size upto and including 500 mm) and (for basic size above 500 mm upto and including 3150 mm), where D is in mm and it is the geometric mean of the lower and upper diameters of a particular step in which the component lies.

The above formula is empirical and is based on the fact that the tolerance varies more or less parabolically in terms of diameter for the same manufacturing conditions. This is so because manufacture and measurement of higher sizes are relatively difficult. The various diameter steps specified by ISI are:

1-3, 3-6, 6-10, 10-18, 18-30, 30-50, 50-80, 80-120,180-250, 250-315, 315-400, and 400-500 mm. The value of 'D' is taken as the geometric mean for a particular range of size to avoid continuous variation of tolerance with size.

The fundamental deviation of type d,e,f,g shafts are respectively $-16D^{0.44}$, $-11D^{0.41}$ $-5.5D^{0.41}$ & $-2.5D^{0.34}$

The fundamental deviation of type D,E,F,G shafts are respectively $+16D^{0.44}$, $+11D^{0.41}$ $+5.5D^{0.41}$ & $+2.5D^{0.34}$.

The relative magnitude of each grade is shown in the table below;

Tol. Grade	IT 5	IT 6	IT 7	IT 8	IT 9	IT 10	IT 11	IT 12	IT 13	IT 14	IT 15	IT 16
	7i	10i	16i	25 i	40 i	64 i	100 i	160 i	250 i	400 i	640 i	1000 i

It may be noted that from IT 6 onwards, every 5th step is 10 times the respective grade.

i.e. IT 11=10xIT6=10x10i=100 i, IT12=10xIT7=10x16i=160 i, etc.

Numerical Problem 1:

Calculate the limits of tolerance and allowance for a 25 mm shaft and hole pair designated by H₈d₉. Take the fundamental deviation for'd' shaft is $-16D^{0.44}$.

Solution:

The given size of 25 mm lies in the standard diameter step of 18-30 mm.

$\therefore D=\sqrt{18\times 30} = \textbf{\textit{23.238 mm}}$

The value of fundamental tolerance unit $i = 0.45\sqrt[3]{D} + 0.001D$

microns $i.e \sqrt{i} = 0.45\sqrt[3]{23.238} + 0.001(23.238) = \textbf{\textit{1.307μ}}$

For a hole of quality 8, (i.e. IT 8) the standard tolerance value is $=25\ i$

$\therefore$ Tolerance $25 \times 1.307 = \textbf{\textit{33μ}}$

For the H hole, the fundamental deviation is zero.

Hence, the hole limits are 25 mm and (25+0.033)=25.033 mm

∴ Hence, tolerance on the hole = (25.033 − 25) = **0.033 mm**

For quality 9 shaft, tolerance = IT9 =40i=40 ×1.307=**52μ = 0.052**

mm For *d* shaft the fundamental deviation is $-16D^{0.44}$

$= -16D^{0.44} = -16(23.238)^{0.44} =$ **-64μ = 0.064 mm**

∴ The shaft limits are (25 − 0.064) = **24.936 mm** and

$$25 - (0.064 + 0.052) = 24.884 \text{ mm}$$

∴ Tolerance on the shaft =UL-LL = (24.936 − 24.884) = **0.052 mm**
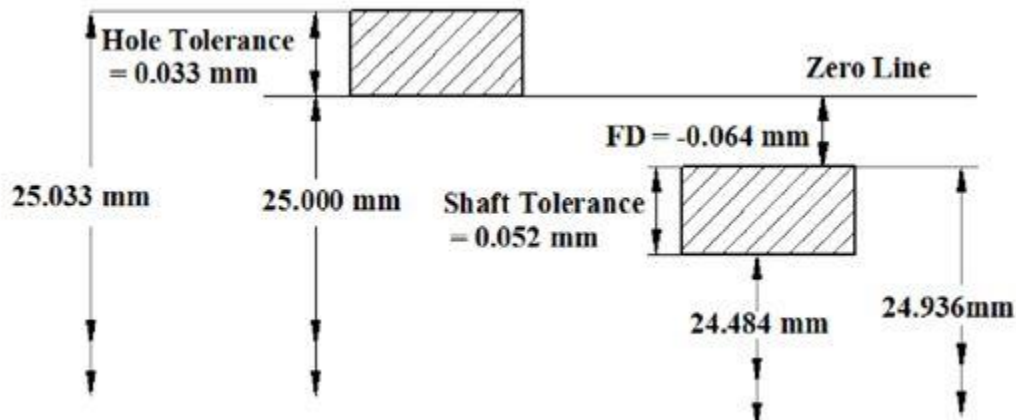
Numerical Problem 2

Determine the tolerances on the hole and the shaft for a precision running fit designated

by 50 H7g6, given;

50 mm lies between 30-50 mm

i (in microns)=0.45(D)$^{1/3}$+0.001D

Fundamental deviation for 'H' hole=0

Fundamental deviation for g shaft =-2.5D$^{0.34}$

IT7=16i and IT6=10i

State the actual maximum and minimum sizes of the hole and shaft and maximum and

minimum clearances.

Solution:

The given size of 50 mm lies in the diameter step of 30-50 mm.

∴ D=$\sqrt{30 \times 50}$ = **38.7 mm**

The value of fundamental tolerance unit $i = 0.45\sqrt[3]{D} + 0.001D$

microns $i.e \sqrt{i = 0}.45 \sqrt[3]{38.7} + 0.001(38.7) = \boldsymbol{1.56\mu}$

For a hole of quality 7, (i.e. IT 7) the standard tolerance

value is $=16\ i\ \therefore$ Tolerance $16 \times 1.56 = \boldsymbol{25\mu = 0.025\ mm}$

For the H hole, the fundamental deviation is zero.

Hence, the hole limits are 50 mm and (50+0.025)=50.025 mm (Or $50^{+0.025}_{-0.000}$ *mm*)

$\therefore$ Hence, tolerance on the hole $= (50.025 - 50) = \boldsymbol{0.025\ mm}$

For quality 6 shaft, tolerance = IT6=10i =10i=10 ×1.56=**15.6** μ = **0.0156**

mm For g shaft the fundamental deviation is $- 2.5D^{0.34}$

$$= -2.5(38.7)^{0.34} = \boldsymbol{-8.664\mu = 0.009\ mm}$$

$\therefore$ The shaft limits are $(50 - 0.009) = \boldsymbol{49.991\ mm}$
and $50 - (0.009 + 0.016) = \boldsymbol{49.975\ mm}$ (Or $50^{-0.009}_{-0.025}$ *mm*)

Actual maximum and minimum size of hole is 50.025 mm

and 50.000 mm, and for shaft is 49.991 mm and 49.975 mm.

