

SRM INSTITUTE OF SCIENCE AND TECHNOLOGY
FACULTY OF ENGINEERING AND TECHNOLOGY
Department of Mechanical Engineering
Drafting Laboratory
18MES101L ENGINEERING GRAPHICS AND DESIGN
Academic Year 2020-2021
Semester-I
List of Exercises

1. Introduction*, lettering, and 2D geometric constructions.
2. Conics and special curves.
3. Fundamentals of projections
Orthographic proj. of points, st. lines inclined to one plane, and freehand sketching.
4. Orthographic multi-view projections.
Orthographic proj. of st. lines and planes inclined to both the principal planes
5. Projection of solids
6. Combinations of solids (Constructive Solid Geometry)
7. Section of solids
8. Building drawing (2D)
9. 3D part modelling
10. Creating 2D drawings from 3D models.
11. Development of surfaces
12. Assembly modelling from parts and assembly drawings

* The introduction in Exercise 1 also covers demo on **AutoCAD 2019** drafting, editing tools, etc. for **All other branches other than Aerospace, Automobile, Civil, Mechanical, & Mechatronics Engineering** (who also have Manual Drafting). Whereas, for the listed branches it starts only after COMPLETE manual drafting exercises until week 4, i.e. it starts at Exercise 5. **Pro | E** starts from Exercise 9 on words.

IMPORTANT NOTE 1

Manual Drafting is only for branches of Aerospace, Automobile, Civil, Mechanical, and Mechatronics; whereas, all other branches will practice and solve problems in software only.

Thus the topic of introducing and using AutoCAD software including object creation, modification, and *dimensioning* outlined in Week 5, has to be covered in the first week theory class for other branches in addition to the basic exercises, whereas, the same will be introduced to the above mentioned branches as outlined in the lesson plan.

IMPORTANT NOTE 2

All the exercises outlined are representative only, due to time limitations for practical sessions; related problems that rely on the concepts outlined or its extension possible within the scope of the syllabus shall appear for the model and end examinations.

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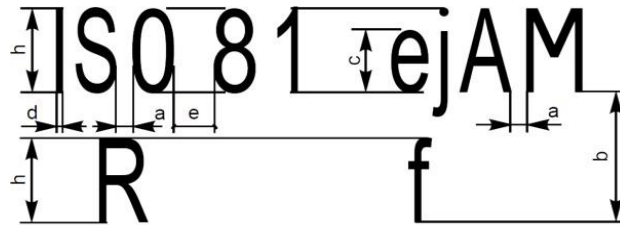
WEEK #1. Introduction, lettering and 2D Geometric construction.

1. Write (Manually or using CAD software) the *Capital* letters A to Z, *small* letters a to z, and *Arabic numbers* 0 to 9 with **0.7 mm** thick - lines and **0.5 mm** thick line pencils.

(Refer Table 1 for lettering specifications) 35 min/ 10 marks/ level 1/ Tech writing

Table 1 Lettering B ($d=h/10$)

Characteristic	Ratio	Dimensions, (mm)							
Lettering height (Height of capitals)	h (10/10) h	2.5	3.5	5	7	10	14	20	
Height of lower-case letters (without stem or tail)	c (7/10) h	—	2.5	3.5	5	7	10	14	
Spacing between characters	a (2/10) h	0.5	0.7	1	1.4	2	2.8	4	
Minimum spacing of base lines	b (14/10) h	3.5	5	7	10	14	20	28	
Minimum spacing between words	e (6/14) h	1.5	2.1	3	4.2	6	8.4	12	
Thickness of lines	d (1/10) h	0.25	0.35	0.5	0.7	1	1.4	2	



2. Draw Margins and Title block in drawing sheet. (Refer Figure 1) 45 min/ 05 marks/ level 1/

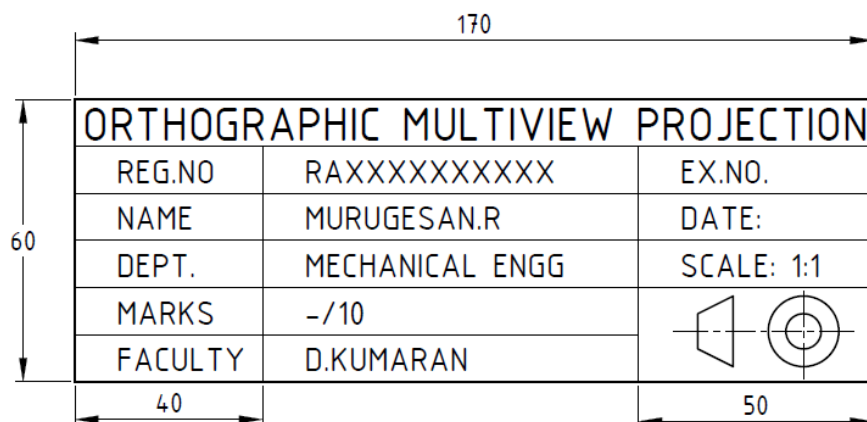


Figure 1 Title Block (All Dimensions are in mm)

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3. Draw the basic 2D *geometric entities*, each of dimension or side or radius of 30mm (a vertical straight line, a horizontal straight line, an equilateral triangle, a square, a regular pentagon, a regular hexagon, and a circle. **With labels and dimensions.** (Students should learn drawing other regular polygonal shapes also) (Refer Figure 2) **70 min/ 35 marks/ level 1/ General**

