

Methodological guidelines for laboratory, graphic and independent work on the subject “Engineering graphics” (for 1st-year full-time foreigner students education level “bachelor” speciality 192 – Building and Civil Protection) / O. M. Beketov National University of Urban Economy in Kharkiv ; com. : M. Liubchenko, A. Radchenko. – Kharkiv : O. M. Beketov NUUE, 2018. – 63 p.

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CONTENTS

The aim of the works.....	5
1 POINTS AND LINES.....	6
1.1 The requirement to the task 1	6
1.2 Order of the task 1	6
1.3 Example of the task 1	7
2 PLANE. AUXILIARY PLANES	8
2.1 The requirement to the task 2	8
2.2 Order of the task 2.....	8
2.3 Example of the task 2	9
2.4 Variants for tasks 1 and 2	10
3 SURFACES. INTERSECTION OF 2 SURFACES.....	11
3.1 The requirement to the task 3	11
3.2 Order of the task 3.....	11
3.3 Intersection examples of 2 surfaces	11
3.4 Example of the task 3	13
3.5 Variants for the task 3	14
4 MULTIVIEW DRAWINGS	16
4.1 The requirement to the task 4	16
4.2 Basic information about multiview drawings	16
4.3 Procedure of the task 4	25
4.4 Example of the task 4	26
4.5 Variants for the task 4	27
5 CREATING 3D MODEL IN AUTODESK AUTOCAD.....	31
5.1 Interface of the program AutoCAD.....	31
5.2 Building of 3D model.....	34
5.3 Creating a 2D drawing from a 3D model.....	38
5.4 Variants for the task 5	43

6 CONSTRUCTION DRAWINGS AND ELEMENTS OF THE BUILDING 46

6.1 Drawings of the building plan 46

6.2 Section drawings 47

6.3 Elevation drawings..... 49

6.4 Examples of the task 6..... 50

6.5 Variants for the task 6 54

REFERENS 63

The aim of the works

The presented methodical guidelines are developed for 1st-year full-time foreigner students education level “bachelor” speciality 192 – Building and Civil Protection. Optional tasks, requirements to the work are formulated, short explanations to implementation of drawings are given and the list of references which should be used when performing provided tasks.

The aims of the work to teach the students use opportunities of the graphic editor AutoCAD which modeling geometrical objects, read the construction drawings and make out its according to standards.

In the first module the student has to solve the descriptive geometry problems. The task of the second module shares on two parts. First part is multiview drawings. The second part of tasks provides implementation of the drawing of the building plan, the elevation and the section.

1 POINTS AND LINES

1.1 The requirement to task 1

1.2 Order of the task 1

1.3 Example of the task 1

1.1 The requirement to the task 1

All drawings are executed on drawing sheets of A3 format:

- conditions of tasks – with pencil using contour lines (0,2–0,3 mm);
- results of the decisions – outline colored pencils.

Points are represented in the form of circles with a diameter of 1 mm. According to the coordinates of the points A, B, C (mm), perform the task on the topics:

- straight line drawing (projection of a straight line, determining the size of a straight line, determining the angles of the inclination of the straight line to the projection planes, the position of the straight lines, lines perpendicular to the planes);
- positional problems (the mutual position of the straight line for the plane, the mutual projection of the planes, etc.), metric problems (determining the distance between the planes, between the adjoining lines, the definition of angles, etc.).

1.2 Order of the task 1

Given: coordinates of points A, B, C (variants for the task see p. 10)

Problem (to define):

- a) true length of the segment of the straight line AB;
- b) size of the angles α and β of the inclination of the segment AB to the planes of projections: horizontal (HP) and frontal (FP);
- c) straight line l are crossed with point C and parallel to line AB;
- d) horizontal line h and frontal line f are from point C and intersecting straight line AB.

There are two topics “drawing of a point” and “drawing of a straight line” in this essay. Construction should be done on two planes of projections H and F. The points are in the first quarter of a space. The segment AB under condition is a section of the general situation.

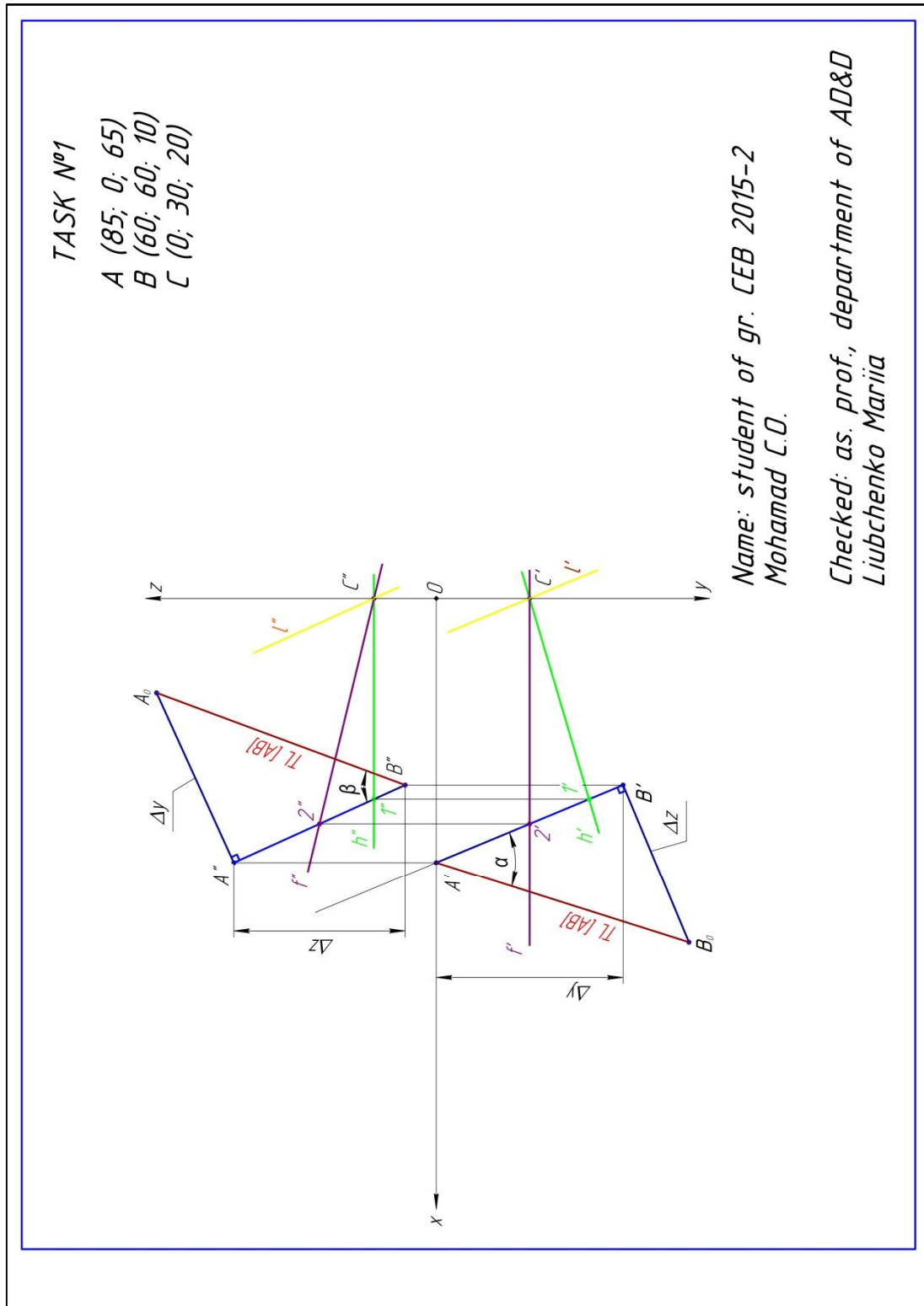
Let's consider the order of the task performed in the example (p. 7). To construct the projections of points in the given coordinates, it is necessary to postpone the coordinate X of point A to the left of zero on the X-axis. Conduct the line perpendicular to the X-axis. Coordinate Y put down on this line. We obtain a horizontal projection of point A (point A_1). Coordinate z is put up on the same line. We obtain a frontal projection of point A (point A_2). Similarly, we construct projections of other points. If one of the coordinates is equal 0 the corresponding projection will be on the coordinate axis.

We obtain a projection of a segment of a straight line AB when connecting the same projections of points A and B.

After that we turn to the definition of the values are given in the task:

a) the segment's true length of a straight line is found by the method of a rectangular triangle. On the horizontal projection from point B', we restore the perpendicular. The value Δz is deposited on it, taken from the frontal projection and get the point B₀. Connect points B₀ and A'. The obtained hypotenuse of a rectangular triangle (A'B₀ and A''B₀) is the true size of a segment of a straight line AB.

1.3 Example of the task 1



2 PLANE. AUXILIARY PLANES

2.1 The requirement to the task 2

2.2 Order of the task 2

2.3 Example of the task 2

2.4 Variants for tasks 1 and 2

2.1 The requirement to the task 2

All drawings are performed on drawing sheets of A3 format:

- conditions of tasks – with pencil using contour lines (0,2–0,3 mm);
- results of the decisions – outline of red pencil.

Points are represented like circles with a diameter of 1 mm. According to the coordinates of the points A, B, C and D (mm) draw the task on the topics:

- plane's drawing (projection of a planes, determining the true size of a plane);
- positional problems (the mutual position of the plane by the main planes), metric problems (determining the true size of a plane, using auxiliary planes).

2.2 Order of the task 2

Given: coordinates of points A, B, C and D (variants of task see p. 10)

Problem (to define):

- a) true size of the plane ABC;
- b) distance between the plane ABC to point D is determined by auxiliary planes method.

Firstly, you draw a frontal projection of horizontal line (h'') in plane of triangle $A''B''C''$. Point $1'$ is found as point of intersection $A''B''$ and h'' . Point $1'$ is determined as point lying on $A'B'$.

Then, you draw a new auxiliary plane perpendicular to h' . Axis of the new plane is called X_1 . We position the new (auxiliary) image plane perpendicular to the line h' . The new image plane can be positioned anywhere in the plan or elevation and any distance from the line as long as it is perpendicular to the line. The auxiliary projection should be kept relatively close to the line without overlapping other views. In a 2D drawing, the only part of the auxiliary plane that we will see is the folding line (X_1) usually. Then, we project the end points of the triangle $A'B'C'$ onto the auxiliary plane, as with all projections we assume a position at infinity, perpendicular to the plane, so all points are projected onto the plane at right angles.

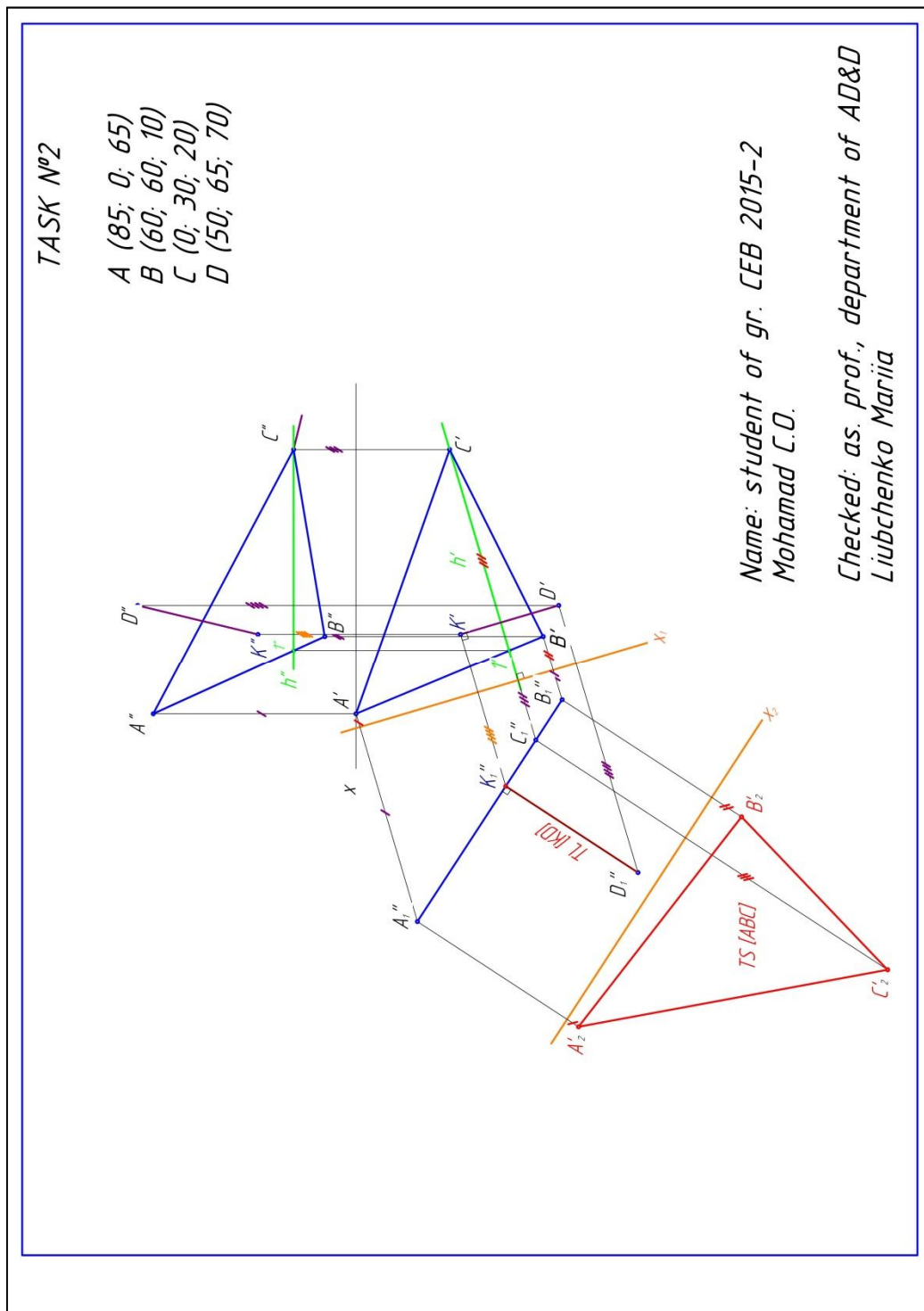
We chose to take an auxiliary projection from the frontal view. If we examine the line in space we see that the line is the same distance from the auxiliary projection that it is from the horizontal view, so we can take the distances from the frontal view.

