The Shirpur Education Society's

# R. C. Patel College of Engineering and Polytechnic, Shirpur

## Department of Mechanical Engineering

**NAME OF COURSE: -** Production Drawing

**CODE OF COURSE: -** 313311

**SEMESTER: -** ME-3K (SYME)

# Unit - 3 Production Drawing

**16 Marks**

**SUBJECT TEACHER**

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# Production Drawing – (313311)
(PDR)

## Unit 3 - Production Drawing

### Limit, Fits & Tolerances -

In production process, it is impossible to manufacture an object/part precisely as given dimentions.

Factors affecting –

i) Man
ii) Machine
iii) Material
iv) Environment
v) Electricity.

If an object/part is mfg. precisely with perfect size, it will increase the cost of production,

So, it is important to allow some ~~variation~~ permissible variation in ~~mafu~~ manufacturing

### # 3.1 Limits

Def$^n$ - Limits are two extreme permissible sizes, between which actual size of an object/part must lies

Types of Limits =

i) Upper Limit - Maximum dimention of part.
ii) Lower Limit - Minimum dimention of part.

### # ISO system of tolerance -

#### Tolerance

Def$^n$ - The permissible variation in size or dimention is known as tolerance.

Tolerance zone -

The differance between upper & lower limit is known as tolerance zone.

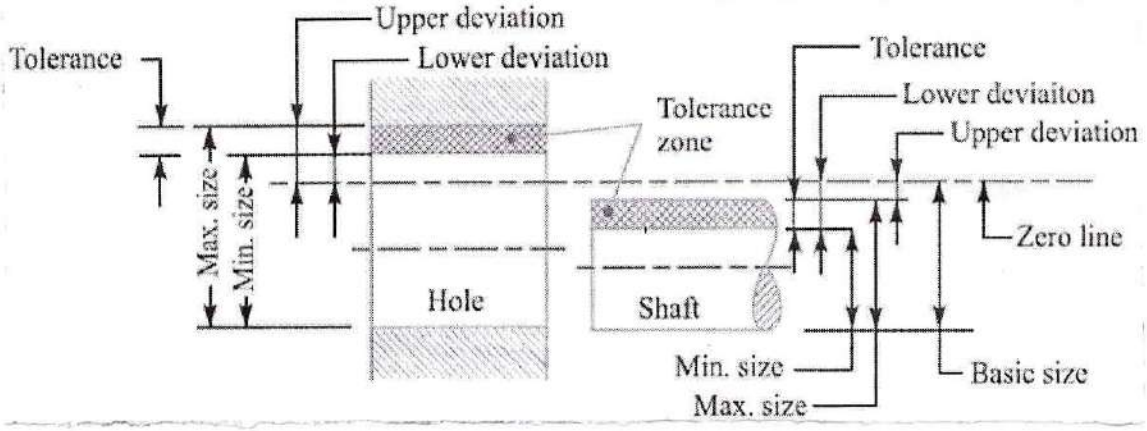
Tolerance zone = Upper limit - Lower limit

Types of tolerance -

i) Unilateral tolerance , ii) Bilateral tolerance.

# Dimensional tolerances =

## Terminology :-




→ Shaft - External dimension of a component.

→ Hole - Internal dimension of a component.

Note- Any assembly is formed by shaft & hole.

→ Basic size (Nominal size) - It is the standard size of a part with reference to which the limits (UL & LL) are derived.
(Basic size is same for shaft & hole)

→ Actual size - Dimension of part measured with measuring instrument.

→ Zero line - A line drawn to represent basic size. (Drawn as center line)

→ Upper deviation - It is difference between the upper limit (UL) of part and basic size.

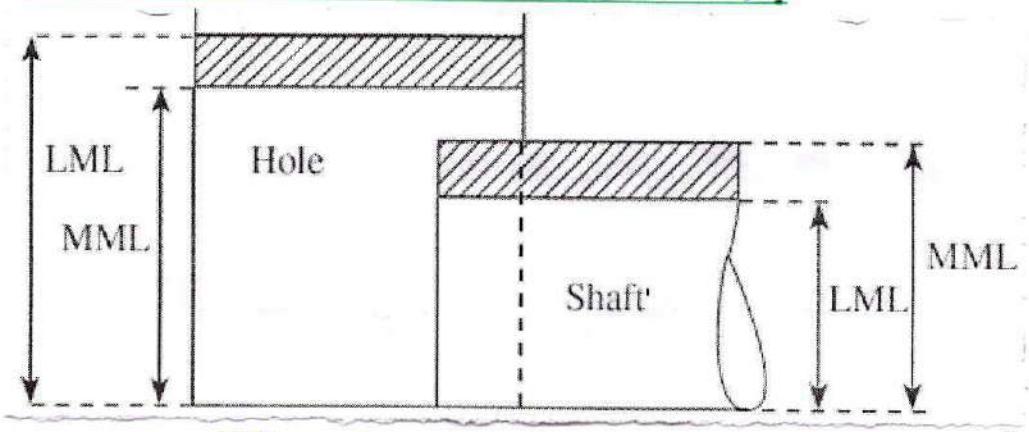
→ Lower deviation - It is difference between the

→ Fundamental deviation - This is one of the deviation from upper or lower deviation which is nearest to basic size line.

→ Basic shaft - Shaft whose upper deviation is zero.

→ Basic hole - Hole whose lower deviation is zero.

→ Maximum metal limit (MML)




The limit that contains maximum possible amount of metal known as MML.

For shaft - MML is with upper limit

For hole - MML is with Lower limit

→ ~~Minimum~~ Least metal limit (LML)

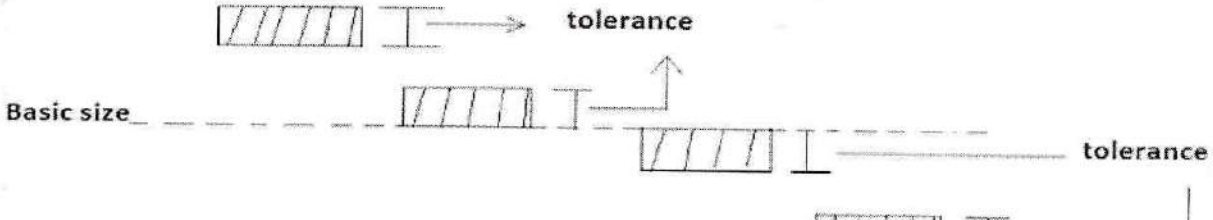
The limit that contains minimum possible amount of metal called as Least metal limit.