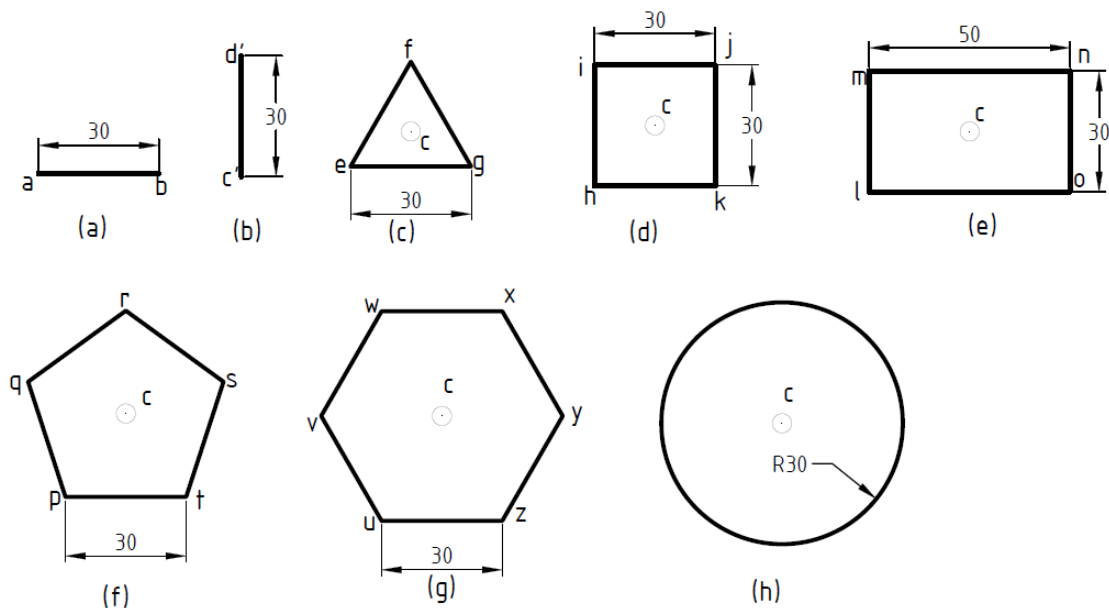


Figure 2 2D Geometric entities (All Dimensions are in mm)

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WEEK # 2. Conics and special curves

Note: All drawings has to be dimensioned.

1. Draw a parabola of base 100 mm and height/ length (along the axis) 80 mm, by
i) Rectangular method, ii) Tangent method. **30 min/ 20 marks/ level 1/ cam profile**
2. Draw an ellipse of major diameter/ axis 150 mm and minor diameter/ axis 70 mm by
i) Oblong method, ii) Concentric Circle method. **30 min/ 20 marks/ level 1/ General**
3. Draw a hyperbola by eccentricity method with eccentricity, $e = 3/2$ whose distance of focus is
at 50 mm from its diretrix. **15 min/ 10 marks/ level 1/ General**
4. Construct a cycloid with rolling circle diameter 60 mm that rolls for one complete revolution,
with trace point A, initially at the bottom. **(Epi-cycloid, and hypo-cycloid, demonstration
only).** **40 min/ 10 marks/ level 3/ Gear tooth**
5. Draw the Involute of a regular pentagon (or any polygon) of side 30 mm, wound/ unwound
for one complete turn. **(Involute of a circle demonstration only).**
15 min/ 10 marks/ level 3/ Gear tooth
6. Draw an Archimedean spiral for one and half convolution. The greatest and the least radii
being 70 mm and 10 mm respectively. Draw the tangent and normal method.
20 min/ 10 marks/ level 1/ Screw

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WEEK #3. FUNDAMENTALS OF PROJECTION

1. Draw the projections of the following points on the same reference line, keeping the projectors 25 mm apart from each other.
 - a). A point 10mm above HP 10mm in front of V.P
 - b). A point 10mm above HP 10mm below V.P
 - c). A point 10mm below HP 10mm in front of V.P
 - d). A point 10mm below HP 10mm behind V.P

(10 min. /5 marks/level 1/ -)

2. Draw the orthographic multi-view projections of the following **points**. Choose appropriate *Scale* if required.
 - a) A toy boat (idealized as a point R) is floating inside a square well 3 m below H.P (floor) and 1 m behind V.P (wall). **(10 min./5 marks/ /level 2/ -)**
 - b) A box (idealized as a point S) is kept in the steps, which is 5 meter below H.P (floor) and 4 meter in front of V.P (wall) from the observer. **(10 min./5 marks/ /level 2/ -)**

3. Draw the multi-view projection of **straight lines inclined to only one plane**.
 - a) The length of the top view of a line, AB parallel to the V.P. and inclined at 45° to the H.P. is 50 mm. One end of the line A, is 12 mm above the H.P and 25 mm in front of the V.P. Draw the projections of the line and determine its true length. **(25 min. /10 marks/ /level 1/ -)**
 - b) The front view of a 7.5 m long lamp post (idealized as a line AB) lying on the ground measures 5.5 m. One of its end A is in the wall. Draw the projections of the line and determine its inclination with the wall (V.P.) **(25 min./10 marks/ /level 2/ Gen.)**

4. Draw a free-hand (manual/ CAD) **CREATIVE** conceptual drawing of a **PROPOSED** (Modify the existing product like pen, sharpener, micro tip pencil, stapler, car, airplane, etc., (**new, presently not-existing features must be added to existing product**)). Label the parts and list out the special features of the product, an example shown below.

(60 min. /5 marks/ /level 3/ General consumer applications)



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WEEK #4. ORTHOGRAPHIC MULTI-VIEW PROJECTION

1. i. Projection of lines inclined to both the planes (without traces)

(15 min. /10 marks/level 1/ -)

A line AB, 80mm long, has its end A on both the H.P. and the V.P. It is inclined at 30° to the H.P. and at 45° to the V.P. Draw its projections and determine the apparent length and angles.

ii. True length and true inclinations of the line

(25 min./10 marks/level 2/ Gen.)

A string CD is connected to the center of the ceiling of a room of dimensions 4.2 m x 3.6 m x 3.6 m high, to one of its floor corners. Determine graphically the maximum true length of the string and the true inclination it makes with the floor. Choose appropriate scale. If required.