Then we draw perpendicular from point D''_1 to the triangle $A''_1B''_1C''_1$ and determine of point K''_1 . Segment $D''_1 K''_1$ is shown shortest distance between point D and triangle ABC, so it is true length of DK. We extend the projections of the DK segment on the horizontal and frontal views are used the projection lines.

Second step is determining of true size of triangle ABC. We chose to take another auxiliary plane projection from the horizontal view and parallel to $A''_1B''_1C''_1$. Axis of the second plane is called X2. Then, we project the end points of the triangle $A''_1B''_1C''_1$ onto the auxiliary plane, as with all projections we assume a position at infinity, perpendicular to the plane, so all points are projected onto the plane at right angles.

We chose to take an auxiliary projection from the horizontal view. For example, we take a distance from point A''_1 to X2 and put it on second auxiliary plane. Projection of triangle $A'_2B'_2C'_2$ is given us true size of triangle ABC.

2.3 Example of the task 2



2.4 Variants for tasks 1 and 2

Variants	Data	Variants	Data	Variants	Data	Variants	Data
1	A(40,5,55) B(0,70,10) C(65,40,0) D(70,50,60)	9	A(55,0,30) B(0,20,60) C(5,55,15) D(35,35,50)	17	A(40,65,20) B(0,10,50) C(55,20,40) D(20,0,30)	25	A(30,55,5) B(75,10,50) C(5,0,20) D(0,35,65)
2	A(20,0,20) B(75,20,50) C(90,60,0) D(50,50,45)	10	A(45,55,10) B(0,25,35) C(60,10,60) D(80,30,0)	18	A(70,20,20) B(25,50,0) C(0,10,50) D(60,40,45)	26	A(0,10,55) B(15,60,10) C(70,30,15) D(60,55,40)
3	A(85,20,80) B(25,40,20) C(90,70,30) D(70,10,10)	11	A(45,0,60) B(80,45,15) C(15,10,10) D(10,60,55)	19	A(0,15,40) B(60,60,75) C(85,45,10) D(50,5,46)	27	A(25,30,30) B(65,10,50) C(10,20,90) D(0,55,45)
4	A(85,42,0) B(25,62,20) C(0,10,40) D(35,35,58)	12	A(0,65,0) B(15,20,50) C(90,10,20) D(60,50,45)	20	A(35,70,0) B(60,40,20) C(20,25,45) D(70,85,50)	28	A(85,0,65) B(60,65,10) C(0,30,20) D(50,35,70)
5	A(10,20,25) B(55,50,10) C(80,0,65) D(40,50,45)	13	A(25,30,50) B(65,50,10) C(10,60,40) D(0,30,15)	21	A(25,5,70) B(65,30,30) C(0,45,25) D(45,65,80)	29	A(70,5,65) B(10,20,30) C(50,50,20) D(20,65,10)
6	A(65,25,70) B(0,40,40) C(90,70,15) D(15,70,100)	14	A(88,50,10) B(62,0,60) C(20,0,30) D(28,34,50)	22	A(25,15,60) B(65,50,15) C(0,80,10) D(50,75,50)	30	A(50,5,70) B(10,30,30) C(75,40,20) D(20,65,75)
7	A(40,70,5) B(0,30,30) C(65,25,45) D(20,80,65)	15	A(0,50,10) B(25,40,60) C(70,5,30) D(60,35,70)	23	A(70,25,5) B(15,55,35) C(20,5,50) D(50,75,40)		
8	A(42,72,0) B(0,32,33) C(75,40,55) D(15,65,60)	16	A(105,0,95) B(80,75,30) C(0,30,15) D(5,70,100)	24	A(15,70,0) B(60,40,20) C(0,25,45) D(35,75,60)		

3 SURFACES. INTERSECTION OF 2 SURFACES

- 3.1 The requirement to the task 3
- 3.2 Order of the task 3
- 3.3 Intersection of prism and pyramid
- 3.4 Example of the task 3
- 3.5 Variants for the task 3

3.1 The requirement to the task 3

Drawing is performed on sheet of A3 format:

- condition of task – with pencil using contour lines (0,6 mm);
- projection line – pencil, thin lines (0,2 mm);
- result of the decisions – outline of red pencil.

According to the condition of task (p. 14) draw the third (profile) projection of intersection of 2 surfaces. You should determine the main points of the intersection line and construct them on three projection views and show the visibility of the intersection line and edges on all projections.

3.2 Order of the task 3

Whenever two or more solids combine, a definite curve is seen at their intersection. This curve is called the line of intersection (LOI). The cases of intersection depend on the type of intersecting solids and the manner in which they intersect. Two intersecting solids may be of the same type (prism and prism) or of different types (prism and pyramid).

The type of intersection created depends on the types of geometric forms, which can be two- or three- dimensional. Intersections must be represented on drawings correctly and clearly. For example, when a conical and a cylindrical shape intersect, the type of intersection that occurs depends on their sizes and on the angle of intersection relative to their axes as well as relative position of their axes [1].

Use the line method to solve the problem. A number of lines are drawn on the lateral surface of one of the solids and in the region of the line of intersection. Points of intersection of these lines with the surface of the other solid are then located. These points will lie on the required line of intersection. They are more easily located from the view in which the lateral surface of the second solid appears edgewise (i.e. as a line). The curve drawn through these points will be the line of intersection.

3.3 Intersection examples of 2 surfaces

Intersection of prism and pyramid

A square prism stands on its base on the HP with the perpendicular faces to the FP. The prism is intersected completely by the triangular pyramid. No one of the lateral faces of the prism is perpendicular to the HP. Draw the line of intersection of the solids (Fig. 3.1).

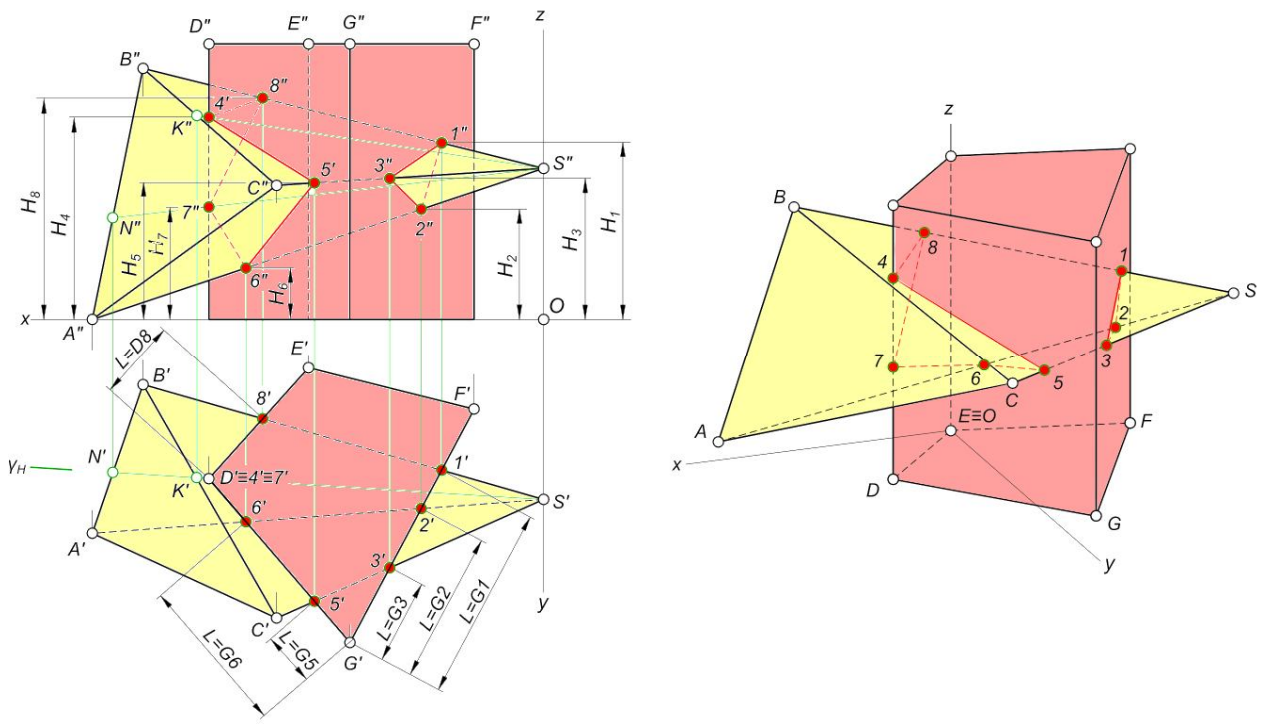


Figure 3.1 – Intersection of prism and pyramid

Intersection of cylinder and cone

A vertical cylinder with diameter D and high H is intersected by a cone with diameter D_1 and high H_1 , the axis of which is perpendicular to the axis of the cylinder. Draw their projections showing curves line of intersection (Fig. 3.2).

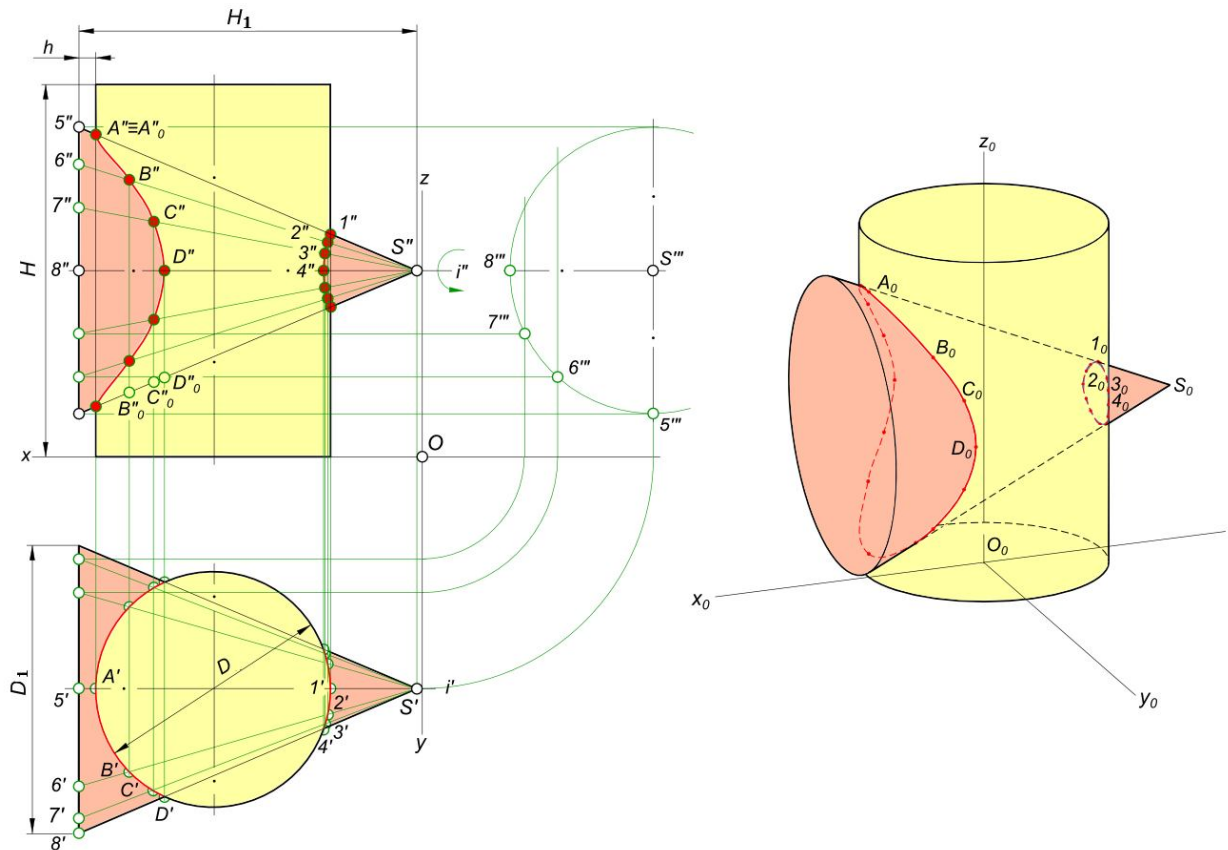


Figure 3.2 – Intersection of cone and cylinder

3.4 Example of the task 3

Algorithm of the task

1. Determine the type of surfaces and their position relative to projection planes (which of the surfaces is projective).
2. Identify the main points.
3. Construct missing projections of the main points of the intersection line as points belonging to the surface.
4. Identify visible and invisible sections of the intersection of surfaces on all projection planes (Fig. 3.3).