For shaft - LML is with lower limit

For hole - LML is with upper limit.

# Unilateral & Bilateral tolerance system.

- Unilateral tolerance - In this system, the dimension of a part is allow to vary in only one side of basic size line (zero line).

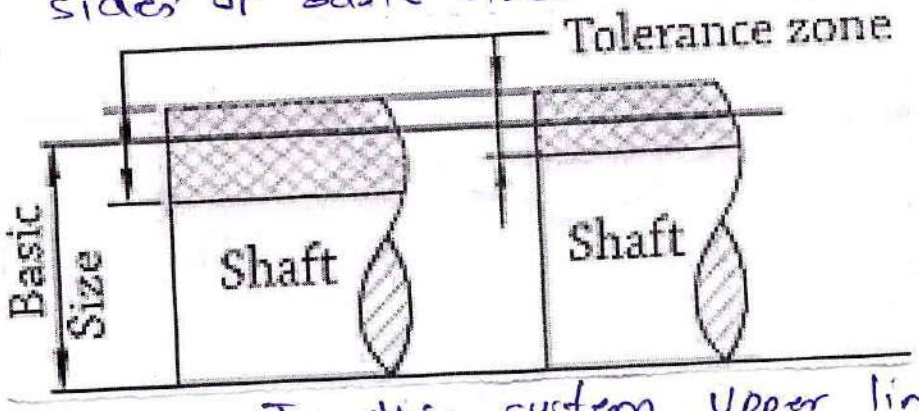


Eg. $25^{+0.02}_{+0.01}$, $29^{+0.04}_{+0.02}$, $35^{-0.02}_{-0.04}$ etc

In this system both upper limit & lower limit of a part lie in one side (above or below) the basic size line.

Bilateral tolerance -

In this system of tolerance, ~~both the~~ dimension of part is allowed to vary on both sides of basic size.




In this system, upper limit or lower limit can be lie in opposite to each other to the basic size line.

## # Fit's

Def^ - The degree of tightness or looseness between two mating parts (shaft & hole) to perform a definite function is known as fit.

Types of fits -

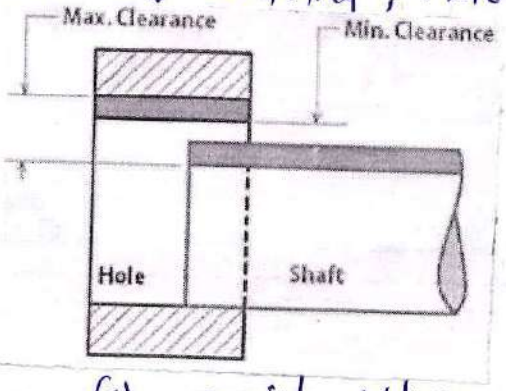
i) Clearance fit, ii) Transition fit, iii) Interference fit.

- Fits
  - i) Clearance
    - a) Slide fit
    - b) Easy slide fit
    - c) Running fit
    - d) Slack running fit
  - Transition fit
    - a) Push fit
    - b) Wringing fit
  - Interference fit
    - a) Force fit
    - b) Tight fit
    - c) Shrink fit

## Clearance fit -

In this fit the dimension of shaft is always smaller than the hole.

So, the shaft can rotate, slide, make movements. Eg- Bearing, Piston-cylinder, etc.




Clearance fit exist when the shaft and hole are made with maximum metal condition. as shown in above dia

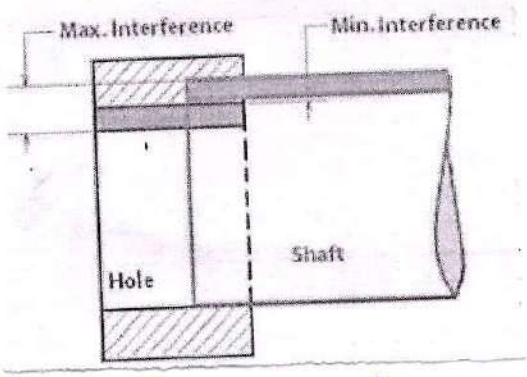
Types of clearance fit -

i) Slide fit, ii) Easy slide fit, iii) Running fit, iv) Slack running fit, v) Loose running fit.

## Interferance fit -

In this type of fit minimum allowable diameter of shaft is larger than the maximum permissible diameter of the hole.

The hole & shaft are intended to be attached permanently. No relative motion between hole & shaft.



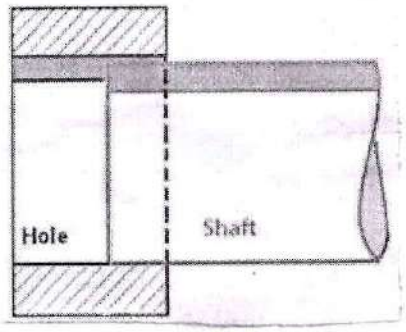

Types of interferance fit -

## Transition fit -

This fit is a midway between clearance & interferance fit.

In this type the limits of hole & shaft are so selected that either interferance or clearance may occur.

Tolerance zones of hole & shaft are overlap in part.

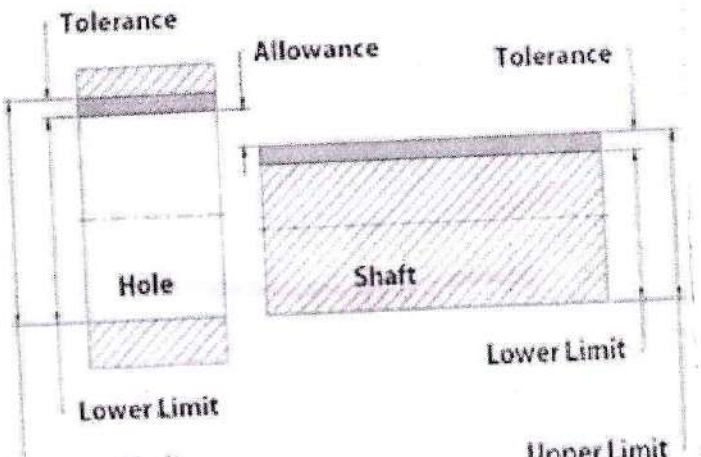



Types of transition fit -
i) Wringing fit, ii) Push fit

## # Allowance -

Allowance is intentional differance between dimensions of two mating parts for getting type of fit. The difference between lower limit of hole & higher limit of shaft

Positive allowance - Clearance
Negative allowance - Interferance.