Maximum clearance =UL of hole $-$ LL of shaft = (50.025-49.975)=**0.05 mm**

Minimum clearance = LL of hole $-$ UL of shaft = (50.000-49.975)=**0.009 mm**
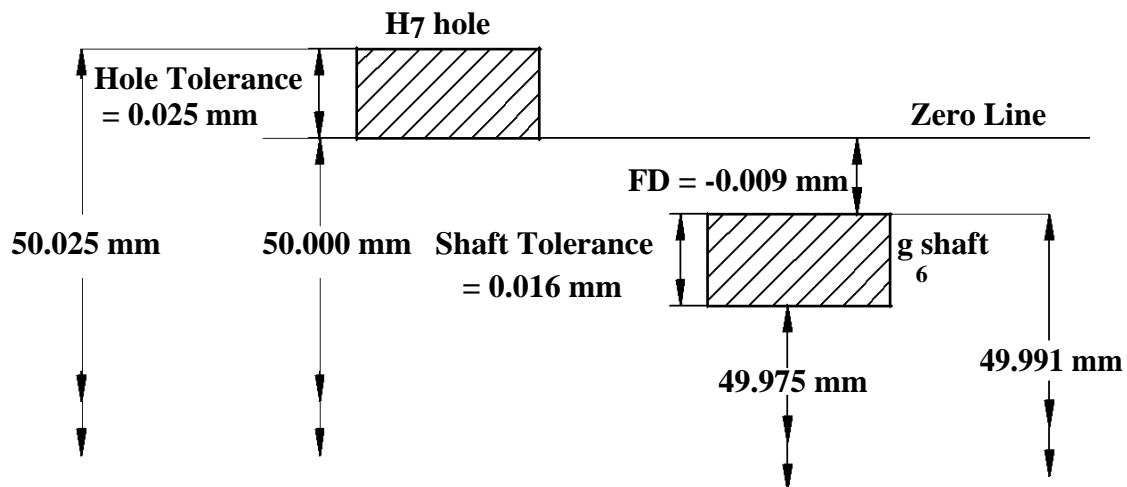
Numerical Problem 3:

Calculate all the relevant dimensions of 35H7/f8 fit, dimension 35 mm falls in the step of 30-50 mm. The fundamental deviation for f shaft is – 5.5D0.41. i (in microns)=0.45(D)1/3+0.001D, IT7=16i and IT8=25i.

Solution:

The given size of 35 mm lies in the diameter step of 30-50 mm.

$$\therefore D = \sqrt{30 \times 50} = \textbf{38.7 mm}$$

The value of fundamental tolerance unit $i = 0.45\sqrt[3]{D} + 0.001D$

microns $i.e \sqrt{i = 0}.45 \sqrt[3]{38.7} + 0.001(38.7) = \textbf{1.56}\boldsymbol{\mu}$

For a hole of quality 7, (i.e. IT 7) the standard tolerance

value is $= 16\ i$ $\therefore$ Tolerance $16 \times 1.56 = \textbf{25}\boldsymbol{\mu} = \textbf{0.025 mm}$

For the H hole, the fundamental deviation (FD) is zero.
Hence, the hole limits are 35 mm and (35+0.025)=35.025 mm (Or $35^{+0.025}_{-0.000}$ *mm*)

$\therefore$ Hence, tolerance on the hole $= (50.025 - 50) = \textbf{0.025 mm}$

For quality 8 shaft, tolerance $=$ IT8=16i $=16 \times 1.56 = \textbf{25}\ \boldsymbol{\mu} = \textbf{0.025 mm}$

For *g* shaft the FD is $-5.5D^{0.41} = -5.5(38.7)^{0.41} = \textbf{-24.63}\boldsymbol{\mu} = \textbf{0.025 mm}$

$\therefore$ The shaft limits are $(35 - 0.0246) = \textbf{34.9754 mm}$

and $35 - (0.0246 + 0.0375) = \textbf{34.9379 mm}$ (Or $35 -^{0.0246}_{0.0621}$ *mm*)
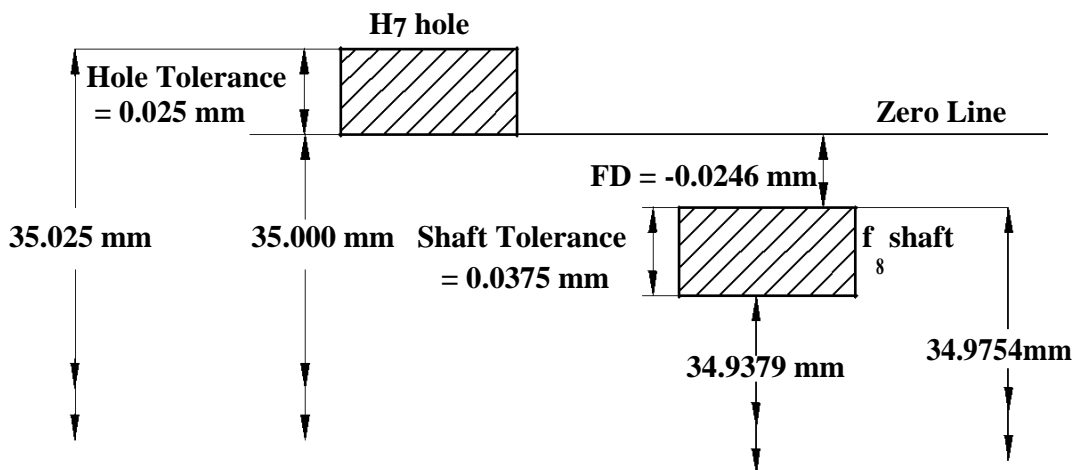
Exp:3 **SKETCHING THE NECESSARY VIEWS OF FAST AND LOOSE PULLEYS**

Aim:
- ➤ To create 2D model of FAST AND LOOSE PULLEY part using PRO-E CREO.
- ➤ To create the assembly of fast and loose pulleys using PRO-E CREO.
- ➤ To understand the type of fits and tolerance used in the Assembly.

Procedure:

- ➤ The drawing of FAST AND LOOSE PULLEY parts (shafts, pulley, and key) is studied.
- ➤ 2D models of all the parts are created as per the drawing specification.
- ➤ The Assembly of Fast and Loose Pulleys was created as per the drawing specification.