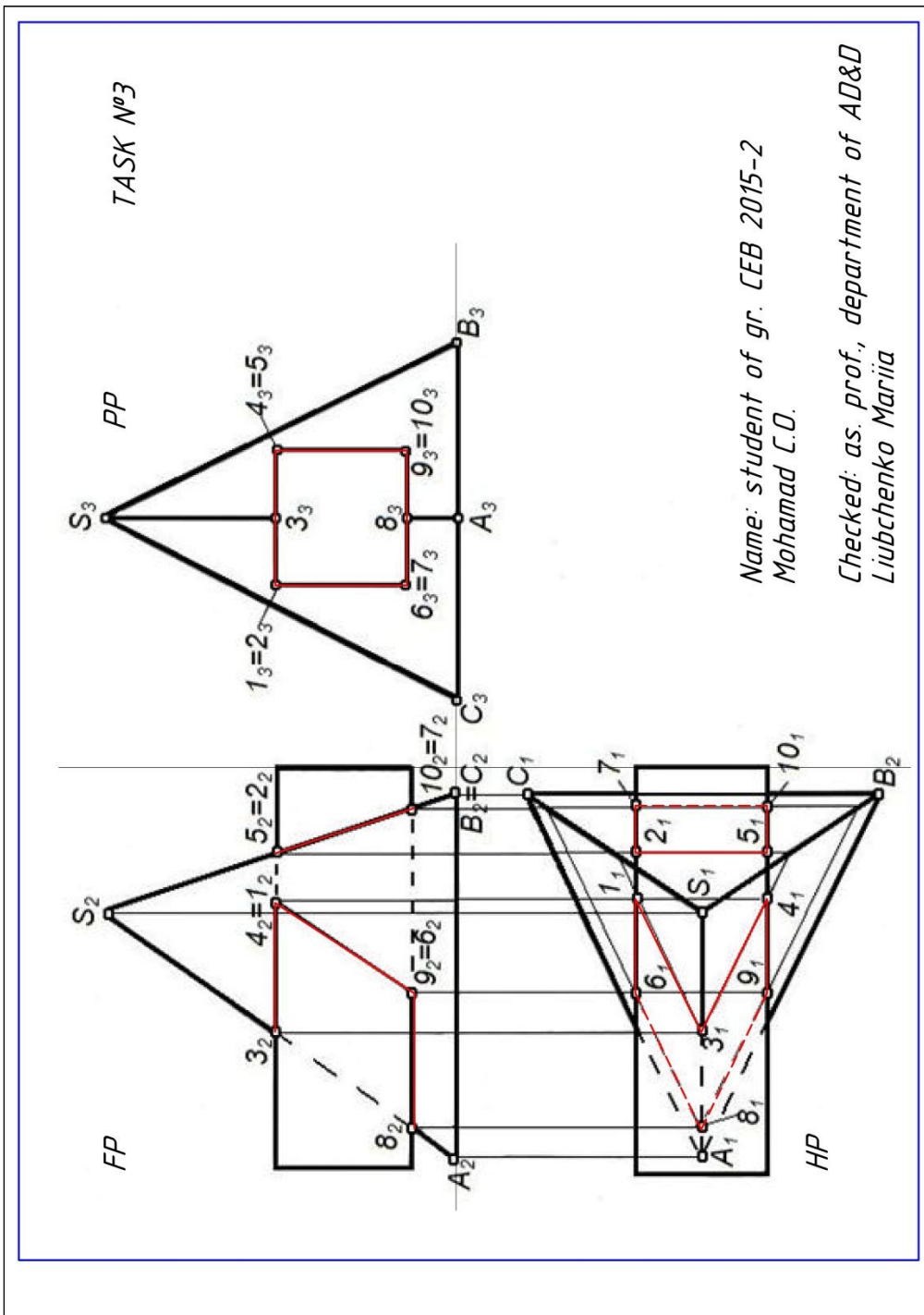
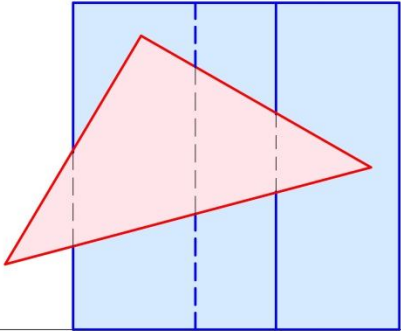
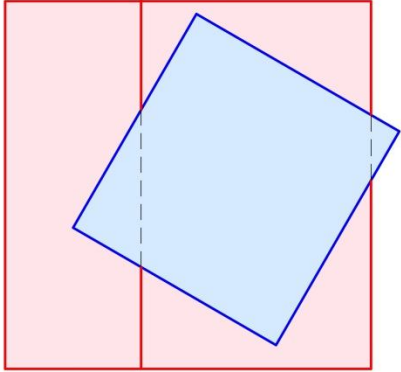
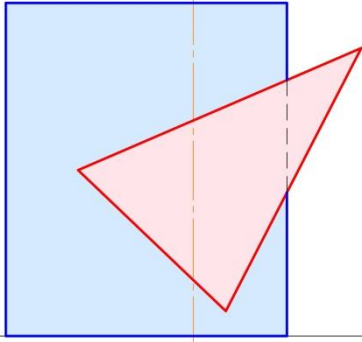
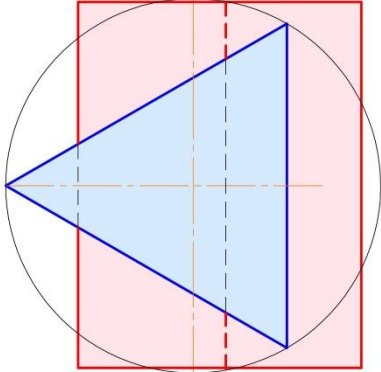
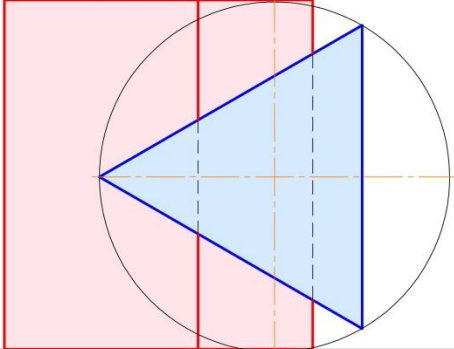
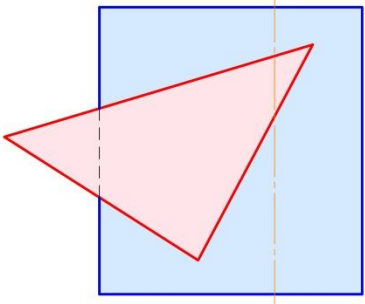
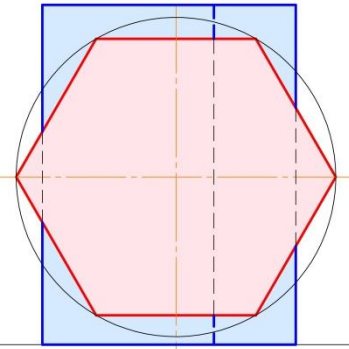
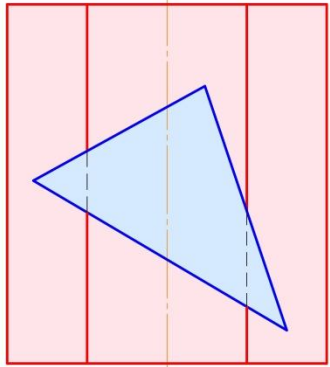
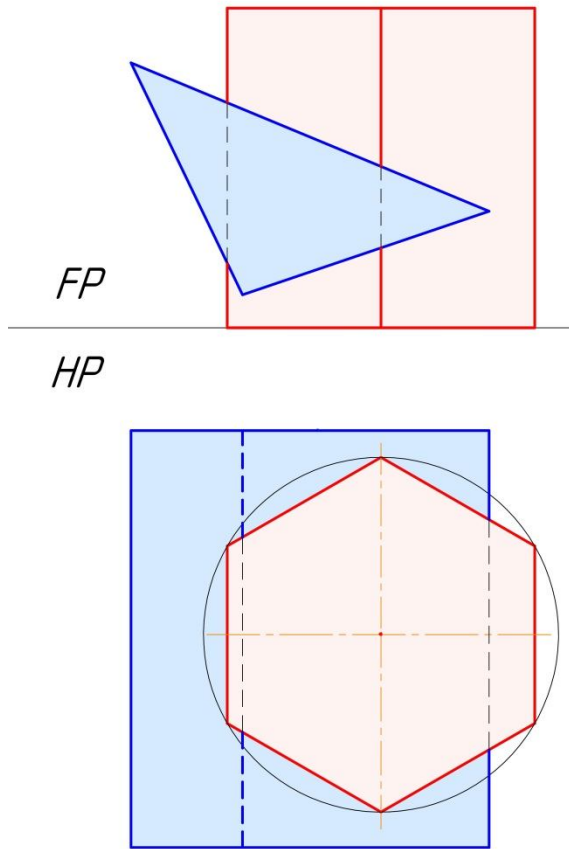


Figure 3.3 – Example of task 3. Intersection of prism and pyramid

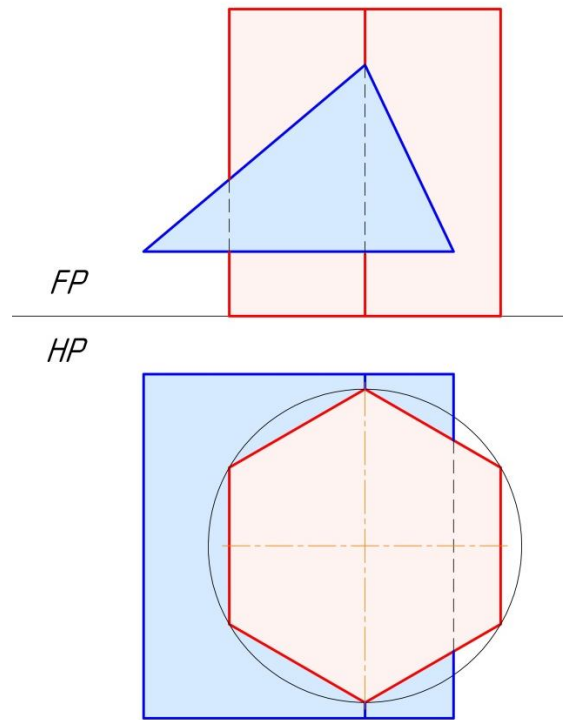
3.5 Variants for the task 3

Variant 1	Variant 2
<p data-bbox="212 629 264 667"><i>FP</i></p>  <p data-bbox="212 712 264 750"><i>HP</i></p> 	<p data-bbox="868 629 920 667"><i>FP</i></p>  <p data-bbox="868 712 920 750"><i>HP</i></p> 
Variant 3	Variant 4
<p data-bbox="188 1608 240 1646"><i>FP</i></p>  <p data-bbox="188 1682 240 1720"><i>HP</i></p> 	<p data-bbox="868 1608 920 1646"><i>FP</i></p>  <p data-bbox="868 1682 920 1720"><i>HP</i></p> 

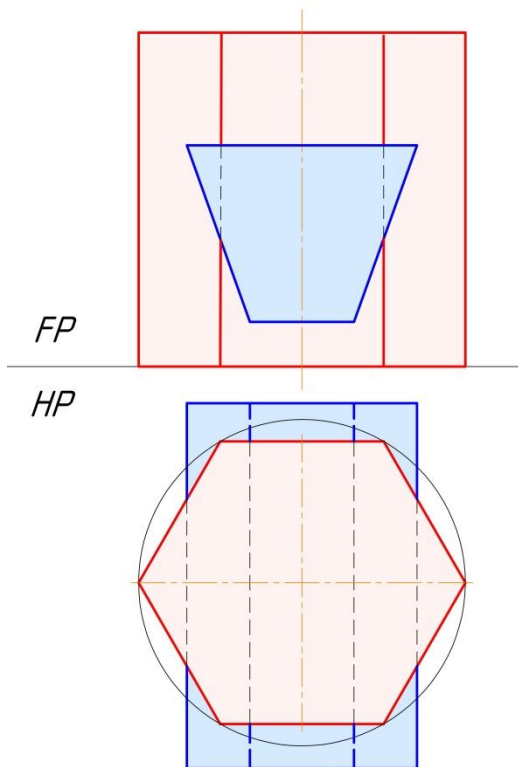
Variant 5



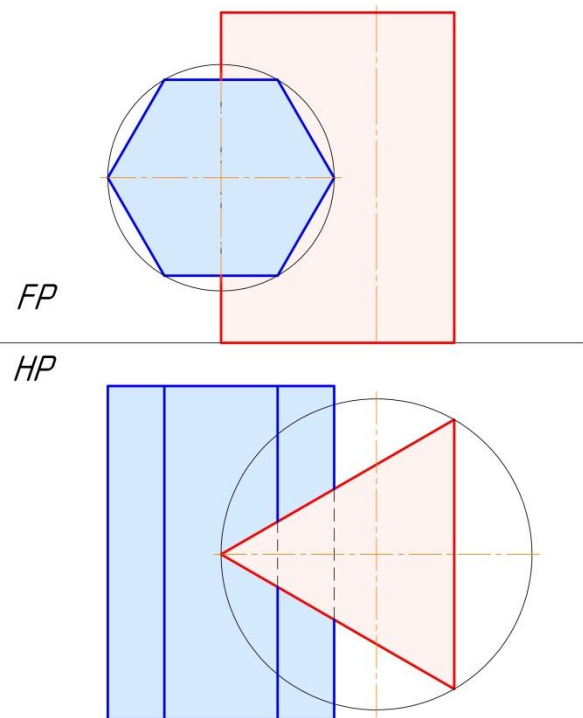
Variant 6



Variant 7



Variant 8



4 MULTIVIEW DRAWINGS

4.1 The requirement to the task 4

4.2 Basic information about multiview drawings

4.3 Intersection of prism and pyramid

4.4 Example of the task 4

4.5 Variants for the task 4

4.1 The requirement to the task 4

The drawing is executed on sheet of A3 format:

- condition of task – with pencil using contour lines (0,6 mm);
- projection line – with pencil using thin lines (0,2 mm);
- result of the decisions – with pencil using contour lines (0,6 mm) and hidden lines (0,3 mm).

According to the criterion of the task (p. 27) draw the third view with cut of solid. You should determine the main points of the cut line and construct them on three views, show the visibility of the intersection line and edges of solid on all views. Draw isometric view of solid.

4.2 Basic information about multiview drawings

Views

A system that allows you to make a two-dimensional drawing of a three-dimensional object is multiview drawings. Lines of solid are formed on the planes by projecting the edges of the object onto the planes. These images are called “views”.

A box is formed by six mutually perpendicular planes of projection that are located around the object. There are six views formed by the planes of a box (Fig. 4.1).