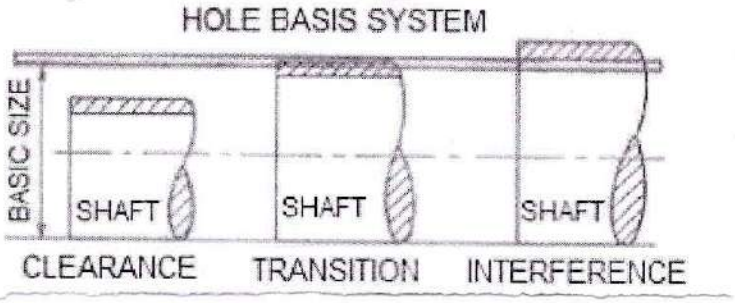


# System to obtain different types of fits -

i) Hole basis system, ii) Shaft basis system

## i) Hole basis system -

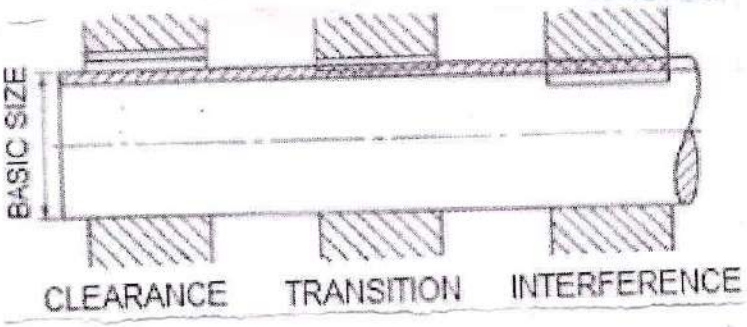
In this system, dimension of hole kept content while the dimension of ~~hole is~~ shaft is varied to obtain required type of fits.




The lower deviation of hole is zero.
i.e. Lower limit of hole is taken as basic size.
The upper limit of hole, & upper limit of shaft & lower limit of shaft is then varied to obtain desired fit. (view fig)

## ii) Shaft basis system -

In this system, dimension of shaft is kept constant while the dimension of hole is varied to obtain required type of fit.




The upper deviation of shaft is zero
i.e. upper limit of shaft is taken as basic size
The lower limit of shaft, upper & lower limit of hole is then varied to obtain desired output.

# Selection of fit for engineering applications –

i) Application –

a) Free rotation required – Clearance fit
eg. Shaft in bearing.

b) Fixed connection required – Interference fit
eg. Screwed joint.

c) Connection with low mfg. cost – Transition fit
eg – Nut-bolt assembly.

ii) Load & stress requirement.

a) Minimum loading – Clearance fit

b) For high load & torque – Interference fit

c) Accurate location with → Transition fit
some load.

iii) Material – Interference fit can handle high stresses, ~~So as per type of fit~~ – as compared with clearance & transition fit. So, proper selection of material needed.

iv) Cost & time requirement.
It is very difficult to obtaine either clearance or interference fit. So, transition fit is less time consuming & also low cost solution to above problem.

# Simple numericals for calculating type of fit –

1) The shaft size is $\phi 27.470$ mm & $\phi 27.445$ mm. Hole size is $\phi 27.5$ mm & $\phi 27.523$ mm. Determine type of fit.

→ For hole –

UL of hole = 27.5 mm

LL of hole = 27.523 mm

UL of shaft = 27.470 mm

Max. allowance = UL of hole - LL of shaft
= 27.5 - 27.445
= 0.078 (+ve)

Min. allowance = LL of hole - UL of shaft
= 27.523 - 27.470
= 0.02 (+ve)

As Max & min allowance has +ve values so the type of fit is clearance fit.

2) The shaft has $\phi 9^{-0.025}_{-0.047}$ & hole is $\phi 9^{+0.022}_{+0}$. Determine type of fit.

→ UL of hole = 9 + 0.022 = 9.022 mm
LL of hole = 9 + 0 = 9 mm
UL of shaft = 9 - 0.025 = 8.975 mm
LL of shaft = 9 - 0.047 = 8.953 mm

Max allowance = UL of hole - LL of shaft
= 9.022 - 8.953
= 0.069 (+ve)

Min allowance = LL of hole - UL of shaft
= 9 - 8.975
= 0.025 (+ve)

Type of fit is clearance fit. (Both max & min allowance is +ve).

3) The hole has $\phi 16^{+0.018}_{-0.00}$ & shaft has $\phi 16^{+0.023}_{-0.012}$. Determine type of fit.

→ UL of hole = 16 + 0.018 = 16.018 mm
LL of hole = 16 - 0 = 16 mm
UL of shaft = 16 + 0.023 = 16.023 mm
LL of shaft = 16 - 0.012 => 15.988 mm

Max allowance = UL of hole - LL of shaft
= 16.018 - 15.988
= 0.03 mm (+ve)

Min allowance = LL of

4) The shaft has $\phi 25^{+0.04}_{+0.02}$ & hole has $\phi 25^{-0.02}_{-0.04}$ mm. Determine type of fit.

→ UL of hole = 25 − 0.02 = 24.98 mm
LL of hole = 25 − 0.04 = 24.96 mm
UL of shaft = 25 + 0.04 = 25.04 mm
LL of shaft = 25 + 0.02 = 25.02 mm

Max allowance = UL of hole − LL of shaft
= 24.98 − 25.02
= −0.04 mm (−ve)

Min allowance = LL of hole − UL of shaft
= 24.96 − 25.04
= −0.08 mm (−ve)

Type of fit is interference fit.
(Both max & min allowance has −ve)

## # Selection & representation of dimensional tolerances – (Number & Grade method)

It consist of suitable combination of 18 grades of fundamental tolerances and 25 types of fundamental deviations.

18 grades of fundamental tolerances = IT01, IT0, IT1 to IT16.