Command Tool Bar Used:
Advanced Selection, Advanced Datum Features , Advanced Sketching, Advanced Hole Creation, Advanced Drafts and Ribs , Advanced Shells, Advanced Rounds and Chamfers, Relations and Parameters ,Advanced Blends , Sweeps with Variable Sections, Helical Sweeps Swept Blends, Advanced Layers, Advanced Reference Management , Family Tables, Reusing Features Advanced Copy , Advanced Patterns
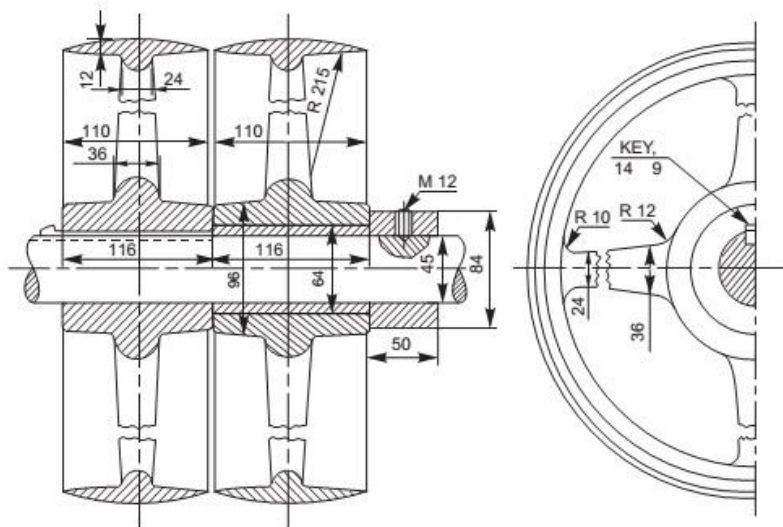
Fast and loose Pulleys

Result:
The 2D Models of **Fast and Loose Pulleys** parts (Shaft, pulley, Key) are created using PRO-E CREO. The type of fits and tolerance used in Assembly are studied.

Exp:4   SKETCHING THE NECESSARY VIEWS OF V-BELT PULLEYS

Aim:
 ➤ To create 2D model of **V-BELT PULLEY** part using PRO-E CREO.
 ➤ To create the assembly of V-BELT PULLEY using PRO-E CREO.
 ➤ To understand the type of fits and tolerance used in the Assembly.

Procedure:

 ➤ The drawing of V-BELT PULLEY parts (Shaft, pulley) are studied.
 ➤ 2D models of all the parts are created as per the drawing specification.
 ➤ The Assembly of V-BELT PULLEY was created as per the drawing specification.

Command Tool Bar Used:
       Advanced Selection, Advanced Datum Features , Advanced Sketching, Advanced Hole Creation, Advanced Drafts and Ribs , Advanced Shells, Advanced Rounds and Chamfers, Relations and Parameters ,Advanced Blends , Sweeps with Variable Sections, Helical Sweeps Swept Blends, Advanced Layers, Advanced Reference Management , Family Tables, Reusing Features Advanced Copy , Advanced Patterns

`V-BELT PULLEY

Result:
       The 2D Models of **V-BELT PULLEY** parts (Shaft, pulley) are created using PRO-E CREO. The type of fits and tolerance used in Assembly are studied.

Exp:5   **SKETCHING THE NECESSARY VIEWS OF BEVEL GEARS**

Aim:
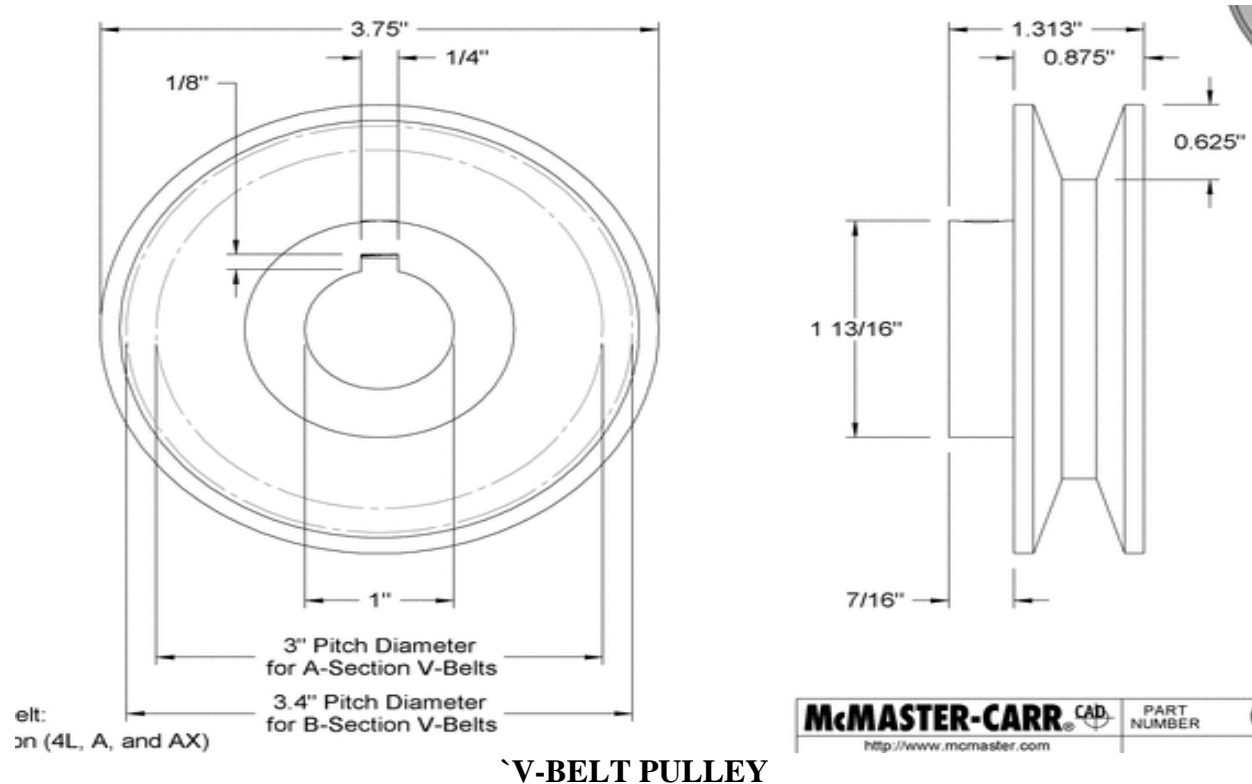- ➤ To create 2D model of **BEVEL GEAR** part using PRO-E CREO.
- ➤ To create the assembly of BEVEL GEAR using PRO-E CREO.
- ➤ To understand the type of fits and tolerance used in the Assembly.

Procedure:
- ➤ The drawing of BEVEL GEAR parts (Shaft, pulley) are studied.
- ➤ 2D models of all the parts are created as per the drawing specification.
- ➤ The Assembly of BEVEL GEAR was created as per the drawing specification.

Command Tool Bar Used:

Advanced Selection, Advanced Datum Features , Advanced Sketching, Advanced Hole Creation, Advanced Drafts and Ribs , Advanced Shells, Advanced Rounds and Chamfers, Relations and Parameters ,Advanced Blends , Sweeps with Variable Sections, Helical Sweeps Swept Blends, Advanced Layers, Advanced Reference Management , Family Tables, Reusing Features Advanced Copy , Advanced Patterns

Bevel Gear

Result:

The 2D Models of **BEVEL GEAR** parts (Shaft, pulley) are created using PRO-E CREO. The type of fits and tolerance used in Assembly are studied.