2. i. Projection of planes inclined to both the planes (without traces)

A rectangular plane ABCD, of side AB, 70 mm and BC, 30 mm, has its side BC on the H.P. (floor). The plane is inclined 60° to the H.P. (floor) and resting side BC is inclined at 45° to the V.P. (wall). Draw the projections of the rectangular plane. **(25 min./15marks/level 1/ -)**

ii. Auxiliary projection

(25 min./15marks/level 2/ -)

A line AB, 80 mm long, is on the H.P. and makes an angle of 30° with the V.P. Its end A is 25 mm in front of the V.P. Draw its projections and obtain its projected length.

3. i. Find the shortest distance between a point and a line

Find the shortest distance between a pencil (line AB) and a sharpener (point C) placed on a table, whose Cartesian coordinates are $A=(10,20,30)$; $B=(30, 40, 60)$, and $C=(60,20,40)$. All units are in mm. **(20 min./15marks/level 3/ -)**

ii. Find the shortest distance between two skew lines (Non intersecting lines) (5-20-3)

Find the shortest distance between a Bus (line AB) and a train (line CD) two skew (non-intersecting) whose Cartesian coordinates are $A=(10,20,30)$; $B=(30, 40, 60)$, $C=(10,30,60)$ and $D=(35,20,80)$. All units are in feet. **(20 min./15marks/level 3/ -)**

iii. Find the shortest distance between point and a plane (20 min./15marks/level 3/ -)

The coordinates of a triangular sheet (ABC) and a stone (Point D) is given as follows $A=(10,20,30)$; $B=(30, 40, 60)$, and $C=(60,20,40)$ and of the point D is $D=(35,20,50)$. Find the shortest distance between the sheet and the stone (plane and a point).

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WEEK #5 PROJECTION OF SOLIDS RESTING ON HP/ VP

1. Draw the projections of a pentagonal pyramid of base side 30 mm and axis 50 mm, having its base on the H.P. with one of its base edge parallel to the V.P. Also draw its side view.

5 Minutes/ 5 Marks/ Level 1

2. Draw the standard projections of (i) a right circular cylinder of base diameter 40 mm and axis length 50 mm, and (ii) a right circular cone, base diameter 40 mm and axis length 50 mm, resting on its base on the H.P.

10 Minutes/ 5 Marks/ Level 1

3. A hexagonal prism of base side 25mm and height 50 mm is resting on one of its rectangular faces on the HP. Its axis is perpendicular to the VP. When the nearer end of the prism is 20 mm in front of the VP. Draw its projections

5 Minutes/ 5 Marks/ Level 1

**PROJECTION OF SOLIDS INCLINED TO ONE REFERENCE PLANE AND PARALLEL TO THE OTHER
(CHANGE OF POSITION METHOD)**

4. A hexahedron of 30 mm sides is resting on one of its corners on HP such that one of the solid diagonals is perpendicular to VP. Draw the projections of the solid.

(OR)

5. A pentagonal prism of base side 25 mm and height 50 mm is resting on HP on one of its base corners such that the top most edge is at a distance of 60 mm above HP. Draw its projections, when the axis of the solid in top view is inclined at 45° to VP. Also, determine the inclination the longer edge of the prism containing the resting corner makes with the HP.

35 Minutes/ 10 Marks/ Level 2

6. A right circular cylinder of 40 mm diameter and height 60 mm is resting on HP on one of its rim or base points such that the axis is apparently inclined at 40° to HP and 50° to VP. Draw the projections of the solid.

(OR)

7. A right circular cone of base diameter 40 mm and axis length 50 mm is resting on HP on a point on the circumference of its base such that its apex is at 40 mm above the HP and the top view of its axis is inclined at 60° to VP. Draw the top and front views of the solid. Also, determine the inclination of the axis when the base is nearer to the observer.

35 Minutes/ 10 Marks/ Level 2

PROJECTION OF SOLIDS BY AUXILIARY PLANE PROJECTION METHOD

8. Draw the projections of a pentagonal prism, base 25 mm side and axis 50 mm long resting on one of its rectangular faces on the H.P., with the axis inclined at 45° to the V.P.

20 Minutes/ 10 Marks/ Level 2

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WEEK #5 APPLICATION PROBLEMS

9. Draw the projections in all three standard views for a thin lamp shade, in the form of a frustum of a cone has its larger end 200 mm in diameter, smaller end 75 mm in diameter and height 150 mm. It is lying on its side on the ground and the axis parallel to the VP.

(OR)

10. Create the projections for a square duct used for ventilation, in the form of a frustum of a square pyramid. The sides of the top and the bottom are 150 mm and 100 mm respectively and its length is 150 mm. It is situated in such a way that its axis is parallel to HP and lies in a plane inclined at 60° to the VP. Assume the thickness of the duct-sheet to be negligible.

40 Minutes/ 30 Marks/ Level 3/General Application

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WEEK #6 COMBINATION OF SOLIDS

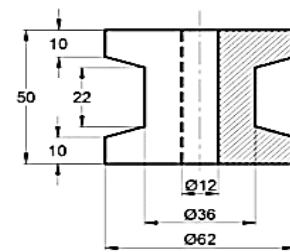
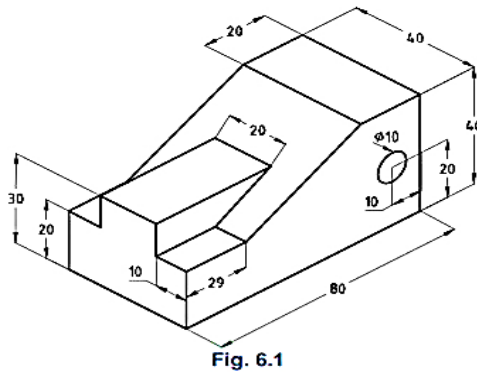
Constructive Solid Geometry

1. Create a CSG model for an extruded component as shown in Fig. 6.1: Viewing in various modes (generate multi-view, print .pdf).