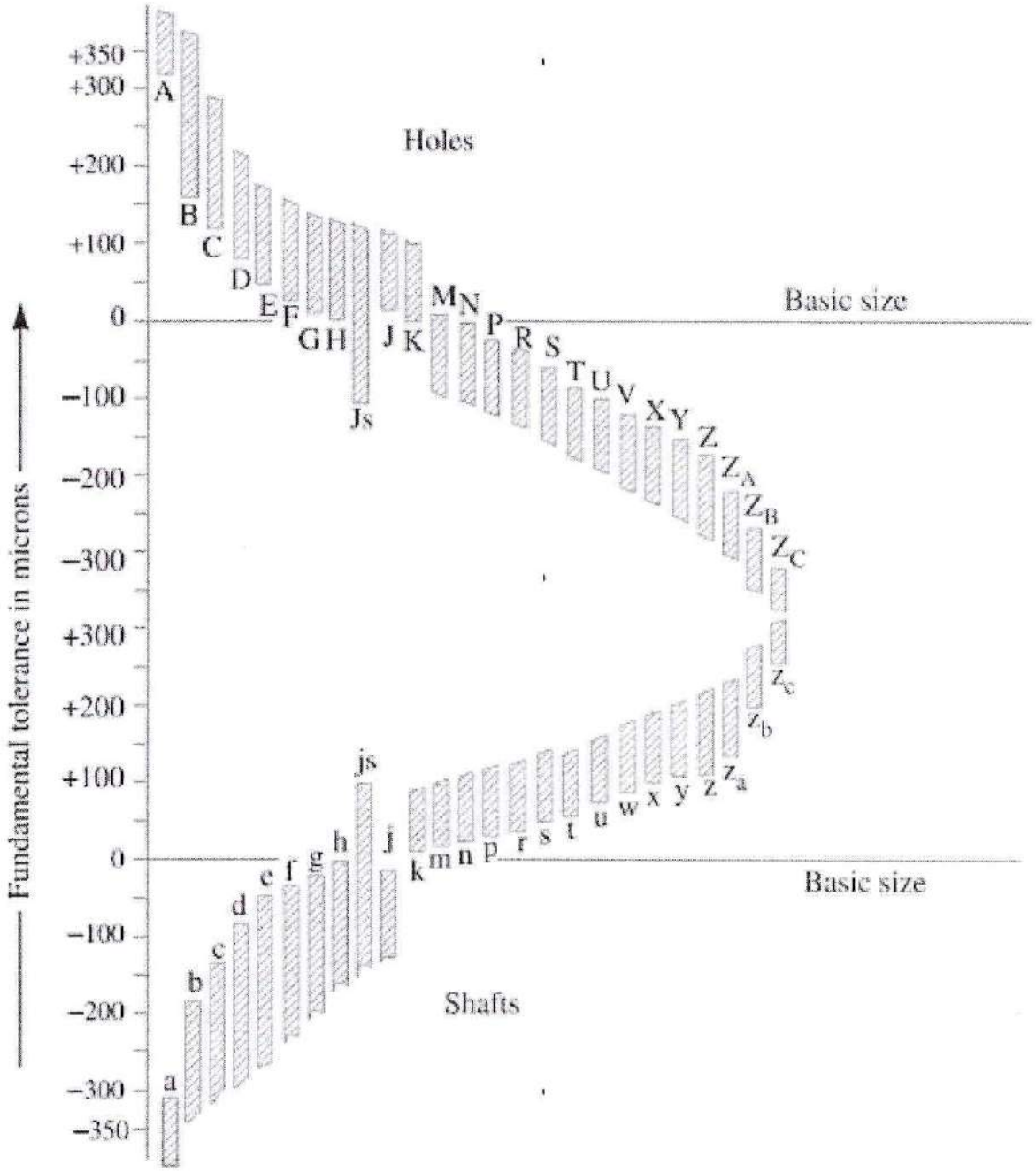
25 Fundamental deviations (Indicated by letter)
A, B, C, D, E, F, G, H, JS, J, K, M, N, P, R, S, T, U, V, X, Y, Z, ZA, ZB, ZC. etc.

For shaft a to h → The upper deviation is bellow zero line j to z it is above zero line.

For hole A to H → The lower deviation is above zero line & J to ZC it is below zero line. (AS attached herewith)

### Designation of holes, shafts & fits -

A hole or shaft can be designated by basic size followed by a letter and


Fundamental tolerance in microns
+350
+300
+200
+100
0
−100
−200
−300
−350
Holes
Basic size
A
B
C
D
E
F
G
H
Js
J
K
M
N
P
R
S
T
U
V
X
Y
Z
$Z_A$
$Z_B$
$Z_C$
Shafts
Basic size
a
b
c
d
e
f
g
h
js
j
k
m
n
p
r
s
t
u
w
x
y
z
$z_a$
$z_b$
$z_c$

eg- (i) A 40 mm hole, with tolerance grade of IT7 is written as 40 H7. (For hole capital letter is used)

(ii) A 40 mm shaft, with tolerance grade of IT8 is written as 40 f8.
(For shaft lower case of letter is used)

(iii) A 40mm hole with IT grade IT7 & 40mm shaft with IT grade f8.
The type of fit can be designated by.
40 H7 f8.

# Numericals

(i) What is the meaning of 25 H7 g8? Determine type of fit.

→ 25 H7 g8
↳ Basic size,
H7 = Hole with tolerance grade IT7.
g8 = shaft with tolerance grade IT8.
Type of fit is clearance fit.