Exp:6   **SKETCHING THE NECESSARY VIEWS OF WORM GEAR**
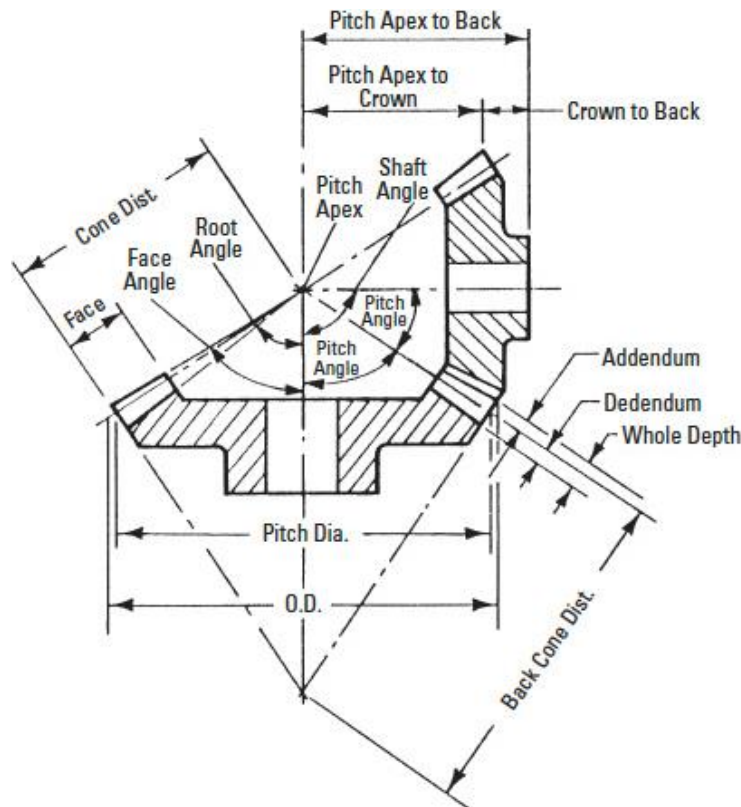
Aim:
- ➢ To create 2D model of **WORM GEAR** part using PRO-E CREO.
- ➢ To create the assembly of WORM GEAR using PRO-E CREO.
- ➢ To understand the type of fits and tolerance used in the Assembly.

Procedure:

- ➢ The drawing of WORM GEAR parts (groove, thread) are studied and drawn.
- ➢ 2D models of all the parts are created as per the drawing specification.
- ➢ The assembly of WORM GEAR was created as per the drawing specification.

Command Tool Bar Used:
    Advanced Selection, Advanced Datum Features , Advanced Sketching, Advanced Hole Creation, Advanced Drafts and Ribs , Advanced Shells, Advanced Rounds and Chamfers, Relations and Parameters ,Advanced Blends , Sweeps with Variable Sections, Helical Sweeps Swept Blends, Advanced Layers, Advanced Reference Management , Family Tables, Reusing Features Advanced Copy , Advanced Patterns
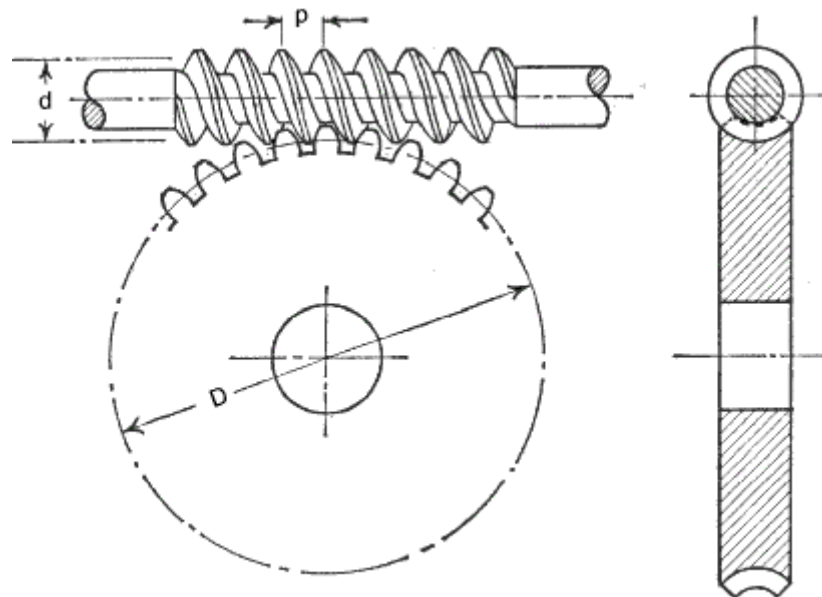
Worm Gear

Result:
    The 2D Models of **WORM GEAR** parts are created using PRO-E CREO. The type of fits and tolerance used in Assembly are studied.

PART MODELLING AND ASSEMBLY OF STEAM ENGINE CONNECTING ROD END

Aim:
- ➢ To create 3D model of steam engine connecting rod part using PRO-E CREO..
- ➢ To create the assembly of steam engine connecting rod using PRO-E CREO..
- ➢ To understand the type of fits and tolerance used in the Assembly.
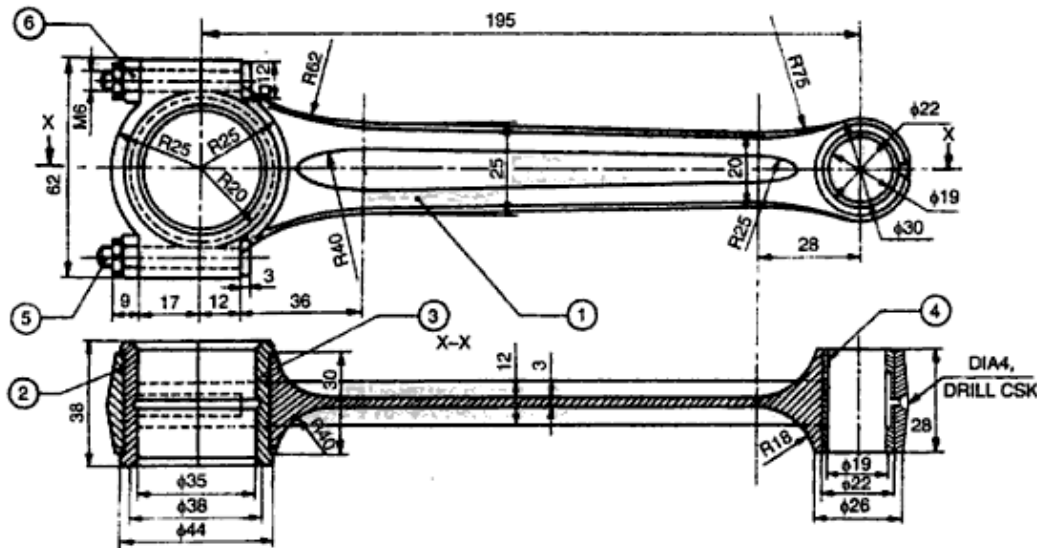
Parts list

Part No.	Name	Matl.	Qty.
1	Rod	FS	1
2	Cap	FS	1
3	Bearing brass	GM	2
4	Bearing bush	P Bronze	1
5	Bolt	MCS	2
6	Nut	MCS	2

Procedure:
- ➢ The parts of the connecting rod's dimensions and arrangements were primarily studied and the 3D model was designed by using PRO-E CREO SOFTWARE.
- ➢ After designing, the parts were to be checked without any errors
- ➢ The parts were designed individually as per the required dimensions.
- ➢ The designed parts were assembled according to the assembly drawing.