20 Minutes/ 20 Marks/ Level 2

2. Create a CSG model for a revolved component as shown in Fig. 6.2: Viewing in various modes (generate multi-view, print .pdf).

All dimensions are in mm.



3. Solid creation using Sweep. Model a 3D spiral spring to be used in a toy whose dimensions are as follows: $r = 5$ mm, $R = 50$ mm, $n = 8$, cross section: Rectangle of 1 along spiral plane X
5 perpendicular to the plane

30 Minutes/ 20 Marks/ Level 3

4. Solid creation using Loft. Fig. 6.3.

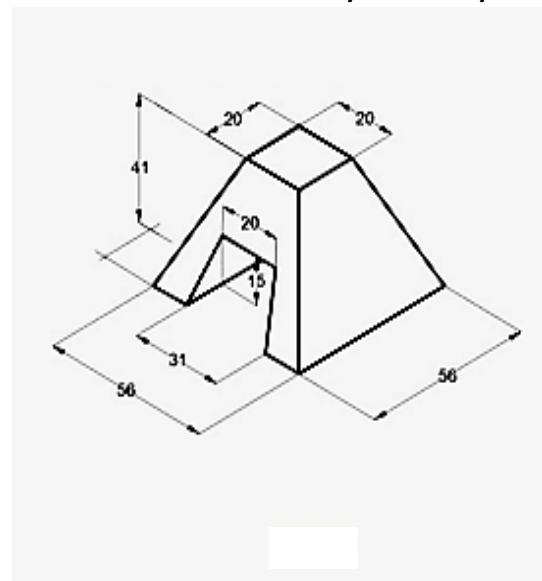
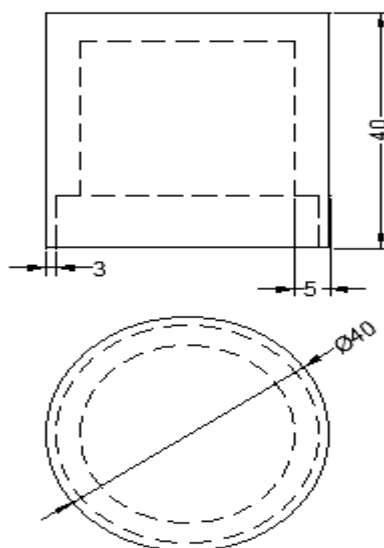
30 Minutes/ 20 Marks/ Level 2

5. Projection of an oblique prism/ pyramid 3D model of a square pyramid of base side directly above one of its corners

25 Minutes/ 20 Marks/ Level 3

6. Solid shell Creation Fig. 6.4

25 Minutes/ 20 Marks/ Level 3



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WEEK #7. SECTION OF SOLIDS (AUTO CAD)

1. Section of solid prism/cylinder, pyramid/cone objects with true shape –cut perpendicular to VP.

- i. A hexagonal pyramid, base 30 mm side and axis height 70 mm rests with its base on the H.P. (ground) with its axis parallel to the V.P. (wall). It is cut by a cutting plane inclined at 35° to HP and perpendicular to VP and is bisecting the axis. Draw the top view, sectional front view and true shape of the section. **(30 min /10 Marks /Level 1)**

- ii. A pentagonal pyramid base side 30mm length of axis 80mm is resting on a base edge on the H.P. with a triangular face containing that edge being perpendicular to the V.P and inclined 60° to the H.P. It is cut by a horizontal section plane whose Vertical Trace (V.T).passes through the mid – point of the axis .Draw the front view, sectional top view. **(30 min /10 Marks /Level 2)**

- iii. A cylinder of base diameter 45mm and height 65mm rests on its base on HP .It is cut by a plane perpendicular to VP and inclined at 30° to HP and the axis at a distance 30 mm from base .draw the front view ,sectional top view , and true shape of section . **(20 min/ 10 Marks / Level 2)**

- iv. A pentagonal pyramid of base side 30mm and axis length 50mm lies on one of its triangular faces on HP and with its axis parallel to VP .It is cut by a horizontal section plane whose VT passes through the center of the base of the pyramid .Draw the sectional plan. **(30min/ 10 Marks / Level 3)**

2. Section of solid prism/cylinder, pyramid/cone objects with true shape –cut perpendicular to HP

- i. A Hexagonal prism of base side 25mm and axis length 70mm rests on one of its rectangular lateral faces on the H.P. (ground), with its axis inclined 30° to the V.P. (wall). It is cut by a section plane perpendicular to the H.P. (ground) and inclined 45° to the V.P. (wall) cuts the axis at a point 20 mm from one of its ends nearer to VP. Draw its top view, sectional front view and the true shape of the section. **(30min /10 marks /level 2)**
- ii. A right circular cone, base 70 mm diameter, axis 75 mm and resting on its base on the H.P., is cut by a *vertical section plane* inclined 60° with the VP, and 12 mm away from the axis, and Further away from V.P. in top view. (i) Draw the sectional front view and the true of the section. Also draw the sectional front view and the top view when same section plane is parallel to V.P **(30min /10 marks /level 2/)**

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ADDITIONAL PROBLEMS

1. A right circular cone, base 60 mm diameter and axis 60 mm long is lying on the H.P. on one of its generators with its axis parallel to the V.P. A vertical section plane parallel to the generator which is tangent to the ellipse (for the base) in the top view, cuts the cone bisecting the axis and removing the portion containing the apex. Draw its sectional front view and true shape of the section.

(30 min /10 marks /level 2/)

2. A right circular cone, base 60 mm diameter and axis 75 mm long, is resting on the H.P. on its base. It is cut by a section plane perpendicular to the V.P., inclined at 45° to the H.P. and intersecting the axis 30 mm above the base. Draw its front view and sectional top view. Also draw its top view when the cone is lying on the ground on its cut-surface with the axis parallel to the V.P.