(ii) 50 H7 s6

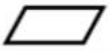
→ 50 = Basic size
H7 = Hole with tolerance grade IT7
s6 = Shaft with tolerance grade IT6
Type of fit is transition fit

(iii) 30 H7 , dg
30 = Basic size
H7 = Hole with IT grade 7
dg = Shaft with IT grade g
Type of fit is clearance

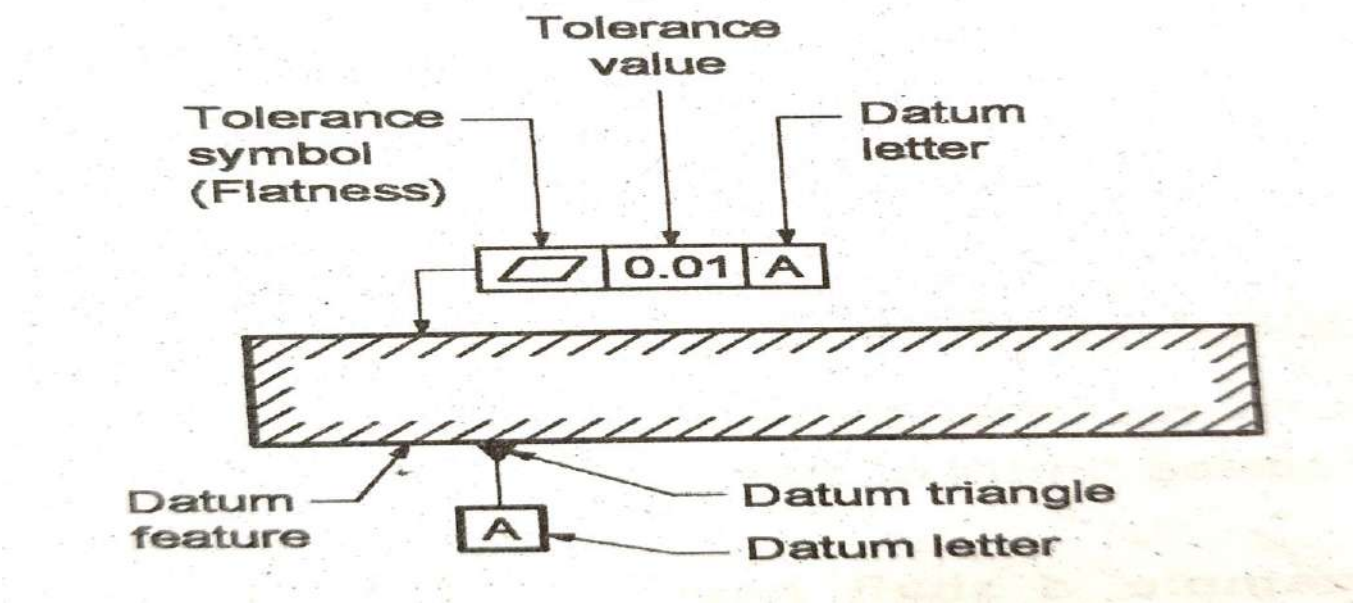
# Production Drawing_PDR_(313311)

## Unit 3 _ Production Drawing

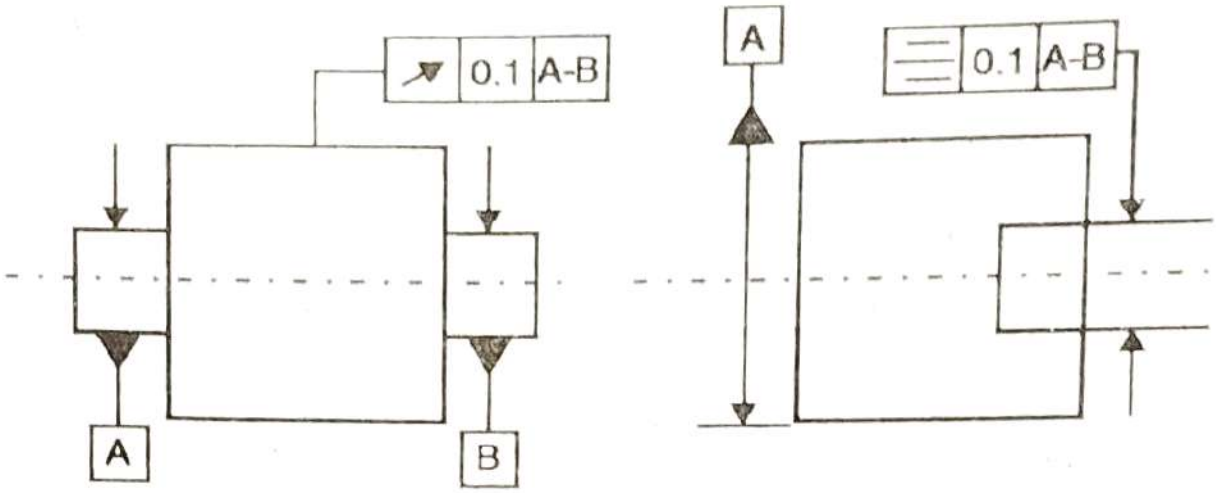
### 3.2 Types of geometrical tolerances

| Type | Geometrical tolerance | Symbol | Datum needed |
|---|---|---|---|
| Form | Straightness |  | NO |
| | Flatness |  | NO |
| | Roundness |  | NO |
| | Cylindricity |  | NO |
| | Profile of a line |  | NO |
| | Profile of a surface |  | NO |
| Orientation | Parallelism |  | YES |
| | Perpendicularity |  | YES |
| | Angularity |  | YES |
| | Profile of a line |  | YES |
| | Profile of a surface |  | YES |
| Location | True position |  | YES or NO |
| | Coaxiality (concentricity) |  | YES |
| | Symmetry |  | YES |
| | Profile of a line |  | YES |
| | Profile of a surface |  | YES |
| Run-out | Run-out |  | YES |
| | Total run-out |  | YES |

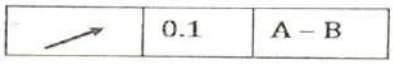
Terminology for deviation



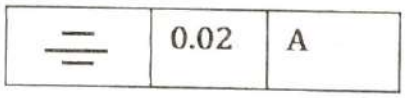

Q1.




Solution

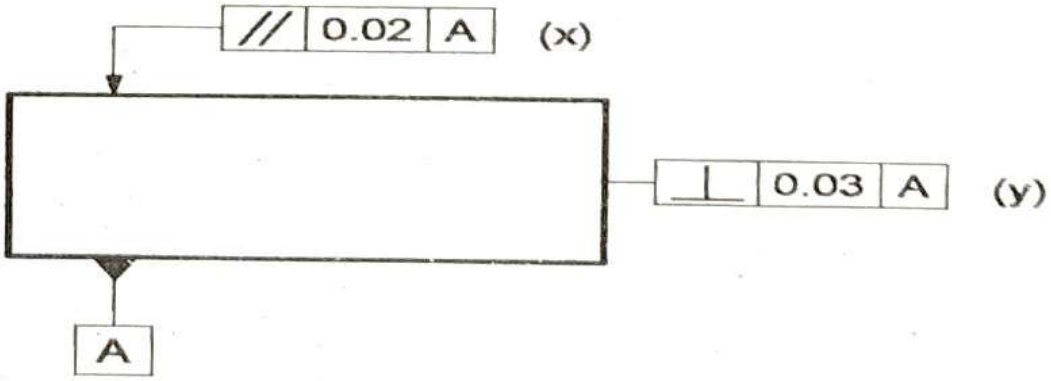
1. 