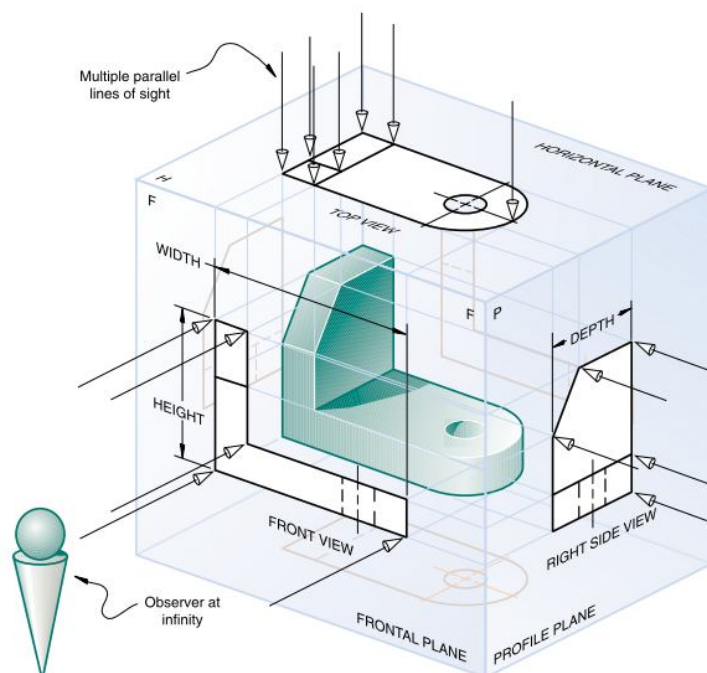


Figure 4.1 – Object suspended in a glass box

Unfolding the box to produce arrangement of the six views (Fig. 4.2).

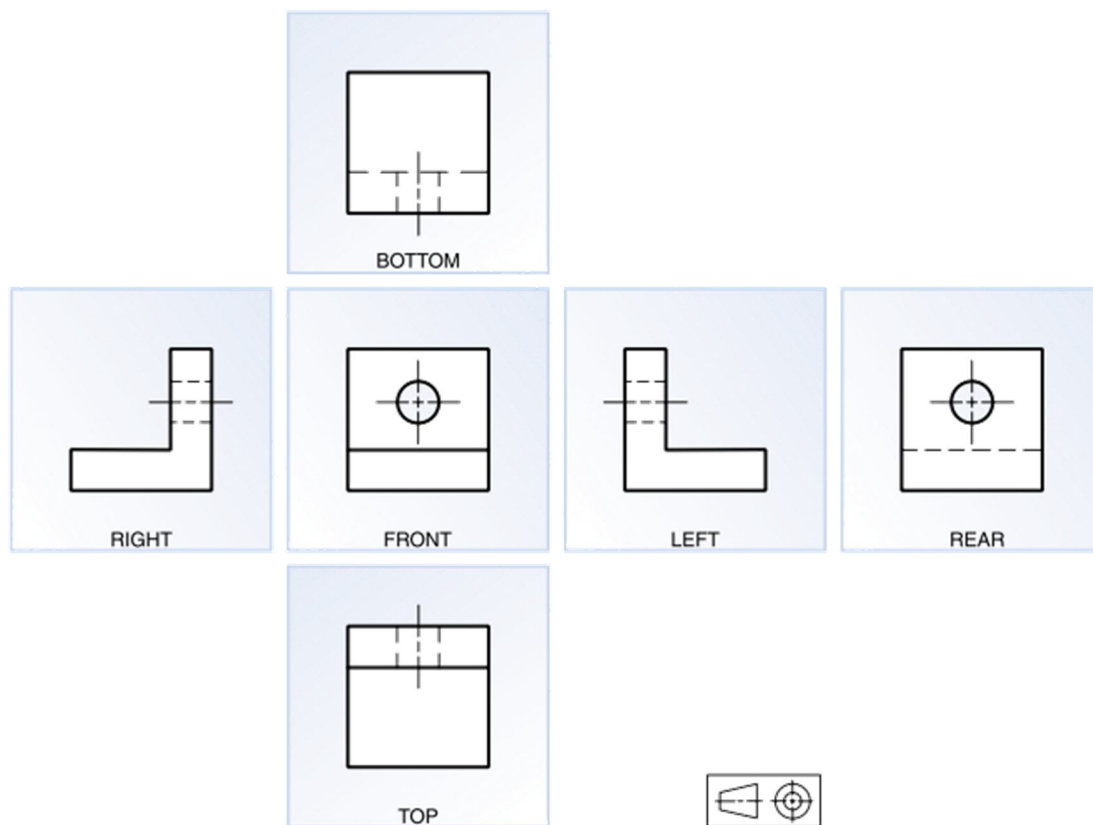


Figure 4.2 – Unfolding the glass box to produce six views

In multiview drawings, generally three views of an object are drawn, and the features and dimensions in each view accurately represent those of the object. The views are defined according to the positions of the planes of projection with respect to the object [2].

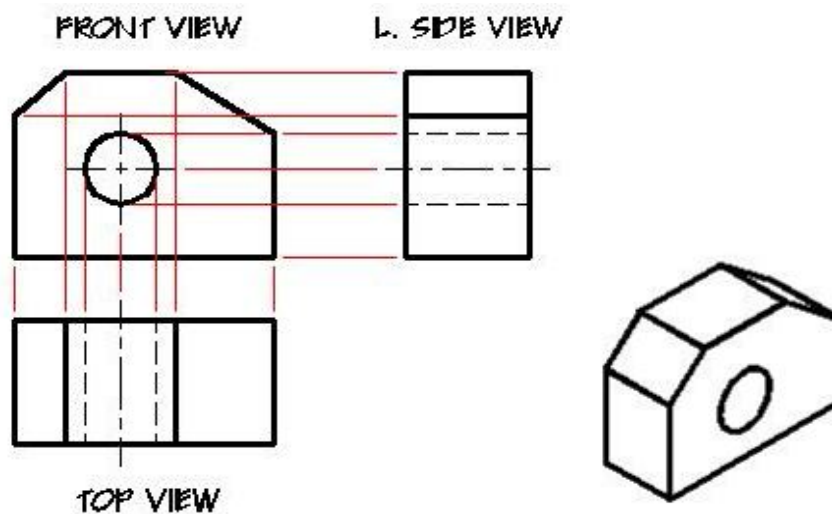


Figure 4.3 – Three views of the object

Paper sizes

Depending on the size of the object, it is placed on standard drawing sheets. The International Standards Organization (ISO) system of paper sizes applies to all grades of paper and paper board and consists of five series of sizes: A, RA, SR, B, and C (Table 4.1).

Table 4.1 – The width and height of ISO A, B and C paper formats

A sizes (mm)		B sizes (mm)		C sizes (mm)	
4A0	1682 x 2378				
2A0	1189 x 1682				
A0	841 x 1189	B0	1000 x 1414	C0	917 x 1297
A1	594 x 841	B1	707 x 1000	C1	648 x 917
A2	420 x 594	B2	500 x 707	C2	458 x 648
A3	297 x 420	B3	353 x 500	C3	324 x 458
A4	210 x 297	B4	250 x 353	C4	229 x 324
A5	148 x 210	B5	176 x 250	C5	162 x 229
A6	105 x 148	B6	125 x 176	C6	114 x 162
A7	74 x 105	B7	88 x 125	C7	81 x 114
A8	52 x 74	B8	62 x 88	C8	57 x 81
A9	37 x 52	B9	44 x 62	C9	40 x 57
A10	26 x 37	B10	31 x 44	C10	28 x 40

By placing two sheets of A series paper next to each other, or by cutting one in half parallel to its shorter side, the resulting sheet will again have the same width to height ratio (Fig. 4.4).

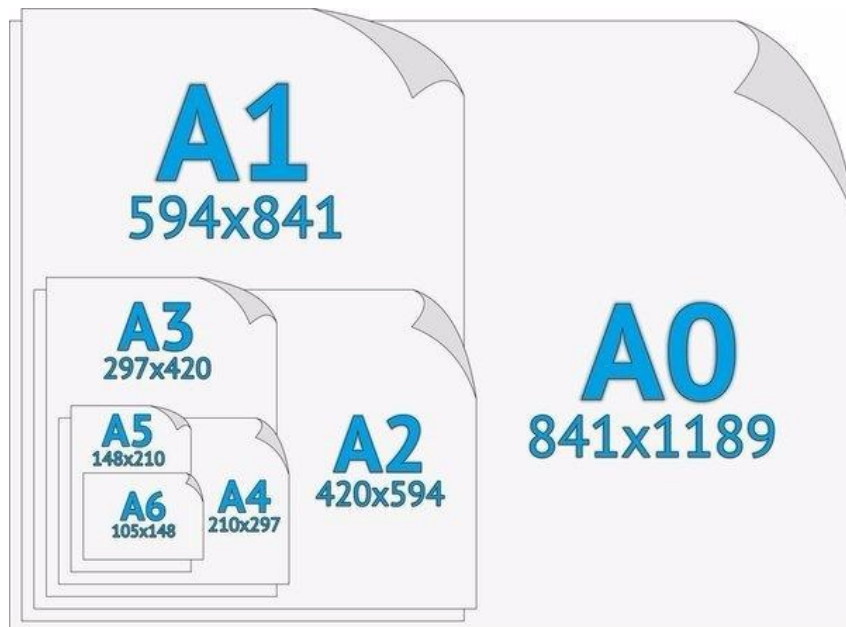


Figure 4.4 – Sheet size

There are 2 types of sheet schema location: horizontal (type X) and frontal (type Y) orientations (Fig. 4.5).

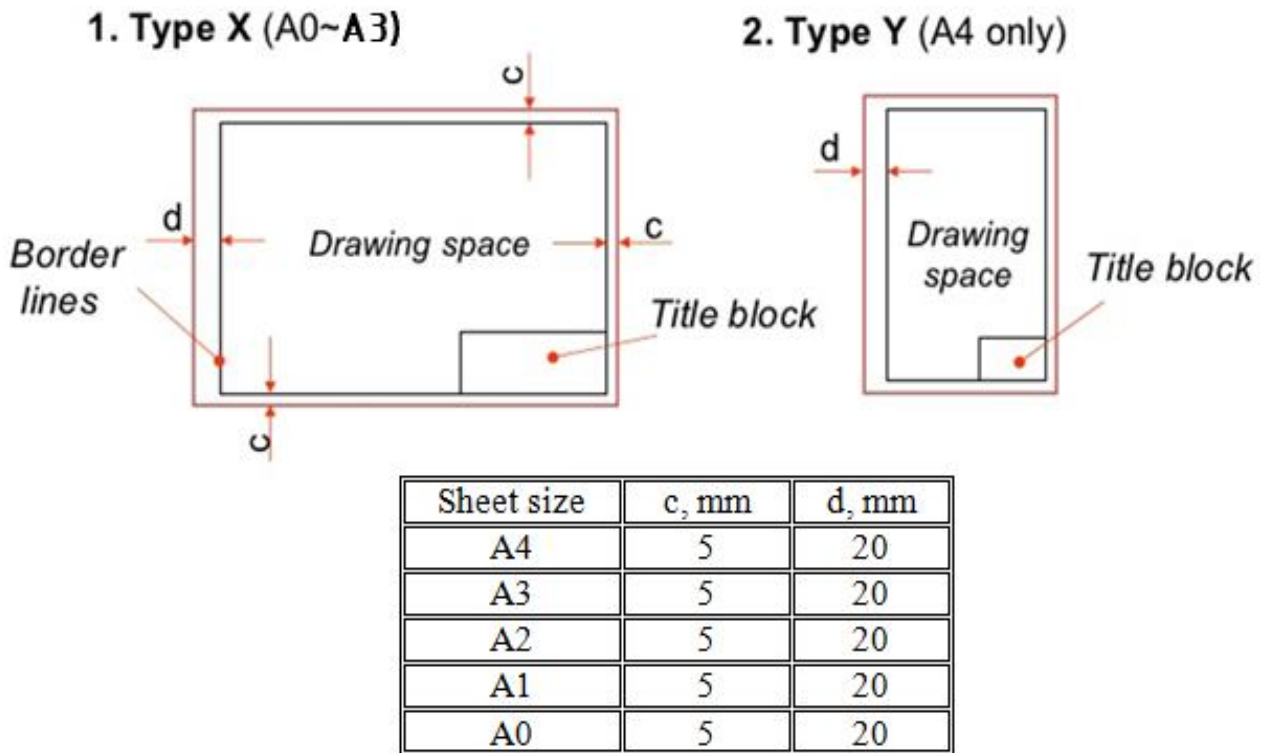


Figure 4.5 – Types of sheets location

The title block is placed in bottom right corner of the drawing sheet (Fig. 4.6).

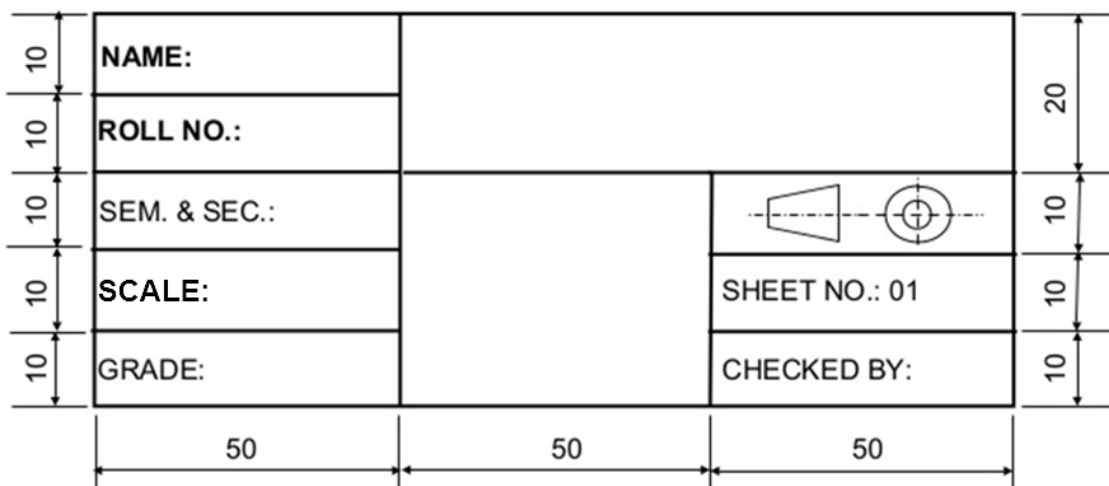


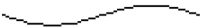
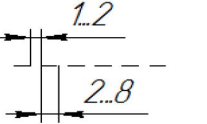

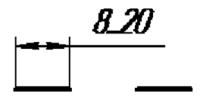



Figure 4.6 – Title block

Basic line types

Line types used in technical drawing are used for different purposes to provide specific information to the people looking at the drawing (Table 4.2).