(30 min /10 marks /level 2/)

3. A right circular cylinder of 40 mm diameter, 60 mm height resting with its base on HP is cut by a section plane, perpendicular to the V.P., inclined at 45° to the H.P. and intersecting the axis 32 mm above its base. Draw its front view, sectional top view, sectional side view and true shape of the section.

(30 min /10 marks /level 3/)

4. A hexagonal prism, has a of base side and height 65mm rectangular face on the H.P. with its axis parallel to the V.P. It is cut by a vertical section plane where H. T. of which makes an angle of 45° with the HP and which cuts the axis at a point 20 mm from one of its bottom end. Draw its sectional front view and the true shape of the section.

(30 min /10 marks /level 3/)

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WEEK #8. Building Drawing

Building drawing in 2D

1. Draw the plan, elevation, and sectional side view A-A, of a police outpost whose outline plan is shown in Fig. 8.1 (150 min /10 marks /level 1)

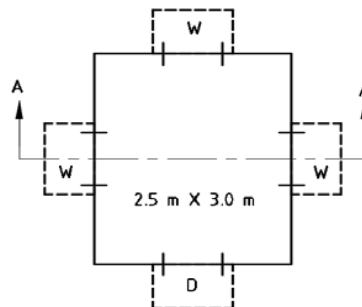


Fig. 8.1

Some standard dimensions of the building are given below:

Tread of steps = 250 mm

Height of parapet = 600mm

Height of ceiling above floor level= 3 000 mm

Window W = 1600 x 1200 mm ; Door D, D1 = 1000 x 1950 mm

Window W1 = 1200 X 1200 mm ; Door D2 = 900 x 1950 mm

Window W2 = 1000 x 1200 mm ; Door D3 = 800 x 1950 mm

Ventilator V = 600 x 450 mm ; R.C.C. slab = 120 mm thick

Additional Problem

1. Draw the plan of new mobile service office/ canteen/ or any building of your choice also show its elevation and sectional side view. Standard dimensions for fittings/accessories and furniture. (150 min /10 marks /level 3/ General)

2. Draw the plan of office space/Residential building /Commercial building or any other building of your choice showing the elevation and sectional side view the same. Use standard dimensions for fitting and furniture. (150 min /10 marks /level 3/ General)

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WEEK #9 3D PART MODELLING

1. Model the component shown in Figure 9.1 using Pro-E Software and view it in wireframe and Isometric Views. **50 Minutes/ 10 Marks/ Level 1/-**
2. Parametric modelling of a hexagonal bolt and Nut (without chamfer and thread) shown in Figure 9.2 **60 Minutes/ 10 Marks/ Level 2/Industrial Application**
 - i. 3D Model a hexagonal bolt of shaft diameter $d = 10$ mm, shaft length $l = 6d$, bolt head height $h = 0.67d$, dimension across flats, $f = 1.5d$.
 - ii. Modelling of hexagonal nut of hole diameter $d = 10$ mm, nut height $h = 0.8d$, dimension across flats, $f = 1.5d$.

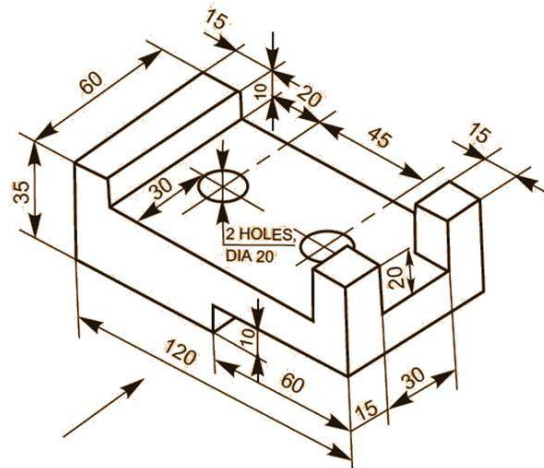


Fig. 9.1

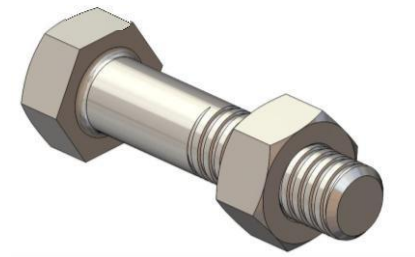
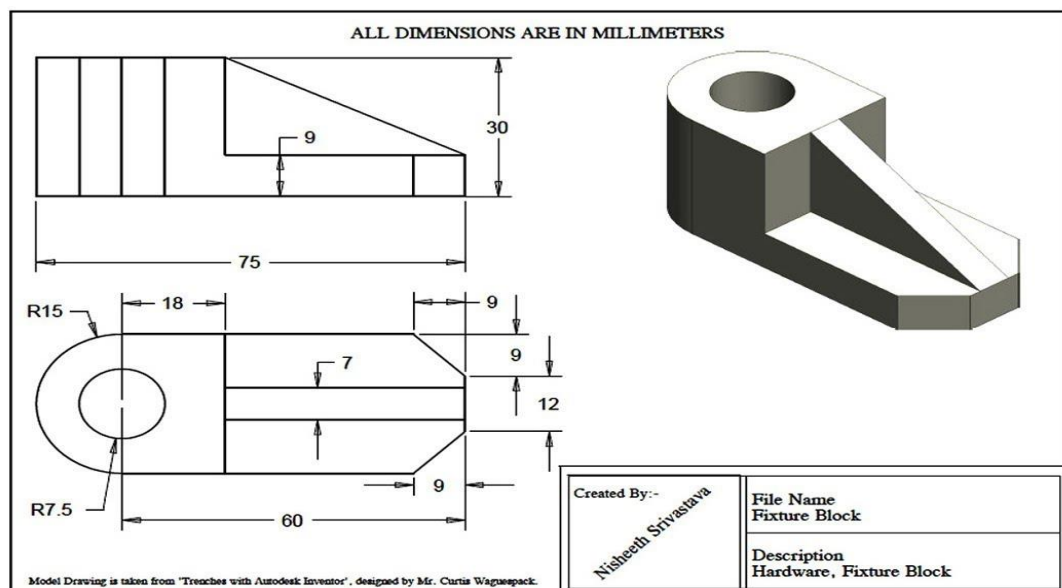