The radial run out shall not be greater than 0.1 in any plane of measurement during one revolution about the datum axis A - B.

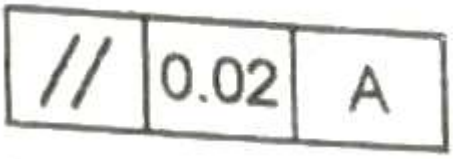
2. 


The median plane of the slot shall be contained between two parallel planes which are 0.08 apart and symmetrically disposed about the median plane with respect to the datum feature A.

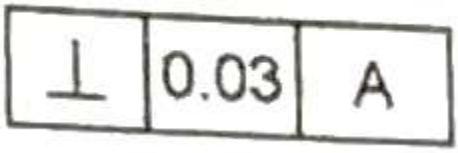
Q2.




Solution

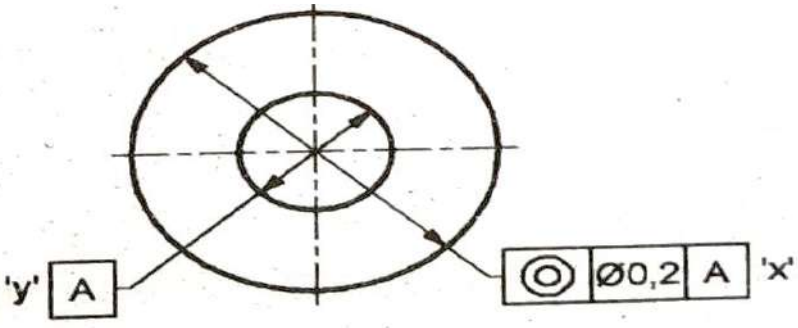



(X) The toleranced edge is parallel within 0.02 mm to the datum line A.)

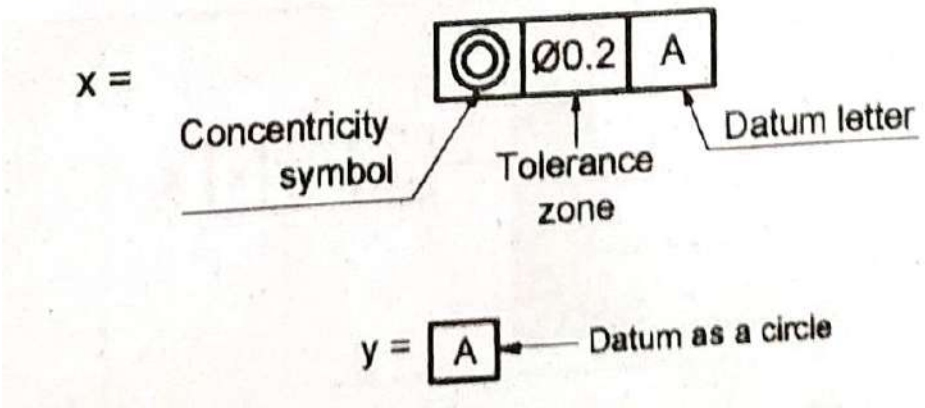



(Y) The toleranced edge is perpendicular within 0.033 mm to the datum line A.

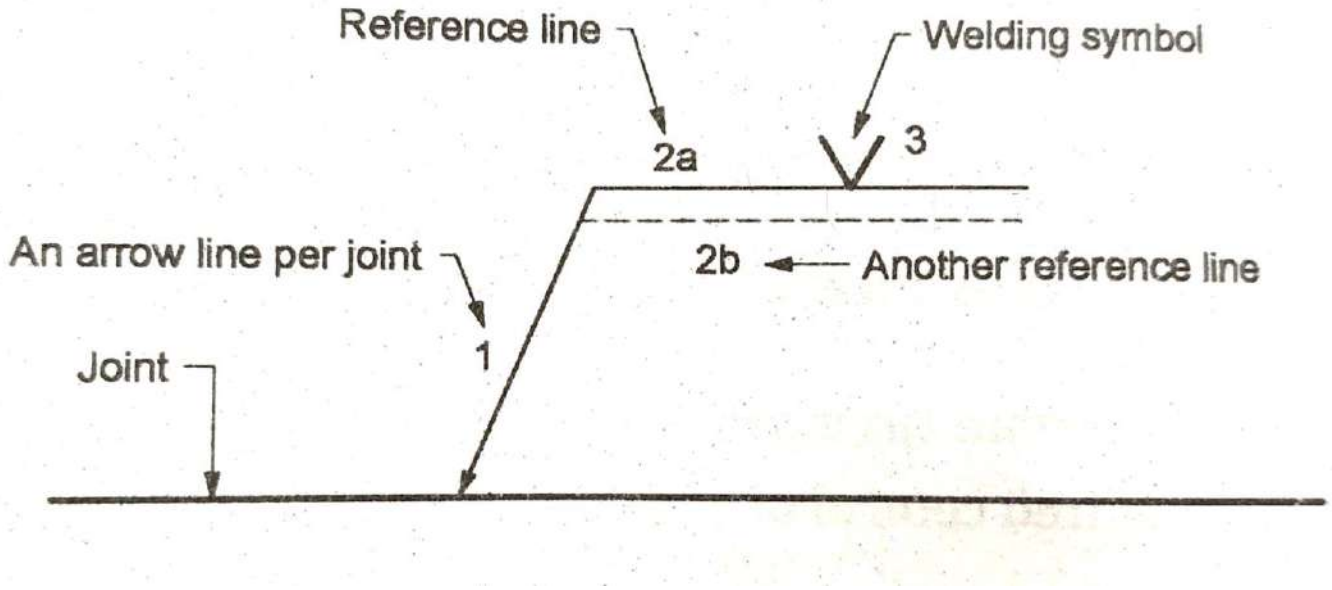
Q3.