Table 4.2 – The line types

Line	Illustration	Thickness	Application
Continuous thick (object)		S= 0,5 – 1,4 mm Thick	Outlines, visible edges, surface boundaries of objects
Continuous thin		S/3 – S/2 Thin	Dimensions, leader, extensional
Shot break (Continuous thin free hand)		S/3 – S/2 Thin	Limits of partial views or sections when the line is not an axis, interrupted views and sections
Hidden		S/3 – S/2 Thin	Hidden outlines and edges
Center		S/3 – S/2 Thin	Centerlines, lines of symmetry
Chain		S – 1,5 S Extra thick	Cutting planes
Long break with zig-zag		S/3 – S/2 Thin	Indicate of long break

Technical drawing lines are used for different purposes to provide specific information for designers, manufacturers, etc. looking at the drawing. The person who will read drawings have to learn what they mean. Line types are also a language type to communicate between technical people.

Axonometric drawing

Axonometric projection is one of the four principal projection techniques: multiview, axonometric, oblique and perspective projection. In multiview, axonometric, and oblique projections, the observer is theoretically infinitely far away from the projection plane. In addition, the lines of sight are parallel to each other and perpendicular to the plane of projection. The main difference between a multiview drawing and an axonometric drawing are that, in a multiview, only two dimensions of an object are visible in each view and hence more than one view is required to define

In trimetric projection, the direction of viewing is such that all of the three axes of space appear unequally foreshortened. The scale along each of the three axes and the angles among them are determined separately as dictated by the angle of viewing. Trimetric perspective is seldom used.

In dimetric projection, the direction of viewing is such that two of the three axes of space appear equally shortened, of which the attendant scale and angles of presentation are determined according to the angle of viewing; the scale of the third direction (vertical) is determined separately. When two of the three angles are equal, the drawing is classified as a dimetric projection. Dimetric drawings are less pleasing to the eye, but are easier to produce than trimetric drawings [2].

In isometric projection, the most commonly used form of axonometric projection in engineering drawing. Here all three angles are equal. The isometric is the least pleasing to the eye, but is the easiest to draw and dimension [3, 4].

Examples of the arrangement of the axonometric axes of isometric projection (Fig. 4.9) and dimetric projection (Fig. 4.10) are illustrated.

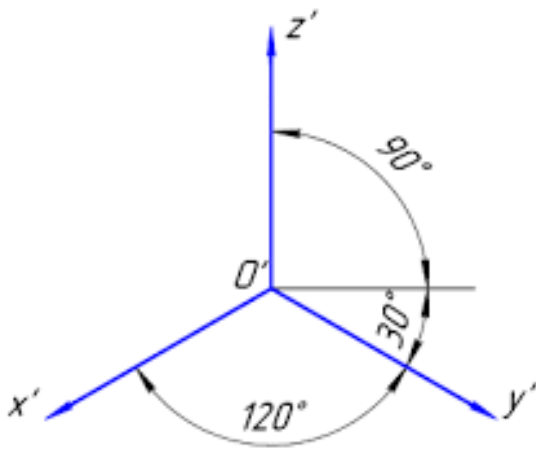


Figure 4.9 – Axes of isometric projection

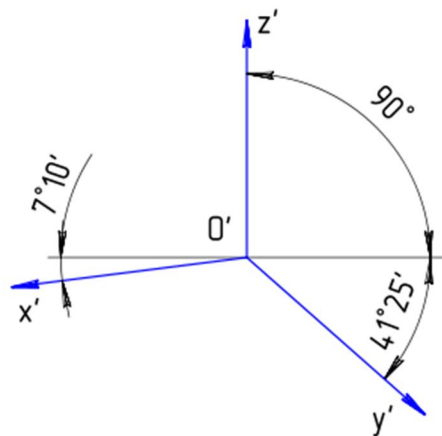


Figure 4.10 – Axes of dimetric projection

Multiview drawing of tetrahedral pyramid is illustrated in Figure 4.11.

The construction steps isometric projection and dimetric projection of it are shown in Table 4.3.

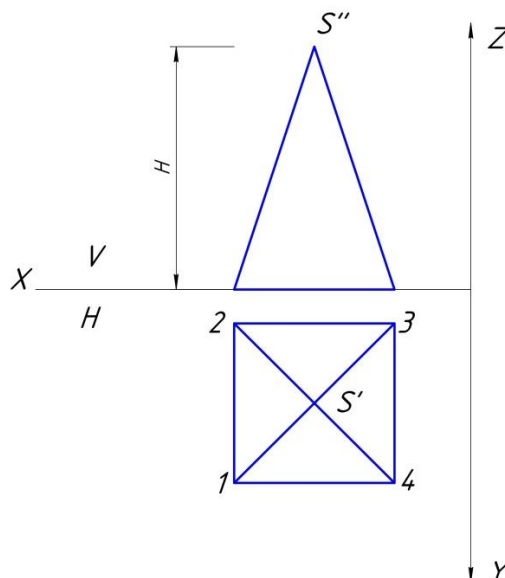
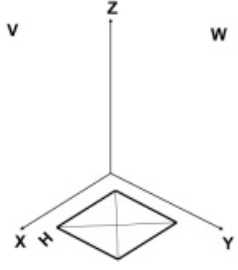
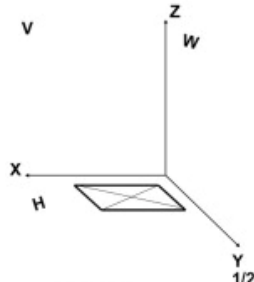
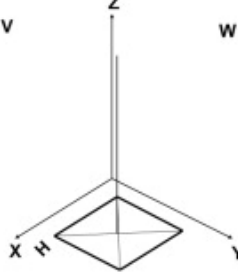
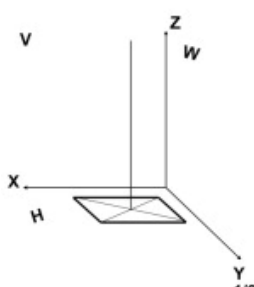
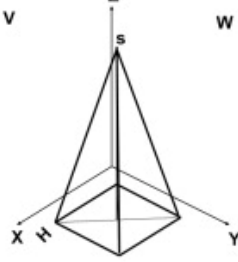
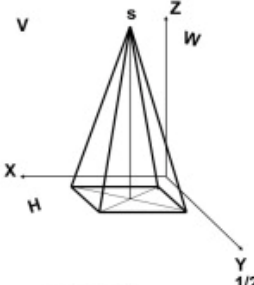
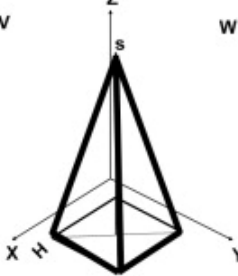
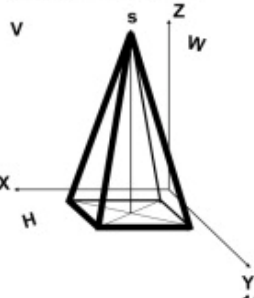


Figure 4.11 – Multiview drawing of tetrahedral pyramid

Table 4.3 – The order of constructing isometric and dimetric projection of pyramid

Step	Isometric projection	Dimetric projection
1. Base		
2. Height		
3. Connect the base points to the vertex S		
4. Outline the visible contours of the pyramid using thick line		

Multiview drawing of hexagonal prism is illustrated in Figure 4.12.

The construction steps isometric projection and dimetric projection of it are shown in Table 4.4.

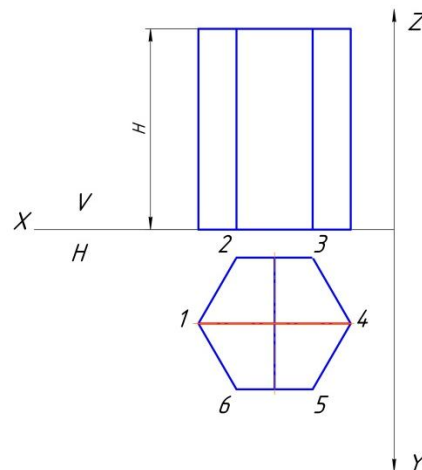
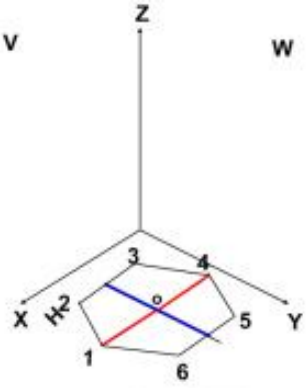
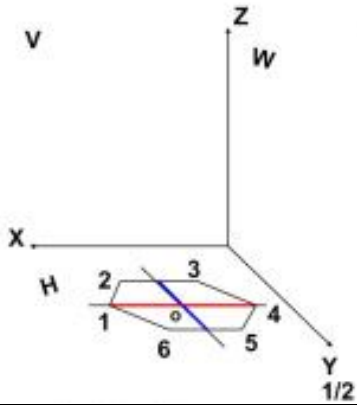
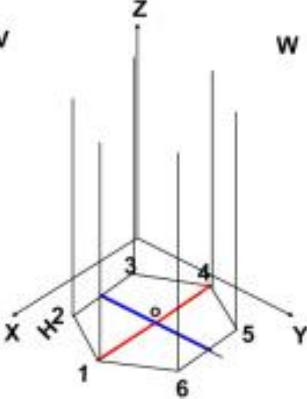
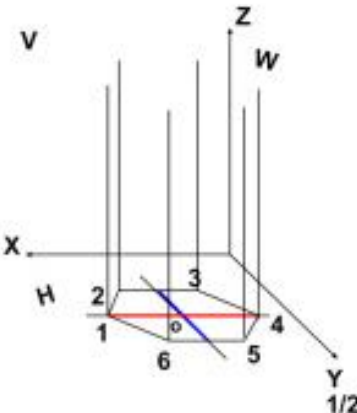
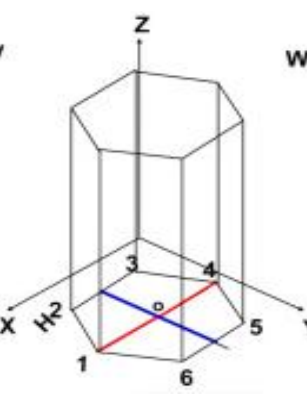
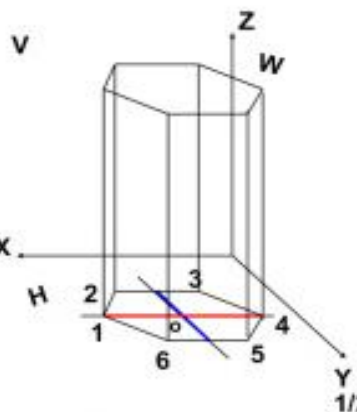
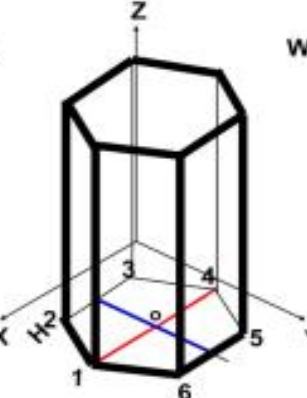
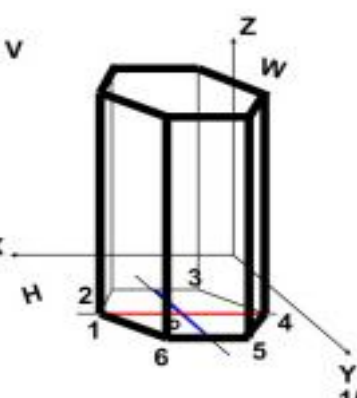


Figure 4.12 – Multiview drawing of hexagonal prism

Table 4.4 – The order of constructing isometric and dimetric projection of prism

<p>1. Base</p>		
<p>2. Height</p>		
<p>3. Connect the bottom base points to the top base points</p>		
<p>4. Outline the visible contours of the prism using thick line</p>		

4.3 Procedure of the task 4

In the sheet A3 format of the drawing paper draw the border lines and the title block.

1. Contours of the main images are applied with thin lines. Draw of the condition of the problem from the top view. All geometric shapes of base are regular polygons inscribed in a circle.

2. Then build a front view of the given sizes. Draw a left view of solid.

Perform cut on the front view. Then draw a contour cut of solid in the front and the left views. For the visible contour is used a continuous thick line, a line of the invisible is a hidden line.

3. Conduct dimensional lines. Dimensions are applied in the following order: dimensional, position elements of the details and shape of elements (Fig. 4.13).