Fig. 9.2

3. Create a simple model of a Fixture Block shown in Figure 9.3 and add any new features to it



40 Minutes/ 10 Marks/ Level 3/Consumer Application
Fig. 9.3

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WEEK #9 ADDITIONAL PRACTICE EXERCISES

1. Model the component shown in Figure 9.4 using Pro-E Software and view it in wireframe and Isometric Views.
50 Minutes/ 10 Marks/ Level 1/-
2. 3D model the engine valve lifter shown in Figure 9.5
50 Minutes/ 10 Marks/ Level 2/Industrial Application

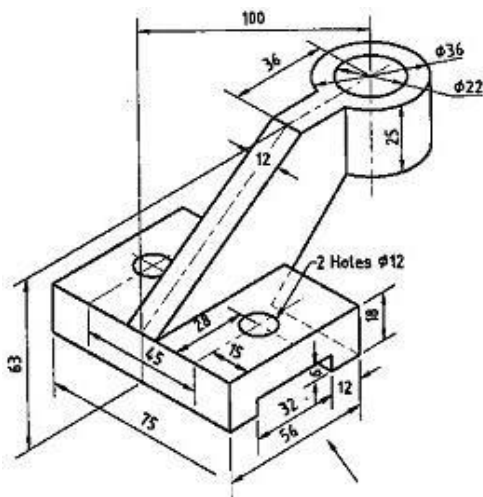


Fig. 9.4

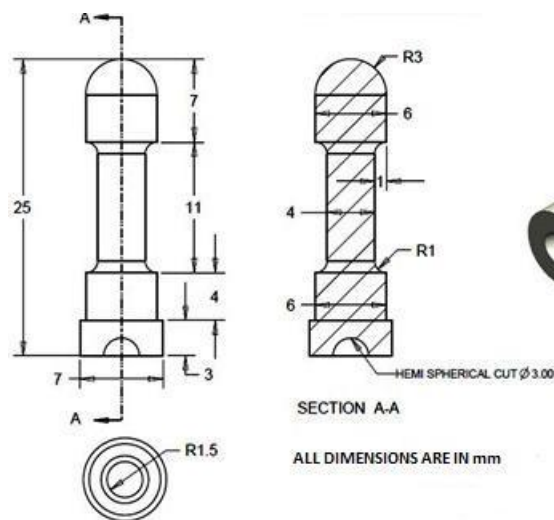


Fig. 9.5

4. Create a simple model of a Torch light shown in Figure 9.6 and add any new features to it

50 Minutes/ 10 Marks/ Level 3/Consumer Application

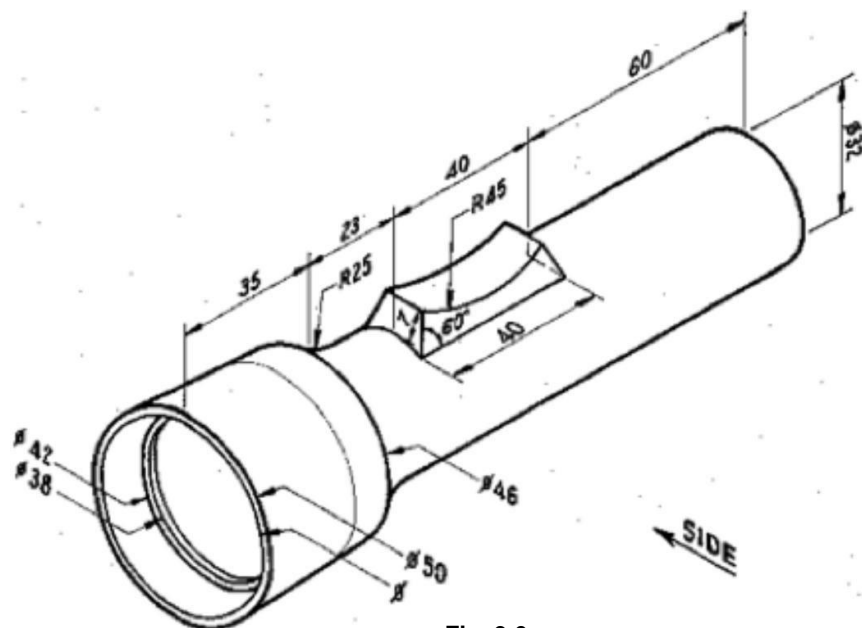


Fig. 9.6

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WEEK #10 3D PART TO 2D DRAWINGS