Command Tool Bar Used:

Advanced Selection, Advanced Datum Features , Advanced Sketching, Advanced Hole Creation, Advanced Drafts and Ribs , Advanced Shells, Advanced Rounds and Chamfers, Relations and Parameters ,Advanced Blends , Sweeps with Variable Sections, Helical Sweeps Swept Blends, Advanced Layers, Advanced Reference Management , Family Tables, Reusing Features Advanced Copy , Advanced Patterns

Result:

The 3 D Models of steam engine connecting rod is created using PRO-E CREO and assembled according to the drawing.

Exp: 8   PART MODELLING AND ASSEMBLY OF ROTARY GEAR PUMP

Aim:
- ➢ To create 3D model of rotary gear pump parts using PRO-E CREO.
- ➢ To create the assembly of rotary gear pump by using PRO-E CREO.
- ➢ To understand the type of fits and tolerance used in the Assembly.

Procedure:
- ➢ The parts of the rotary gear pump's dimensions and arrangements were primarily studied and the 3D model was designed by using PRO-E CREO SOFTWARE.
- ➢ After designing, the parts were to be checked without any errors
- ➢ The parts were designed individually as per the required dimensions.
- ➢ The designed parts were assembled according to the assembly drawing.

Command Tool Bar Used:
          Advanced Selection, Advanced Datum Features , Advanced Sketching, Advanced Hole Creation, Advanced Drafts and Ribs , Advanced Shells, Advanced Rounds and Chamfers, Relations and Parameters ,Advanced Blends , Sweeps with Variable Sections, Helical Sweeps Swept Blends, Advanced Layers, Advanced Reference Management , Family Tables, Reusing Features Advanced Copy , Advanced Patterns

PC	NAME	NO	MAT'L
1	HOUSING	1	C.BRO.
2	HOUSING COVER	1	C.BRO.
3	PULLEY	1	C.I. CLASS 193-76
4	GEAR	2	BRO
5	GEAR STUD	1	BRASS
6	SHAFT	1	BRASS
7	NUT	2	BRO
8	PACKING NUT	2	BRO

GEAR DATA
NUMBER OF TEETH (N) —— 13
DIAMETRAL PITCH (DP) — 10
OUTSIDE DIAMETER (OD) — 38
PRESSURE ANGLE —— 14½

CONCRETE PUMP CAR TYPE
SAE A–TYPE–WITHOUT C/P

H3V63RSC/H5V80RSC
OPERATING SPECIFICATIONS
1. MAX. DISPLACEMENT : 63cm^3/80cm^3
2. RATED SPEED : 1800rpm
3. MAX WORKING PRESSURE : 35(356)MPa(kgf/cm^2)

HAN DOK HYDRAULIC

Result:

The 3 D Models of rotary gear pump is created using PRO-E CREO and assembled according to the drawing.

30

Aim:
  ➢ To create 3D model of Fuel Injector parts using PRO-E CREO.
  ➢ To create the assembly of Fuel Injector by using PRO-E CREO.
  ➢ To understand the type of fits and tolerance used in the Assembly.

Procedure:
➢ The parts of the Fuel Injector's dimensions and arrangements were primarily studied and the 3D model was designed by using PRO-E CREO SOFTWARE.
➢ After designing, the parts were to be checked without any errors
➢ The parts were designed individually as per the required dimensions.
➢ The designed parts were assembled according to the assembly drawing.

Command Tool Bar Used:

Advanced Selection, Advanced Datum Features , Advanced Sketching, Advanced Hole Creation, Advanced Drafts and Ribs , Advanced Shells, Advanced Rounds and Chamfers, Relations and Parameters ,Advanced Blends , Sweeps with Variable Sections, Helical Sweeps Swept Blends, Advanced Layers, Advanced Reference Management , Family Tables, Reusing Features Advanced Copy , Advanced Patterns

Parts list			
Sl No.	Name	Matl	Qty
1	Body	CI	1
2	Nozzle	Brass	1
3	Nozzle holder	MS	1
4	Cap	MS	1
5	Nozzle pin	Brass	1
6	Distance piece	MS	1
7	Spring	Spring steel	1
8	Screw adjuster	MS	1
9	Adjusting screw	MS	1
10	Lock nut	MS	1

Result:

        The 3 D Models of Fuel Injector is created using PRO-E CREO and assembled according to the drawing.