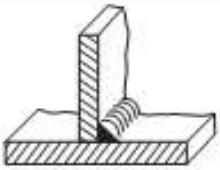
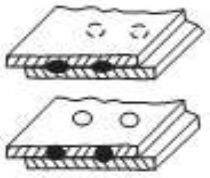
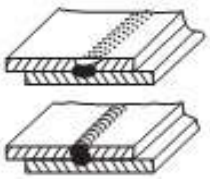

Solution



Representation of geometrical tolerance on drawing



## 3.3 General welding symbols

| No. | Designation | Illustration | Symbol |
|---|---|---|---|
| 1. | Butt weld between plates with raised edges (the raised edges being melted down completely) |  |  |
| 2. | Square butt weld |  |  |
| 3. | Single-V butt weld |  |  |
| 4. | Single-bevel butt weld |  |  |
| 5. | Single-V butt weld with broad root face |  |  |
| 6. | Single-bevel butt weld with broad root face |  |  |
| 7. | Single-U butt weld (parallel or sloping sides) |  |  |
| 8. | Single-U butt weld |  |  |
| 9. | Backing run; back or backing weld |  |  |
| 10. | Fillet weld |  |  |
| 11. | Plug weld; plug or slot weld |  |  |
| 12. | Spot weld |  |  |
| 13. | Seam weld |  |  |

Surface contour and finish of weld

| Sl No. | Particulars | Weld Symbol |
|---|---|---|
| 1 | Flush contour |  |
| 2 | Convex contour |  |
| 3 | Concave contour |  |
| 4 | Grinding finish | G |
| 5 | Machining finish | M |
| 6 | Chipping finish | C |

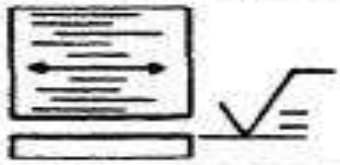
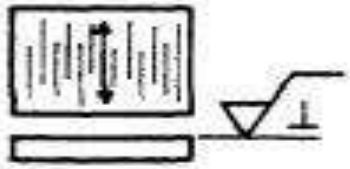
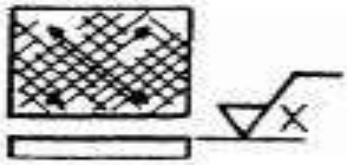
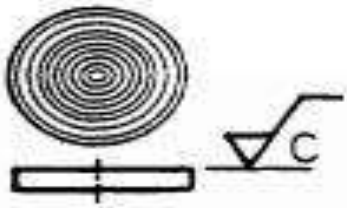
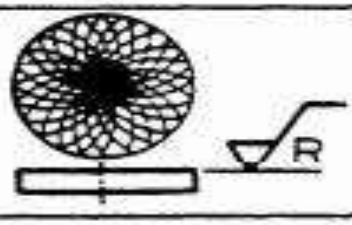
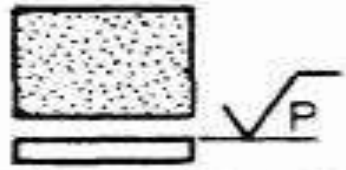
| *Designation* | *Illustration* | *Symbol* |
|---|---|---|
| Flat (flush) single-V butt weld |  |  |
| Convex double-V butt weld |  |  |
| Concave fillet weld |  |  |
| Flat (flush) single-V butt weld with flat (flush) backing run |  |  |

3.4 Machining symbol and surface texture

Roughness grades

| $R_a$ micrometer | Roughness Grade Numbers | Finish Marks |
|---|---|---|
| 50 | N12 |  |
| 25 | N11 | |
| 12.5 | N10 | |
| 6.3 | N9 |  |
| 3.2 | N8 | |
| 1.6 | N7 | |
| 0.8 | N6 |  |
| 0.4 | N5 | |
| 0.2 | N4 | |
| 0.1 | N3 |  |
| 0.05 | N2 | |
| 0.025 | N1 | |

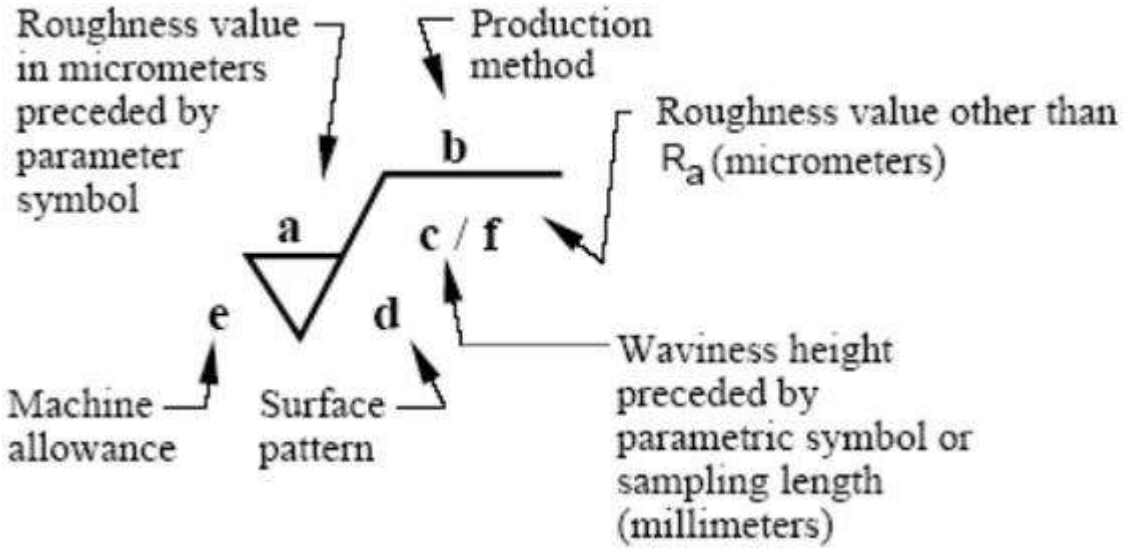
Indication of machining symbol showing direction of lay

| Lay Symbol | Meaning | Example Showing Direction of Tool Marks |
|---|---|---|
| = | Lay approximately parallel to the line representing the surface to which the symbol is applied. |  |
| ⊥ | Lay approximately perpendicular to the line representing the surface to which the symbol is applied. |  |
| X | Lay angular in both directions to line representing the surface to which the symbol is applied. |  |
| M | Lay multidirectional. |  |
| C | Lay approximately circular relative to the center of the surface to which the symbol is applied. |  |
| R | Lay approximately radial relative to the center of the surface to which the symbol is applied. |  |
| $P^3$ | Lay particulate, nondirectional, or protuberant. |  |