4. Draw isometric view.

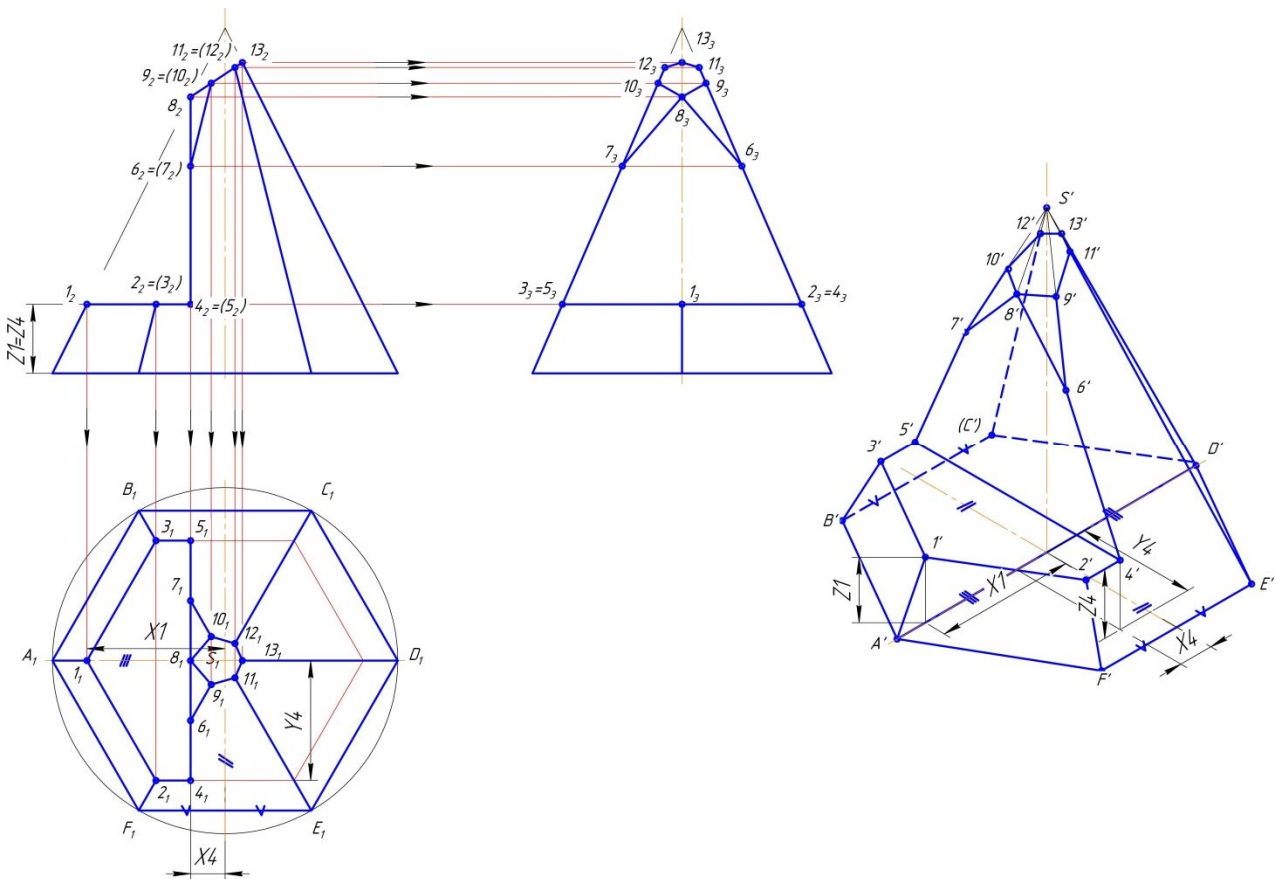
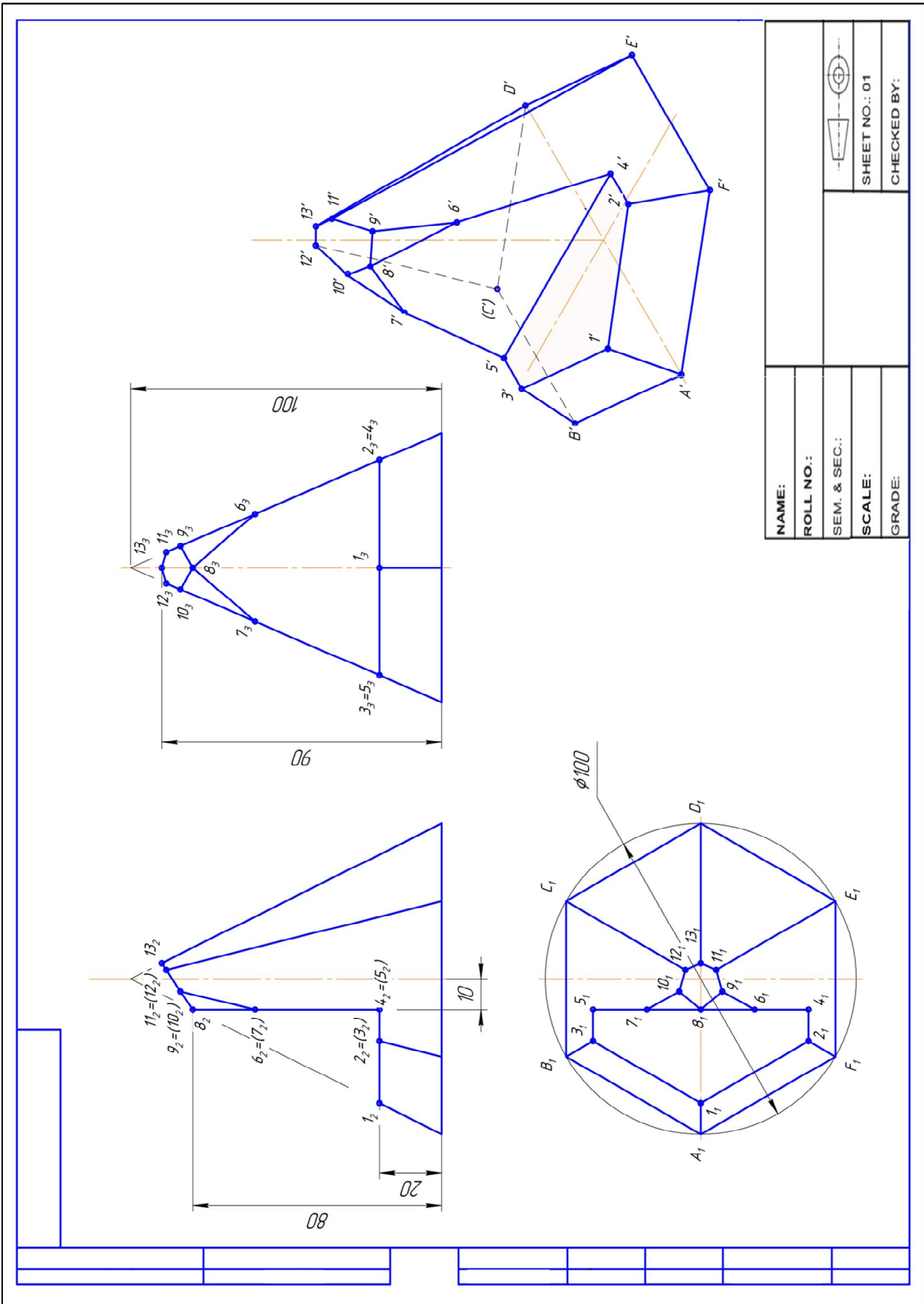


Figure 4.13 – Multiview and isometric drawings of hexagonal pyramid with cut

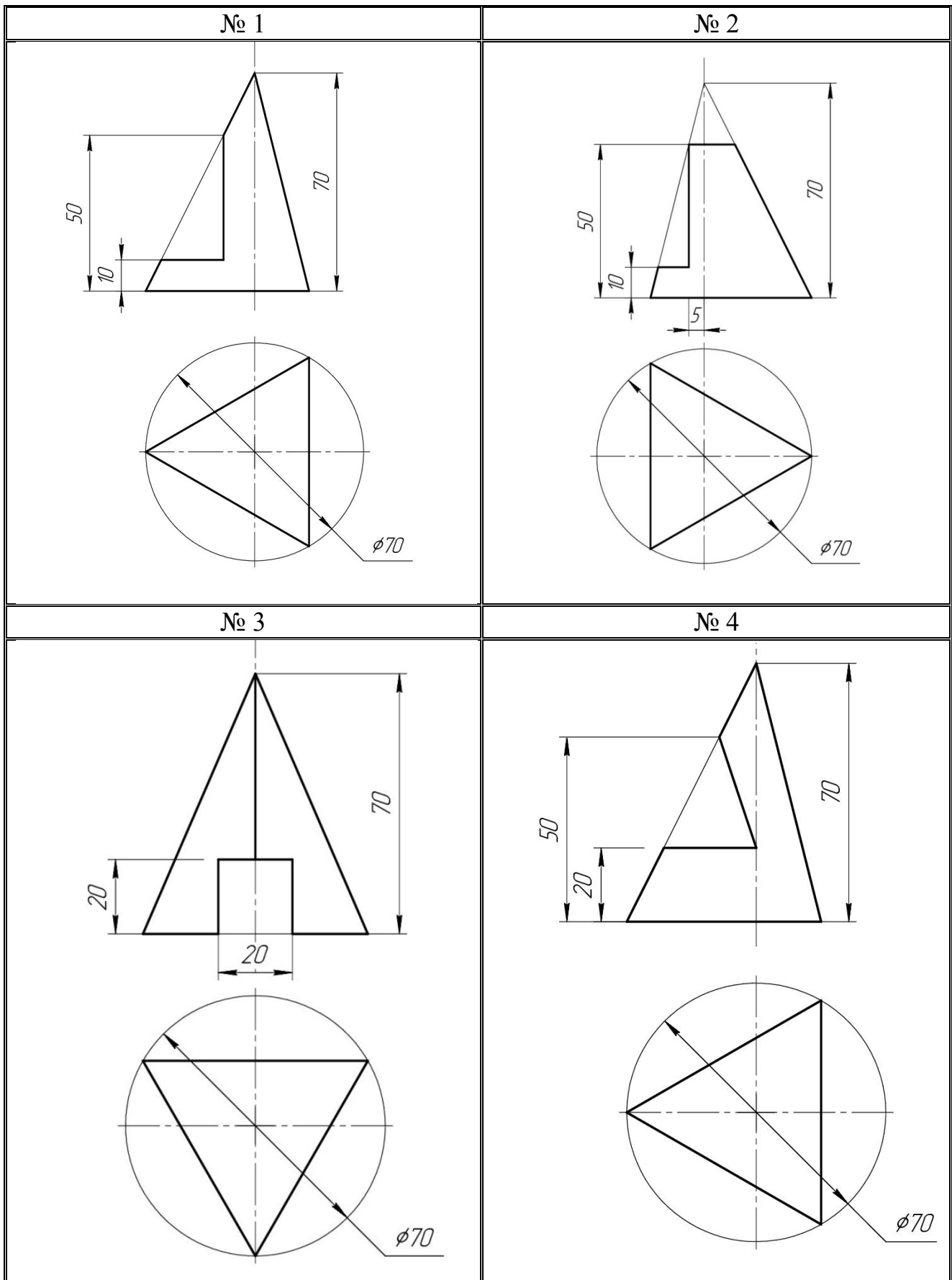
4.4 Example of the task 4



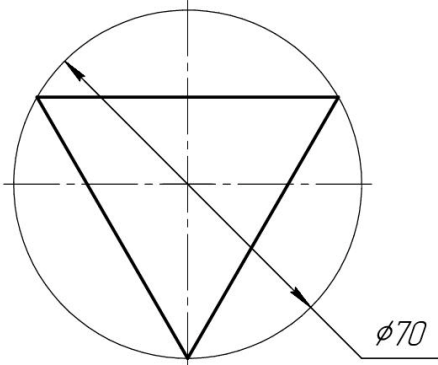
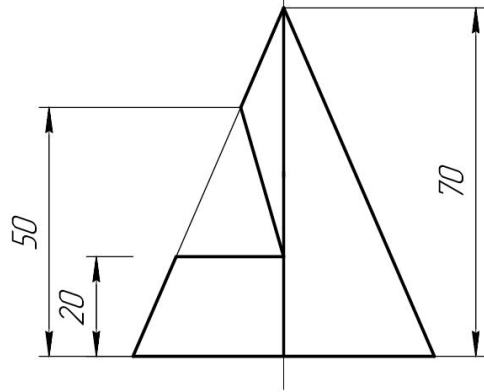
NAME:	
ROLL NO.:	
SEM. & SEC.:	
SCALE:	
GRADE:	

	SHEET NO.: 01
	CHECKED BY:

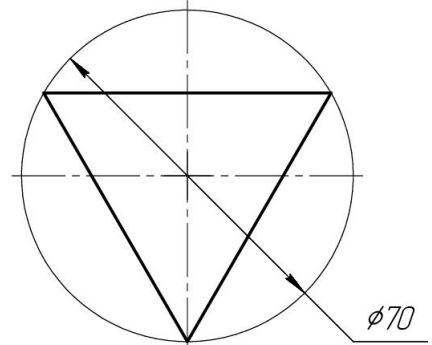
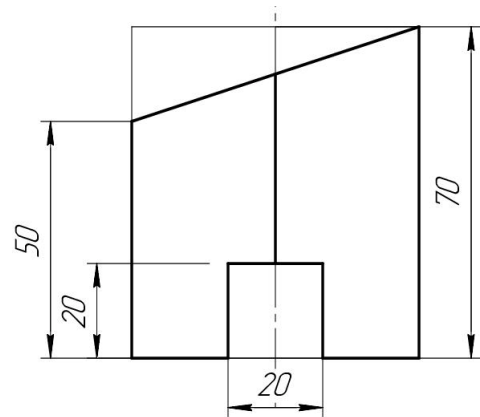
4.5 Variants for the task 4



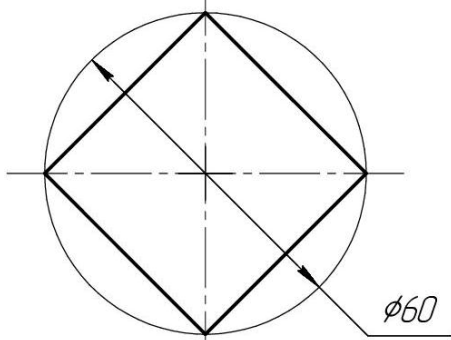
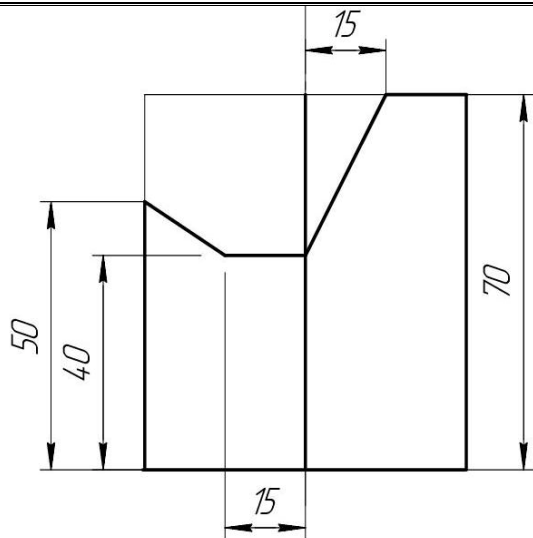
№ 5