1. Generate 2D drawings from 3D model shown in Fig 10.1

60 Minutes/ 10 Marks/ Level 1/-

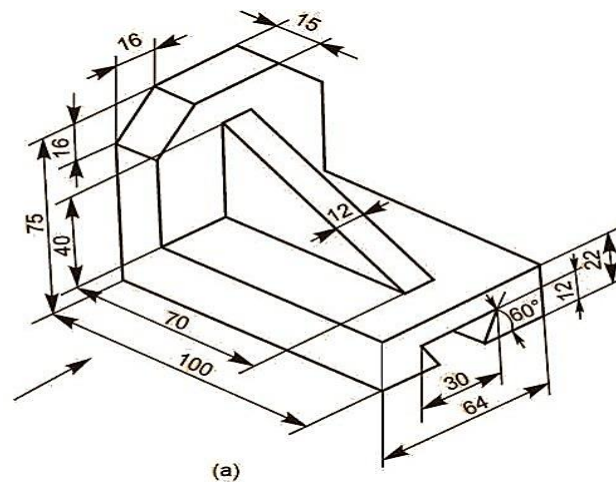


Fig. 10.1

2. Draw the part in 3D and mark Annotations and Tolerance (made from generated 2D) refer Fig. 10.2

90 Minutes/ 20 Marks/ Level 2/ Industrial application

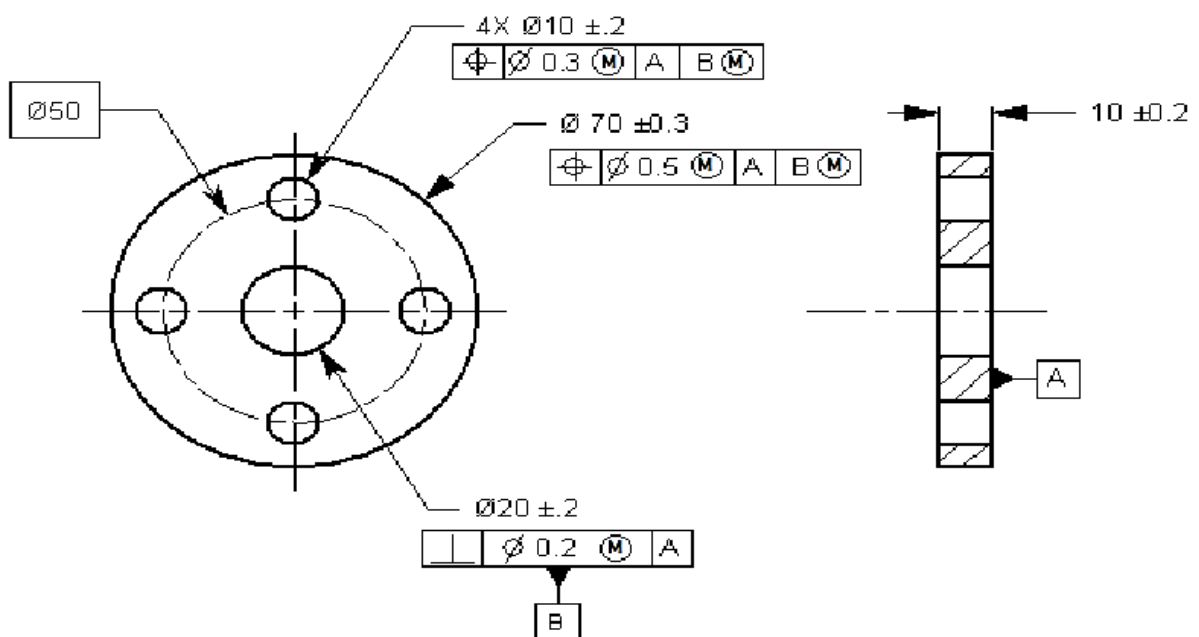


Fig. 10.2

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WEEK #10 ADDITIONAL PRACTICE EXERCISES

1. Generate 2D drawings from 3D model shown in Fig 10.3 **60 Minutes/ 10 Marks/ Level 1/-**

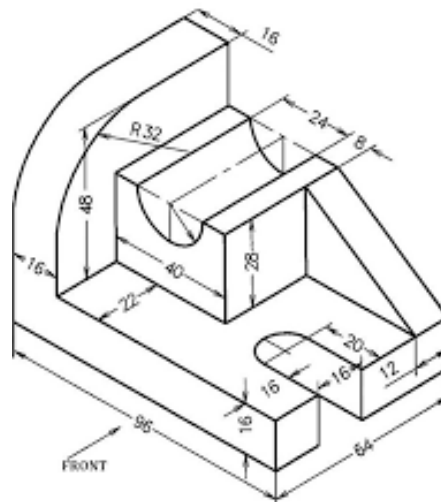


Fig. 10.3

2. Draw the Annotations and Tolerance (made from generated 2D) refer Fig. 10.4

90 Minutes/ 20 Marks/ Level 2/ Industrial application

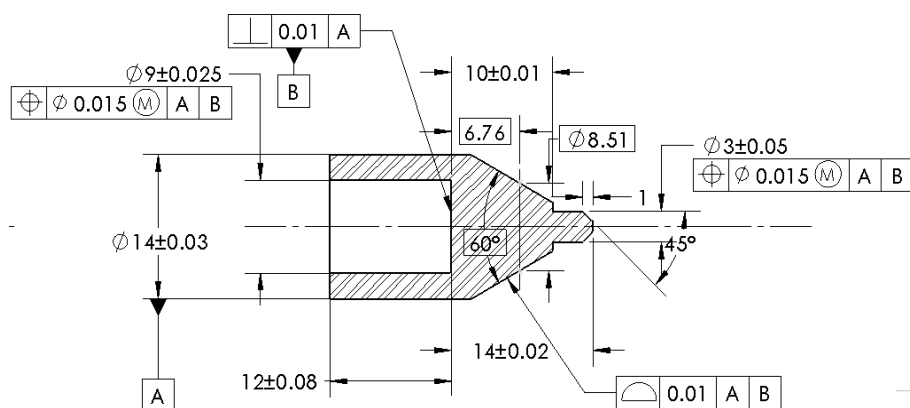


Fig. 10.4

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WEEK #11 DEVELOPMENT OF SURFACES

1. A pentagonal prism, 30 mm base side and 50 mm axis beyond with its base on HP. One of its base edge perpendicular to VP. It is cut by a section plane inclined at 45° to the HP, and passing through the mid-point of axis. Draw the lateral surface of the truncated solid.