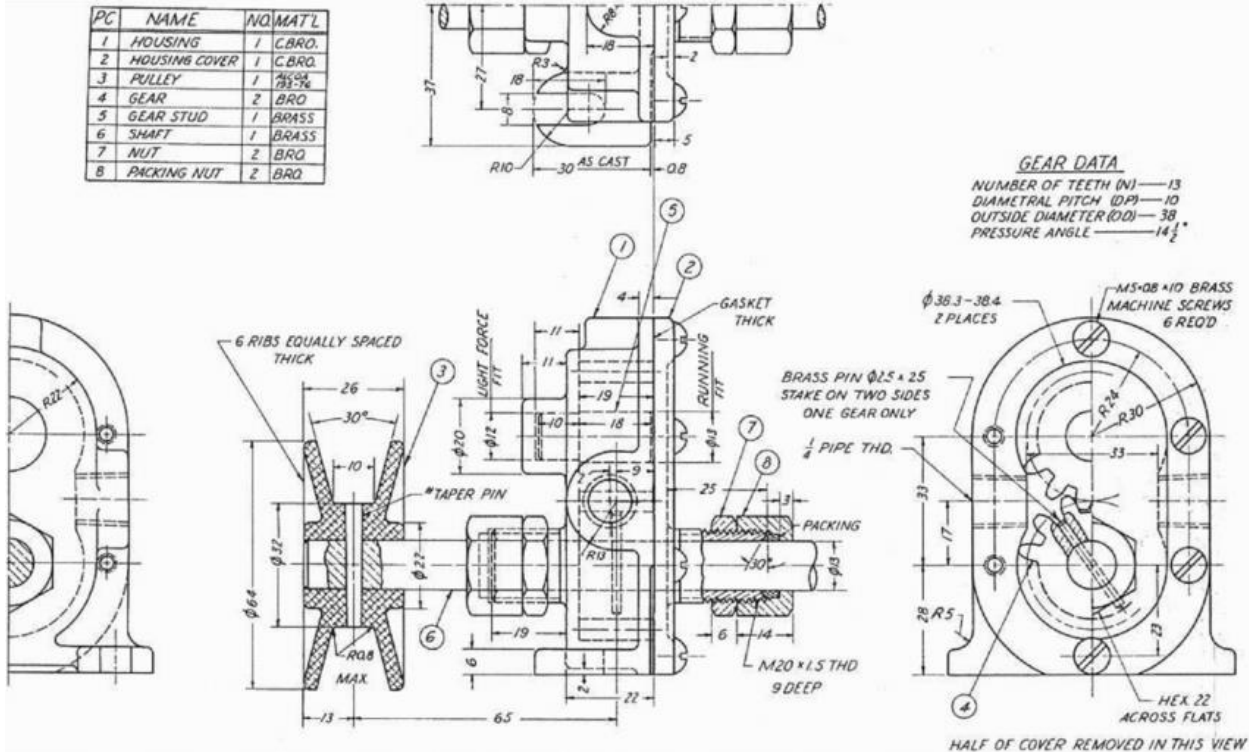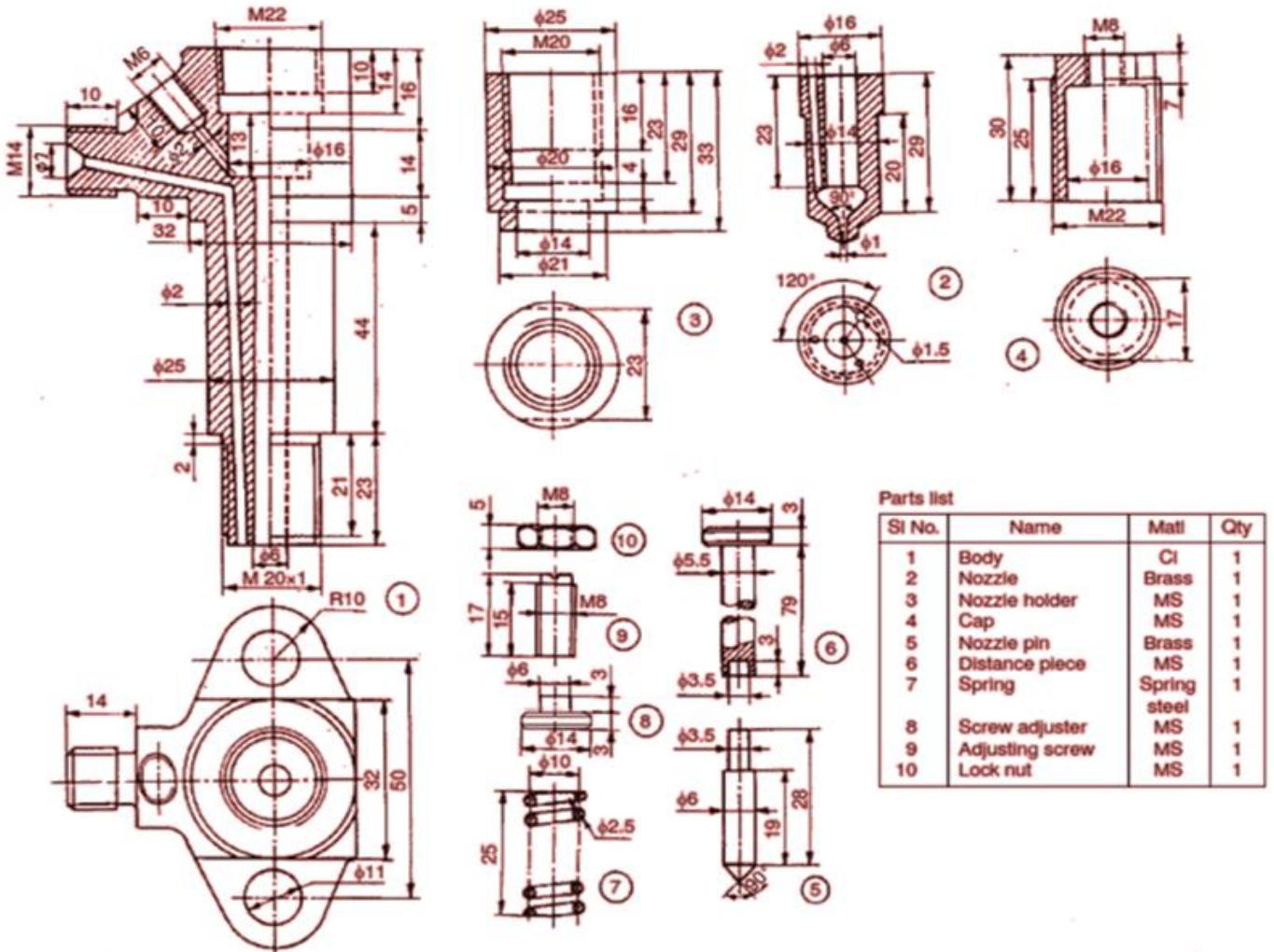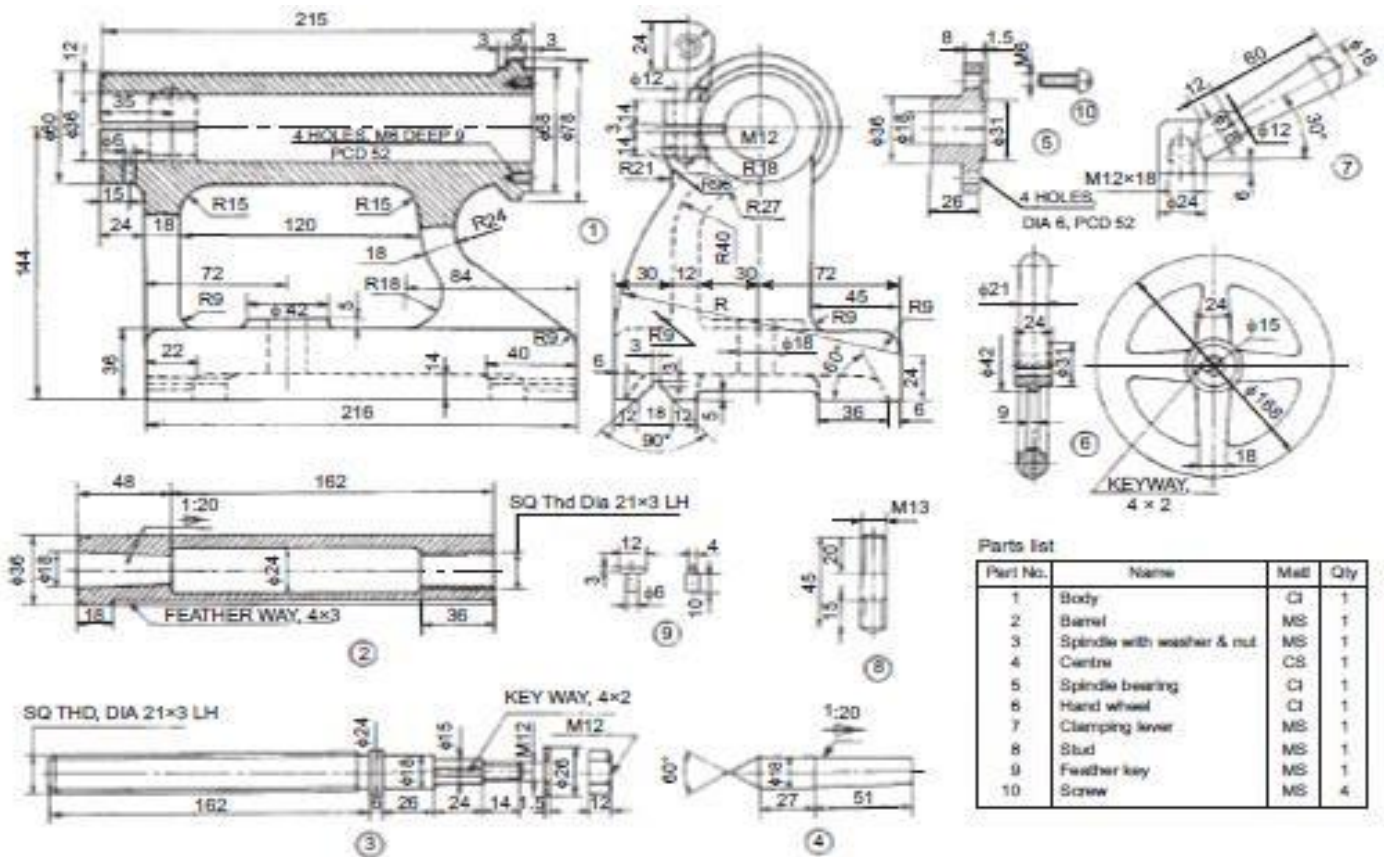### Exp:10   PART MODELLING AND ASSEMBLY OF TAILSTOCK