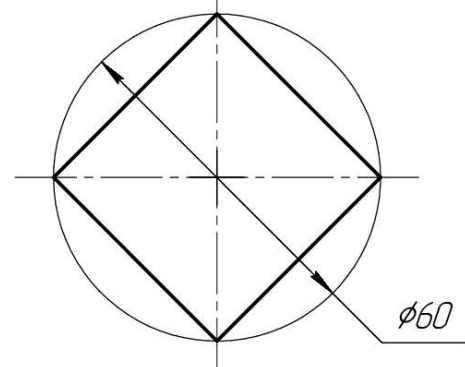
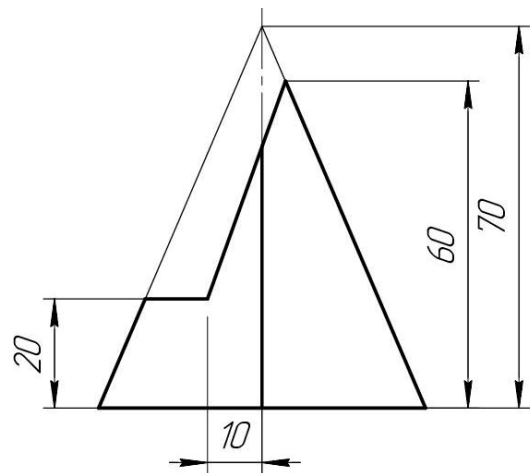
№ 6



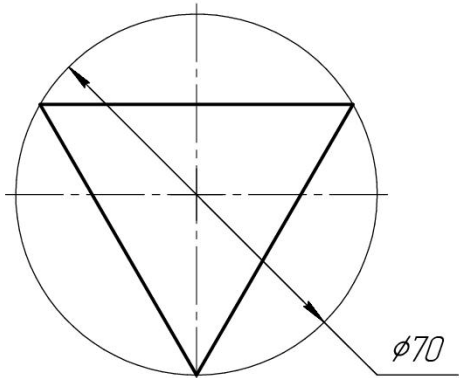
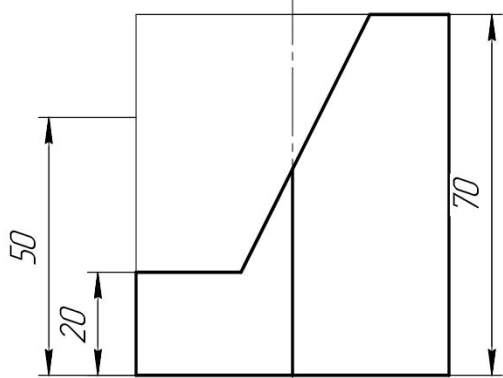
№ 7



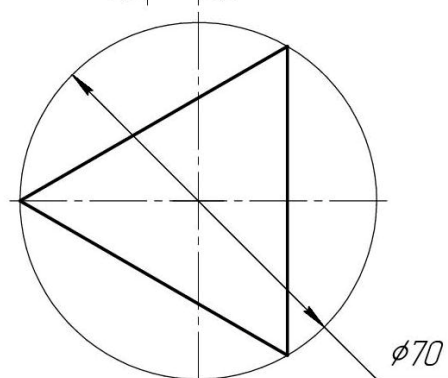
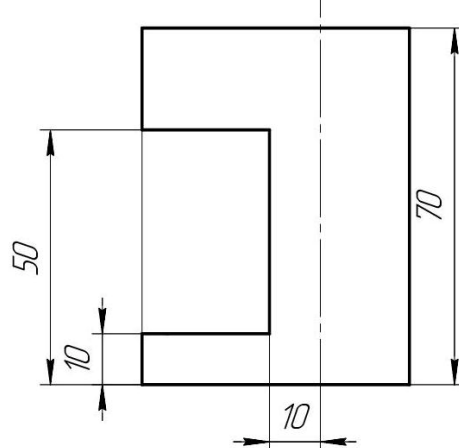
№ 8



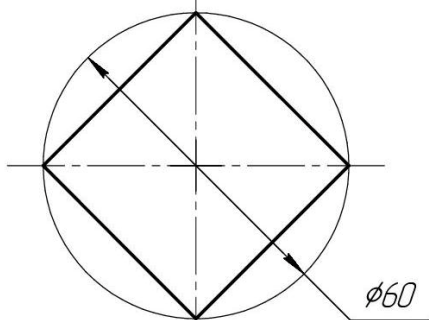
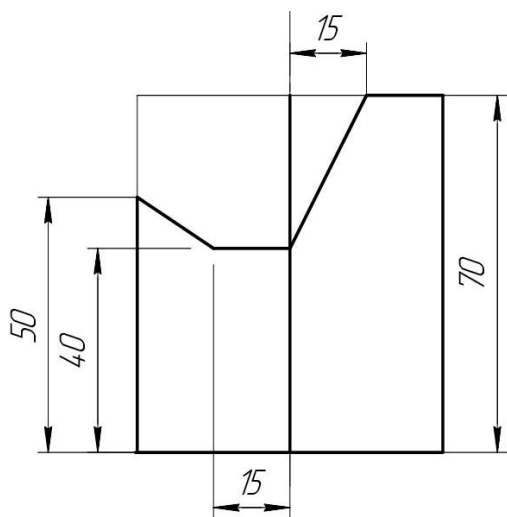
№ 9



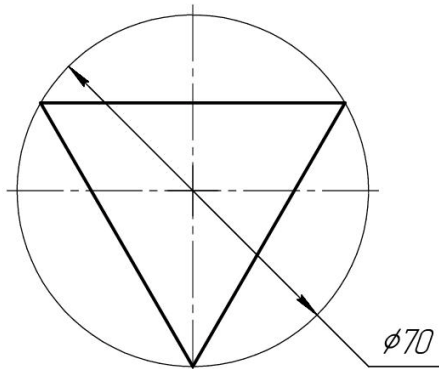
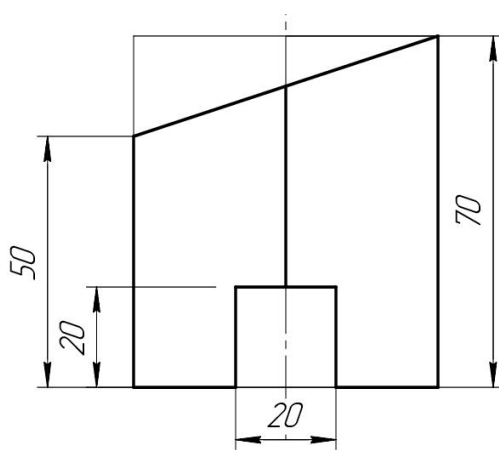
№ 10



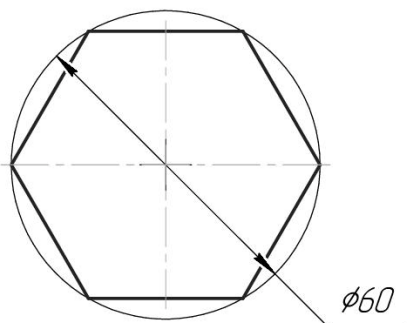
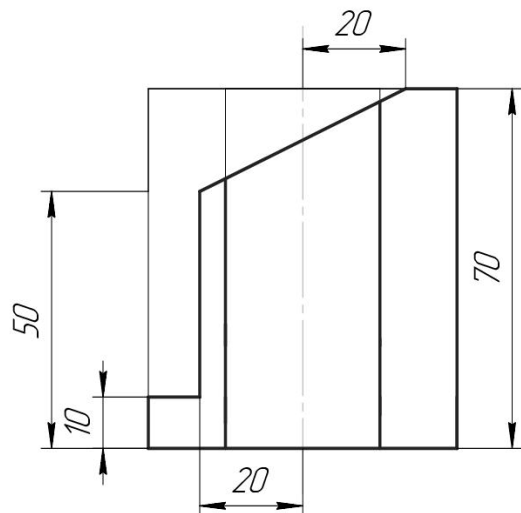
№ 11



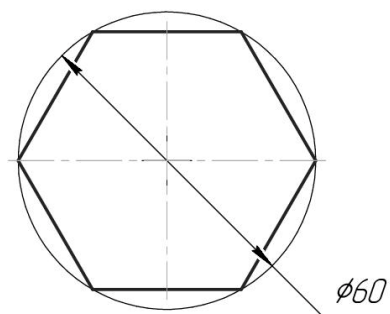
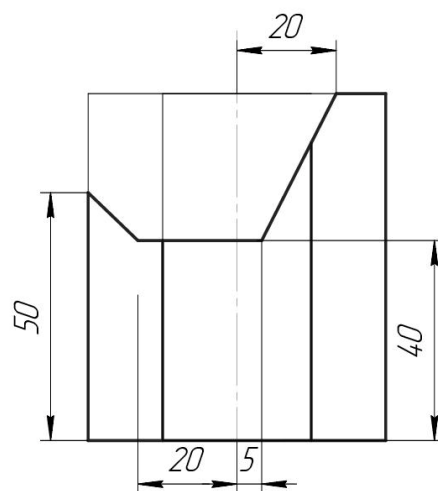
№ 12



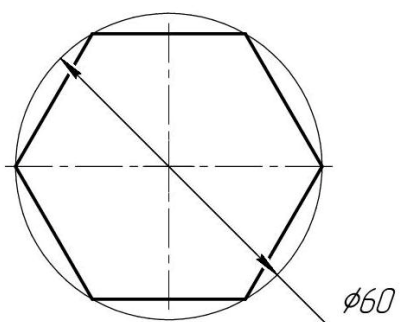
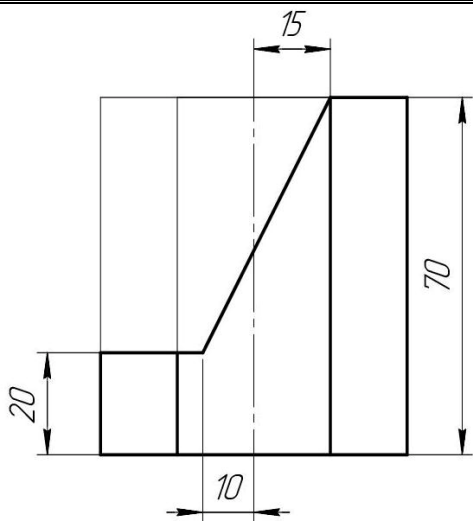
№ 13



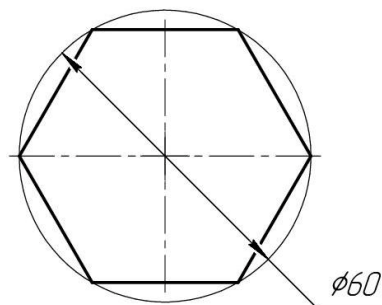
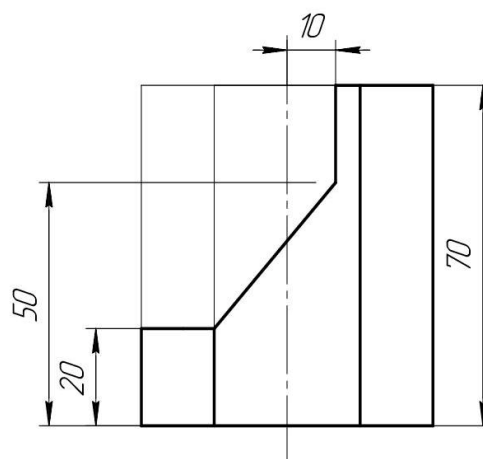
№ 14



№ 15



№ 16



5 CREATING 3D MODEL IN AUTODESK AUTOCAD

- 5.1 Interface of the program AutoCAD
- 5.2 Building of 3D model
- 5.3 Create a 2D drawing from a 3D model
- 5.4 Example of task 5
- 5.5 Variants for task 5

5.1 Interface of the program AutoCAD

Solid 3D model consists of some 3D elements formed from faces, edges, vertexes and planes. 3D solid objects can start from basic primitives, or from extruded, swept, revolved, or lofted profiles. You can combine these using Boolean operations.

Main window of AutoCAD program for 3D-modeling is illustrated in Figure 5.1.

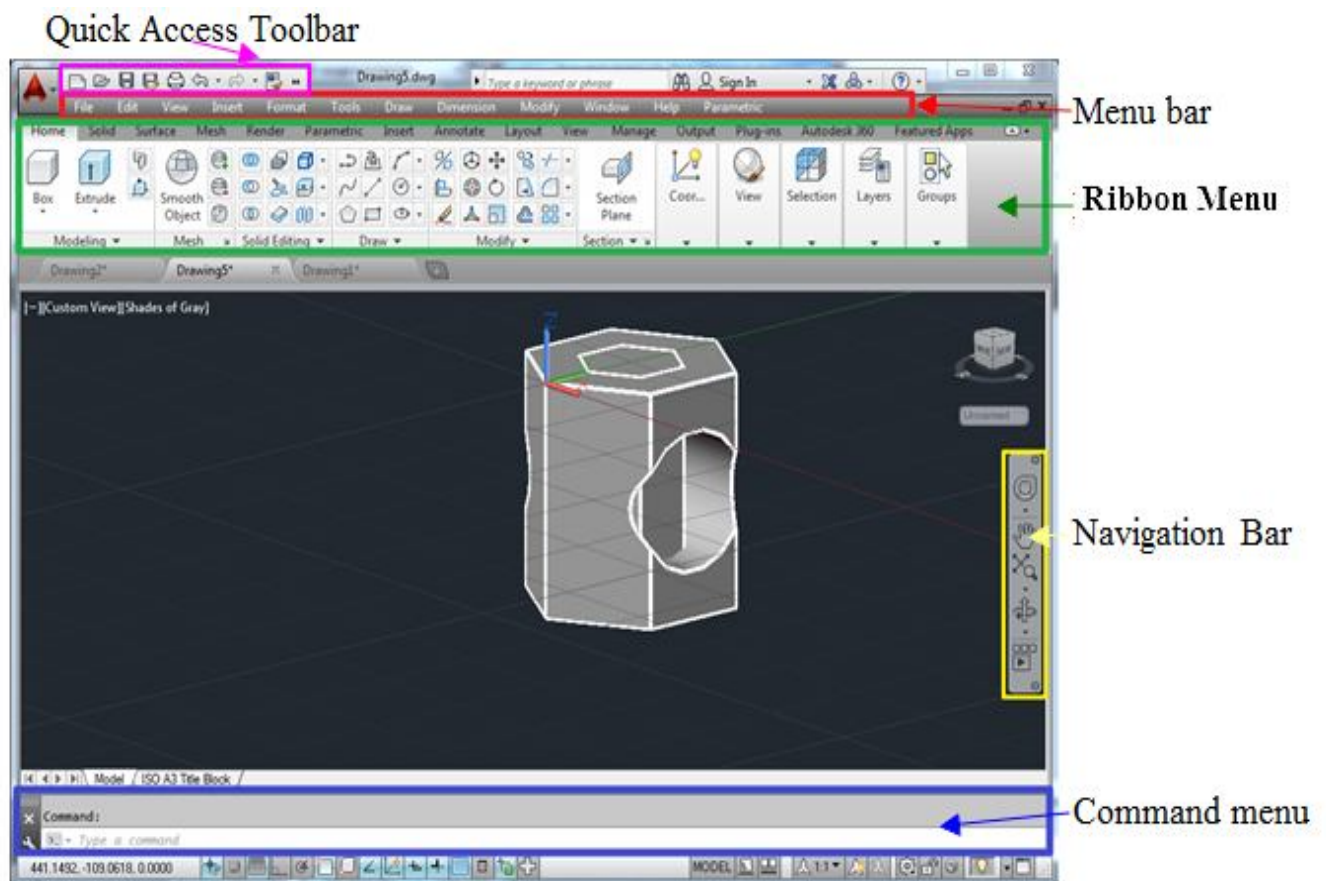


Figure 5.1 – Main window of AutoCAD program

In the **Quick Access Toolbar** you should select the 3D Modeling mode (Fig. 5.2).