40 Minutes/ 30 Marks/ Level 1

2. A right circular cylindrical duct of base 50 mm diameter and axis 60 mm long, is standing on HP on its base. It has a square hole of size 25 mm in it. The hole bisects the axis of the cylinder and is perpendicular to the VP. The faces of the square hole are equally inclined with the HP. Draw its projections and develop lateral surface of the cylinder.

50 Minutes/ 30 Marks/ Level 2/Industrial Application

3. A lamp shape is formed by cutting a cone of 70mm diameter and 90mm height by a horizontal cutting plane at a distance of 36mm from the apex and another cutting plane inclined at 30° degree to HP, passing through the lower left corner of the base. Draw the development of the shade.

60 Minutes/ 40 Marks/ Level 3/Consumer Application

WEEK #11 ADDITIONAL PRACTICE EXERCISES

1. A square pyramid, base 40 mm side and axis 65 mm long, has its base on the HP and all its edges are equally inclined to the VP. It is cut by a section plane, perpendicular to the VP, inclined at 45° to the HP and bisecting the axis. Draw its lateral development.

50 Minutes/ 30 Marks/ Level 1

2. A square prism of 40 mm edge of the base and 65 mm height stands on its base on the HP with vertical faces inclined at 45° with the VP. A horizontal hole of 40 mm diameter is drilled centrally through the prism such that the hole passes through the opposite vertical edges of the prism, draw the development of the surfaces of the prism.

50 Minutes/ 30 Marks/ Level 2/Industrial Application

3. A vertical chimney of circular cross section joints the roof of a room sloping at 35 degree to the horizontal. The largest diameter of the chimney is 400mm and the shortest portion of the chimney is 300mm and total height of chimney measures 700mm respectively. Determine the shape of the sheet metal from which the chimney can be made.

50 Minutes/ 30 Marks/ Level 3/Consumer Application

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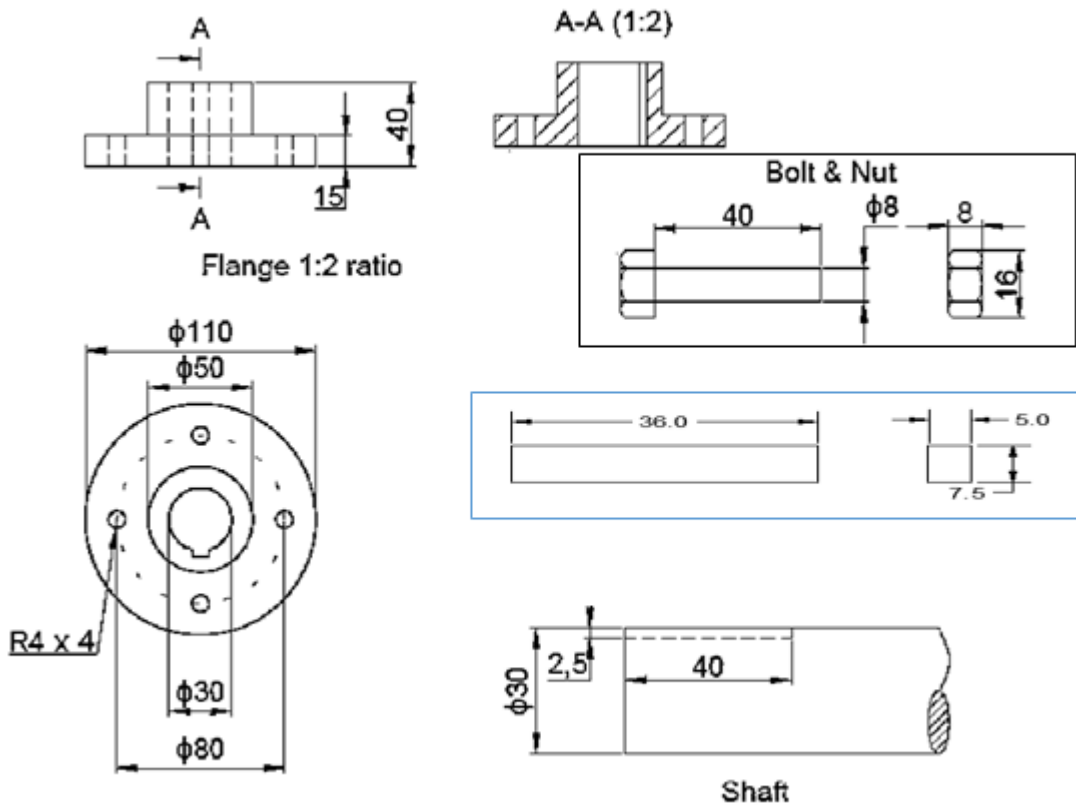
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WEEK #12 ASSEMBLY MODELING FROM PARTS AND ASSEMBLY DRAWINGS

1. Model all the components in figure and save them in a separate folder.
70 Minutes/ 40 Marks/ Level 1
2. Create an assembly of the hexagonal bolt and nut shown in figure. Show the exploded view and generate the assembly drawing.
30 Minutes/ 20 Marks/ Level 2
3. Make the assembly of the flange coupling shown in figure.
50 Minutes/ 40 Marks/ Level 3



SNO	PART NAME	MATERIAL	NO. OFF
1	FLANGE(MALE)	CAST IRON	1
2	FLANGE(FEMALE)	CAST IRON	1
3	NUT	MILD STEEL	4
4	BOLT	MILD STEEL	4
5	KEYS	MILD STEEL	2

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WEEK #12 ADDITIONAL PRACTICE EXERCISES

1. Model all the components in figure and save them in a separate folder.

70 Minutes/ 40 Marks/ Level 1

2. Create an assembly of the fork and center block pin shown in figure. Show the exploded view and generate the assembly drawing.

30 Minutes/ 20 Marks/ Level 2

3. Make the assembly of the universal coupling shown in figure.

50 Minutes/ 40 Marks/ Level 3