Aim:
- To create 3D model of Tailstock using PRO-E CREO.
- To create the assembly of Tailstock by using PRO-E CREO.
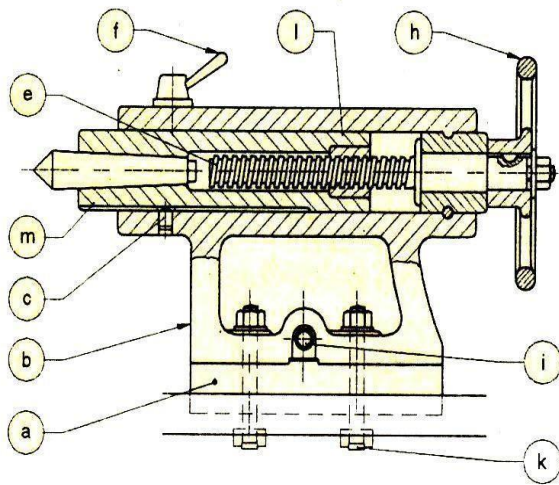- To understand the type of fits and tolerance used in the Assembly.

Procedure:
- The parts of the Tailstock 's dimensions and arrangements were primarily studied and the 3D model was designed by using PRO-E CREO SOFTWARE.
- After designing, the parts were to be checked without any errors
- The parts were designed individually as per the required dimensions.
- The designed parts were assembled according to the assembly drawing.

Command Tool Bar Used:

Advanced Selection, Advanced Datum Features , Advanced Sketching, Advanced Hole Creation, Advanced Drafts and Ribs , Advanced Shells, Advanced Rounds and Chamfers, Relations and Parameters ,Advanced Blends , Sweeps with Variable Sections, Helical Sweeps Swept Blends, Advanced Layers, Advanced Reference Management , Family Tables, Reusing Features Advanced Copy , Advanced Patterns

Parts list

Part No.	Name	Matl	Qty
1	Body	CI	1
2	Barrel	MS	1
3	Spindle with washer & nut	MS	1
4	Centre	CS	1
5	Spindle bearing	CI	1
6	Hand wheel	CI	1
7	Clamping lever	MS	1
8	Stud	MS	1
9	Feather key	MS	1
10	Screw	MS	4

TAILSTOCK ASSEMBLY

Result:

The 3 D Models of Tailstock assembly is created using PRO-E CREO and assembled according to the drawing.

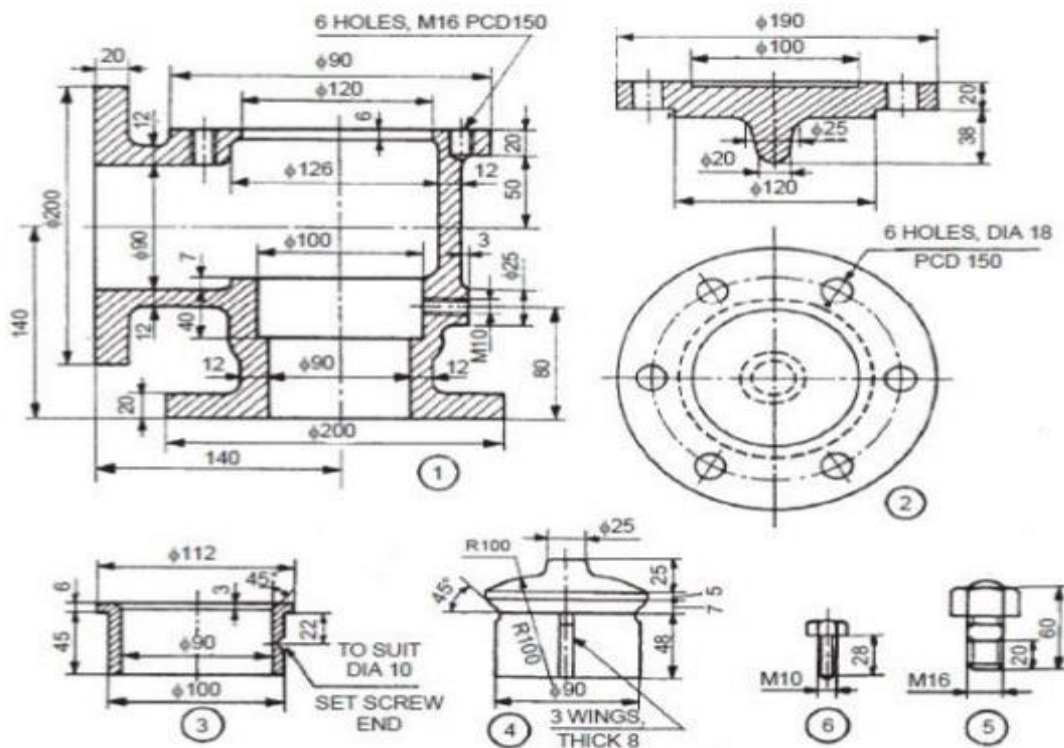**Exp:11   PART MODELLING AND ASSEMBLY OF NON-RETURN VALVE**

Aim:
- ➢ To create 3D model of Non-return valve PRO-E CREO.
- ➢ To create the assembly of Non-return valve by using PRO-E CREO.
- ➢ To understand the type of fits and tolerance used in the Assembly.