Sampling length

| *Ra* (µm) | *Rz* (µm) | Sampling length *lr* (mm) | Evaluation length *ln* (mm) |
|---|---|---|---|
| (0.006) > Ra ≤0.02 | (0.025) > Rz ≤ 0.1 | 0.08 | 0.4 |
| 0.02 > Ra ≤0.1 | 0.1> Rz ≤ 0.5 | 0.25 | 1.25 |
| 0.1 > Ra ≤2 | 0.5 > Rz ≤ 10 | 0.8 | 4 |
| 2 > Ra ≤10 | 10 > Rz ≤ 50 | 2.5 | 12.5 |
| 10 > Ra ≤80 | 50 > Rz ≤ 200 | 8 | 40 |

Representation of surface roughness on drawing.

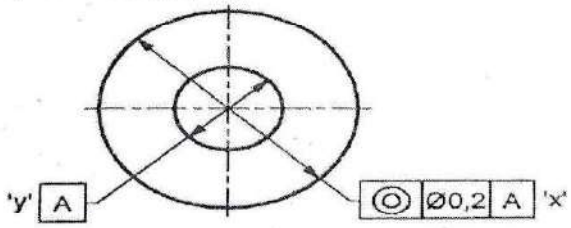


# QUESTION BANK

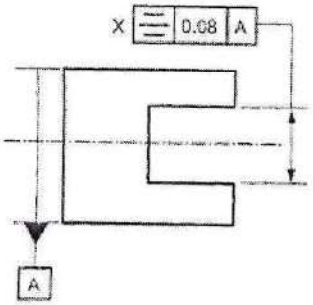
| Program Name: Mechanical Engineering Program Group | Program Code: ME |
|---|---|
| Course Title : Production Drawing (313311) | Semester: Third |

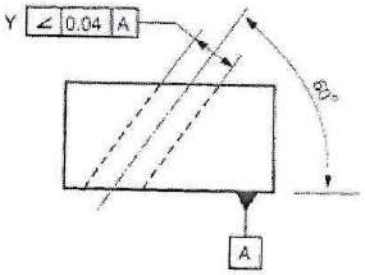
## Unit 3: Production Drawing

**1.** i) The shaft size $\varphi 40^{0.04}$ and Hole size $+40^{0.000}$. Determine the type of fit between them. ii) What is meaning of symbol 'X' and 'Y'. CO3-3.2-A **W-25**




**2.** Refer given Figure No. 2. (a) and (b) what is meaning of 'X' and 'Y'. CO3-3.2-A **W-25**



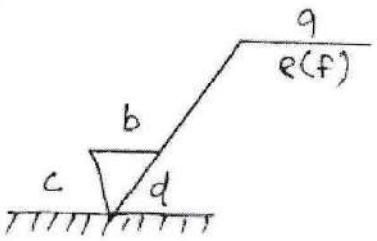

**3.** Draw welding symbol of following :– i) Square butt weld ii) Fillet weld iii) Single V-butt weld with broad root face iv) Concave weld. CO3-3.3-A **W-25**

**4.** The shaft and hole size are given below to find types of fit between them :– CO3-3.1-A **W-25**

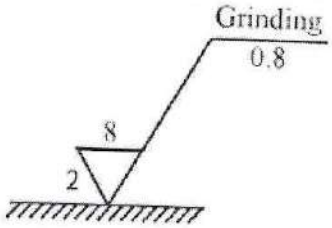
$$\text{Shaft size} = \phi 16^{+0.023}_{-0.012}$$

$$\text{Hole size} = \phi 16^{+0.018}_{-0.000}$$

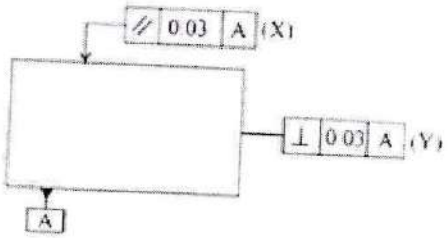
**5.** Give the meaning of following symbol a, b, c, d, e and f Figure No. 3. CO3-3.4-A **W-25**



6. Draw symbol (Tolerance) of following:– CO3-3.2-A **W-25**
   i) Concentricity ii) Perpendicularity iii) Flatness iv) Profile of surface.
7. State the meaning of the symbol shown in Figure No. 1. CO3-3.4-A **W-24,S-25**




8. Draw the symbols for the any two of following: CO3-3.3-A **S-25**
   i) Single V butt weld ii) Seam weld iii) Spot weld iv) Fillet weld with convex finish.
9. Draw the symbols of following features which are controlled in geometrical tolerance.
   i) Symmetry ii) Angularity iii) Concentricity iv) Flatness. CO3-3.2-A **S-25**
10. Two mild steel plants of 8 mm thickness are to be welded to have a lap joint by a fillet weld of leg length 8 mm. Represent the weld on drawing with proper symbol. CO3-3.3-A
11. What is the meaning of symbol at x and y as shown in Figure No. 4. CO3-3.2-A **W-24, S-25**




12. The shaft is given as $\phi 20\ ^{+0.023}_{+0.012}$ and hole size is $\phi 20.\ ^{+0.018}_{+0.000}$ Determine the types of fit between them. CO3-3.1-A **S-25**
13. i. Draw a sketch showing basic size, lower deviation, upper deviation and tolerance. (2Marks) CO3-3.1-A **W-24**
    ii. Show machining symbols to represent direction of lay for approximately radial relative to the center of the surface. (2Marks) CO3-3.4-A **W-24**
14. The shaft size is given as $40^{-0.02}_{-0.04}$ and the hole size is $40^{+0.02}_{-0.04}$. Determine the type of fit between them. CO3-3.1-A **W-24**
15. Two rectangular plates are to be welded with each other along the length. The thickness and length of both plates 12 mm and 60 mm respectively. The plates are to be U Butt welded with convex counter. Prepare welding drawing. CO3-3.3-A **W-24**

8/12/24
Mr A S Patil

8/12/24
Mr. B. S. Patil