Procedure:
- ➢ The parts of the Non-return valve 's dimensions and arrangements were primarily studied and the 3D model was designed by using PRO-E CREO SOFTWARE.
- ➢ After designing, the parts were to be checked without any errors
- ➢ The parts were designed individually as per the required dimensions.
- ➢ The designed parts were assembled according to the assembly drawing.

Command Tool Bar Used:
        Advanced Selection, Advanced Datum Features , Advanced Sketching, Advanced Hole Creation, Advanced Drafts and Ribs , Advanced Shells, Advanced Rounds and Chamfers, Relations and Parameters ,Advanced Blends , Sweeps with Variable Sections, Helical Sweeps Swept Blends, Advanced Layers, Advanced Reference Management , Family Tables, Reusing Features Advanced Copy , Advanced Patterns

Parts list

No.	Name	Matl	Qty
1	Body	Brass	1
2	Cover	Brass	1
3	Valve seat	Bronze	1
4	Valve	Brass	1
5	Stud with nut	MS	6
6	Set screw	MS	1
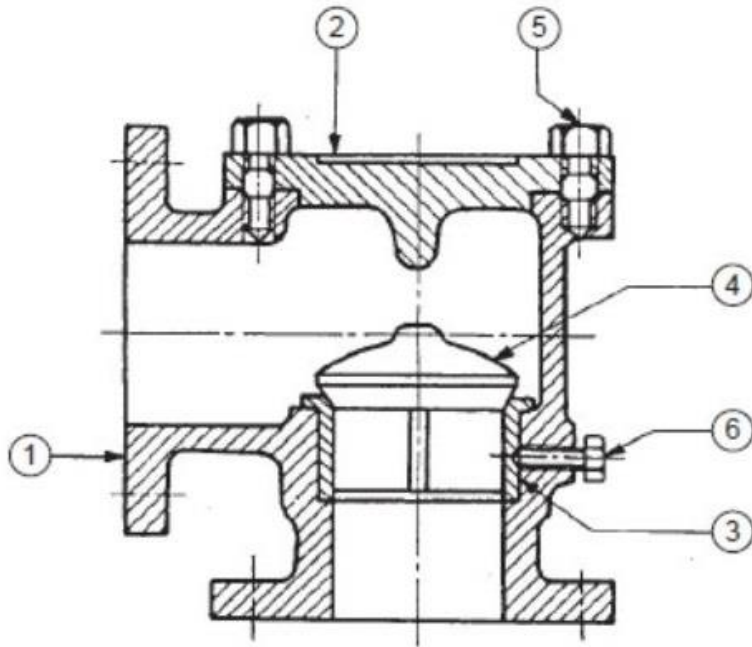
NON-RETURN VALVE ASSEMBLY

Result:

   The 3 D Models of Non-return valve is created using PRO-E CREO and assembled according to the drawing.

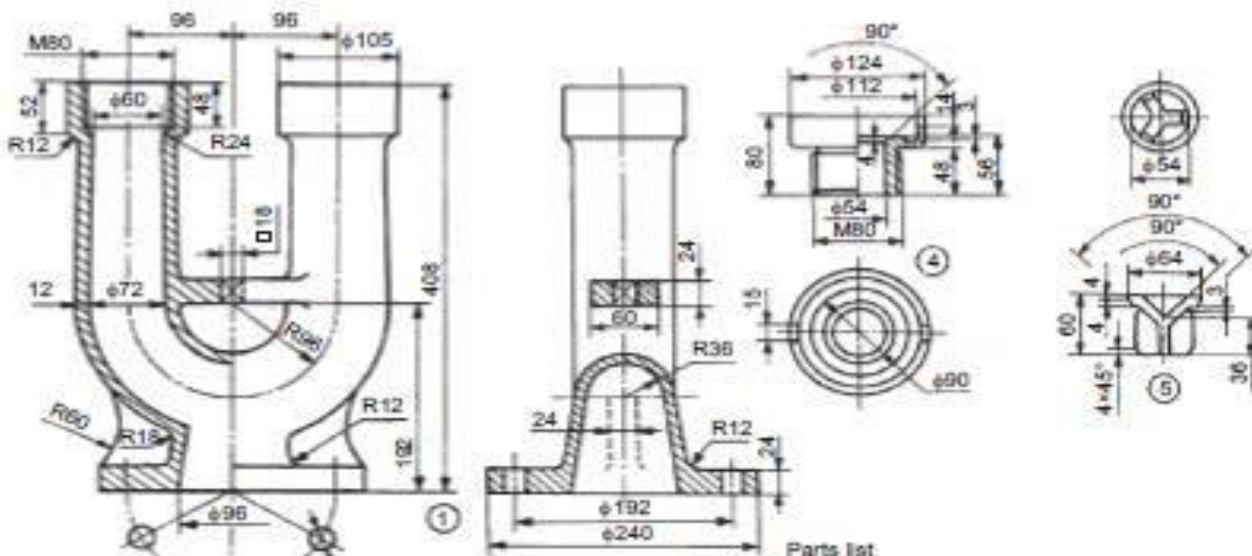### Exp:12 PART MODELLING AND ASSEMBLY OF RAMS BOTTOM SAFETY VALVE

Aim:
- ➢ To create 3D model of Rams Bottom Safety Valve PRO-E CREO.
- ➢ To create the assembly of Rams Bottom Safety Valve by using PRO-E CREO.
- ➢ To understand the type of fits and tolerance used in the Assembly.

Procedure:
- ➢ The parts of the Rams Bottom Safety Valve 's dimensions and arrangements were primarily studied and the 3D model was designed by using PRO-E CREO SOFTWARE.
- ➢ After designing, the parts were to be checked without any errors
- ➢ The parts were designed individually as per the required dimensions.
- ➢ The designed parts were assembled according to the assembly drawing.

Command Tool Bar Used:

Advanced Selection, Advanced Datum Features , Advanced Sketching, Advanced Hole Creation, Advanced Drafts and Ribs , Advanced Shells, Advanced Rounds and Chamfers, Relations and Parameters ,Advanced Blends , Sweeps with Variable Sections, Helical Sweeps Swept Blends, Advanced Layers, Advanced Reference Management , Family Tables, Reusing Features Advanced Copy , Advanced Patterns

Parts list

Part No.	Name	Matl	Qty
1	Housing	CI	1
2	Eye bolt	MS	1
3	Link	MS	2
4	Valve seat	Gunmetal	2
5	Valve	Gunmetal	2
6	Pivot	MS	1
7	Pin	MS	3
8	Split pin	MS	3
9	Lever	MS	1
10	Spring	Spring steel	1
11	Washer	MS	1
12	Lock-nut, M20, 12 Thick	MS	1
13	Nut, M20, 20 Thick	MS	1

Result:

        The 3 D Models of Rams Bottom Safety Valve is created using PRO-E CREO and assembled according to the drawing.