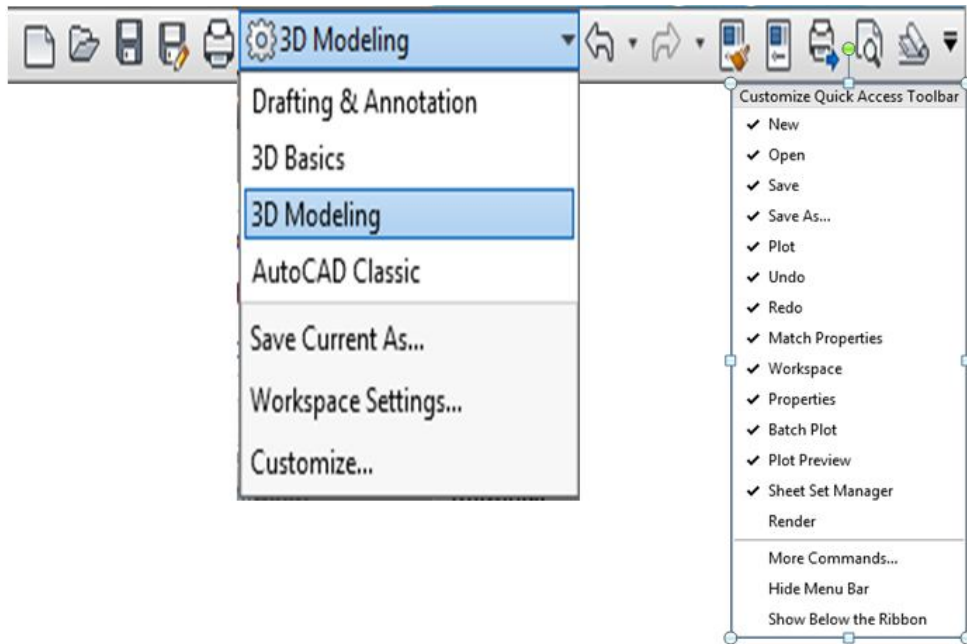


Figure 5.2 – Quick Access Toolbar

Menu Bar consists from tabs: file, edit, view, insert, format, tools and draw (Fig. 5.3).

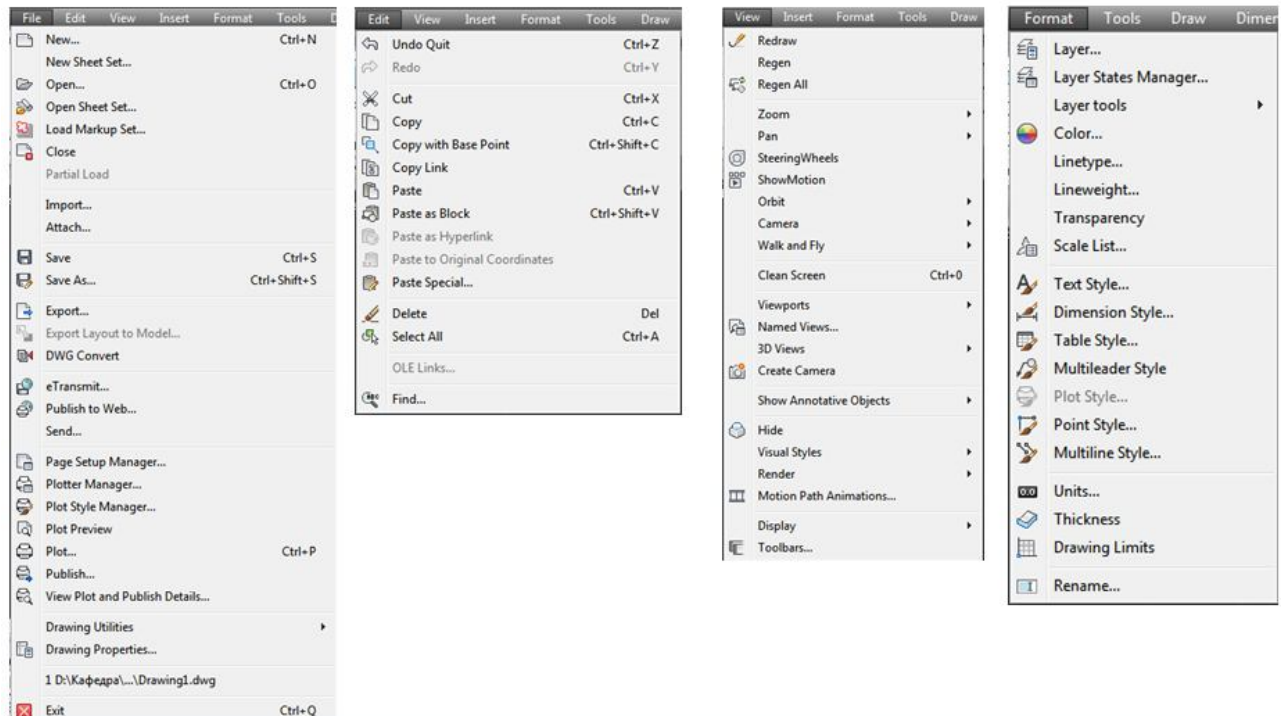


Figure 5.3 – Tabs of Menu Bar

Ribbon Menu and Panels include tabs: home, solid, surface, parametric, insert, annotate, etc (Fig. 5.4). The ribbon is composed of a series of tabs, which are organized into panels that contain many of the tools and controls available in toolbars. Some ribbon panels provide access to a dialog box related to that panel.

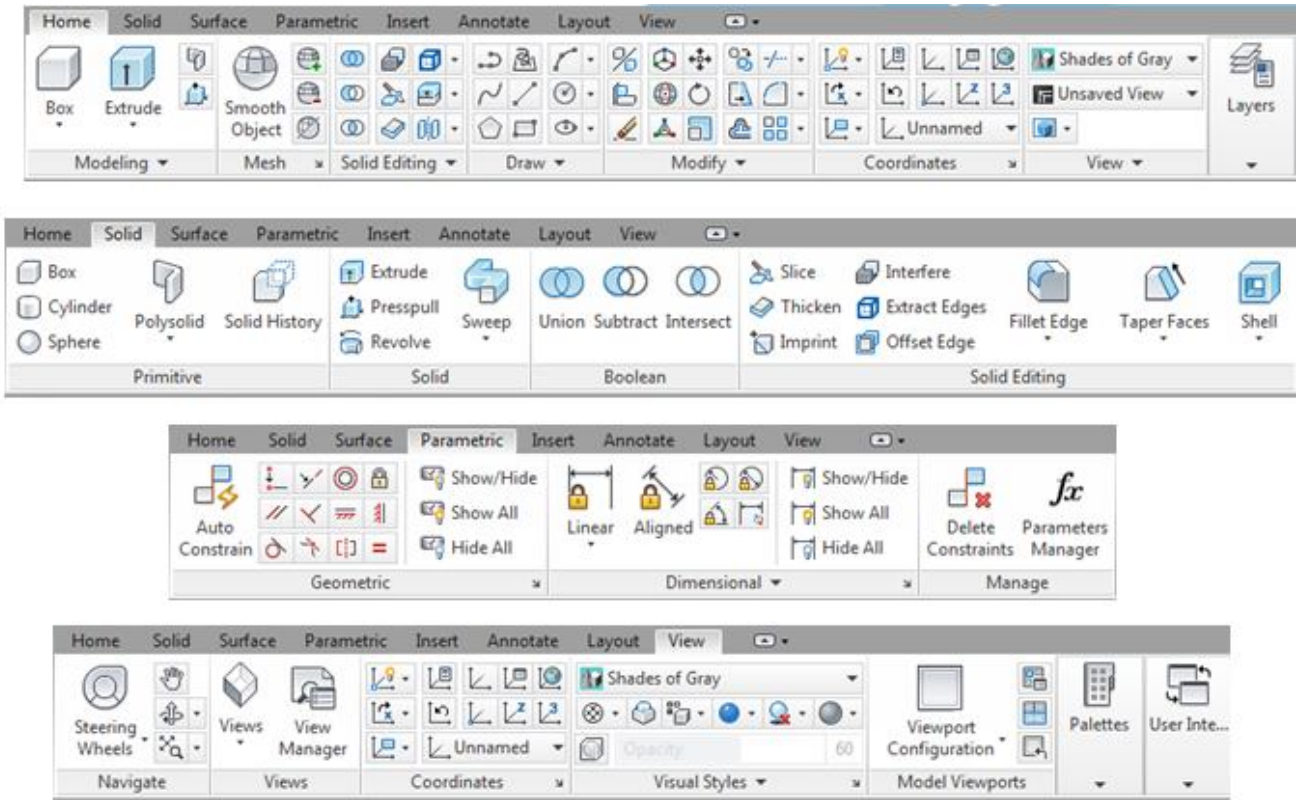


Figure 5.4 – Ribbon Menu and Panels

The **Navigation Bar** is a user interface element where you can access both unified and product-specific navigation tools (Fig. 5.5).

The AutoCAD **Command Window** offers efficient keystroke access to commands and system variables. You can even use it to find other content such as blocks, hatch patterns, and layers (Fig. 5.6).

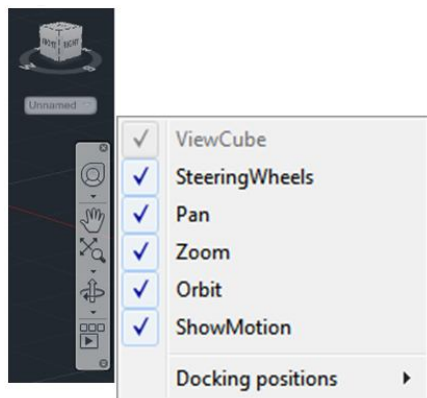


Figure 5.5 – Navigation Bar

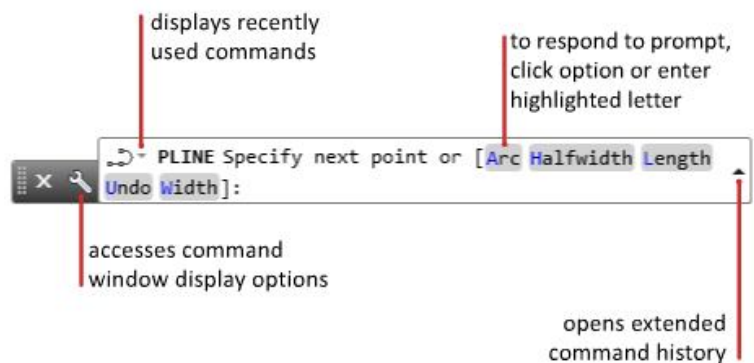


Figure 5.6 – Command Window

5.2 Building of 3D model

1. Open program AutoCAD. Click New (Fig. 5.7) to choose from several drawing template files:

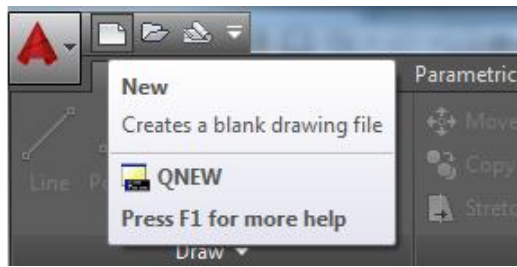


Figure 5.7 – New button of standard ribbon

Put on icon  → New → Drawing → SheetSets → Manufacturing Metric.dwt → Open.

2. Choose a **3D Modeling** on the **Quick Access Toolbar** (Fig. 5.8).

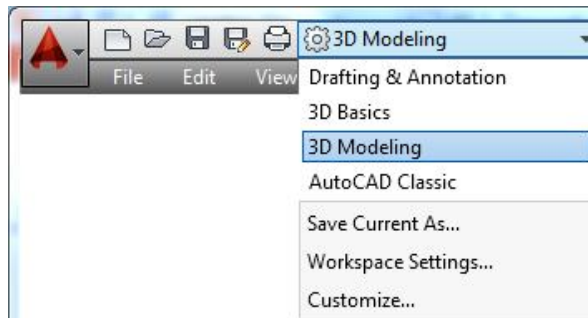



Figure 5.8 – 3D Modeling

3. Create new layer (LA). Put the button  (Fig. 5.9):

- Name – Solid 1;
- Color – red;
- Linetype – put  ;
- ACAD_ISO04W100 (ISO long-dash dot);
- Lineweight – 0,3 mm.

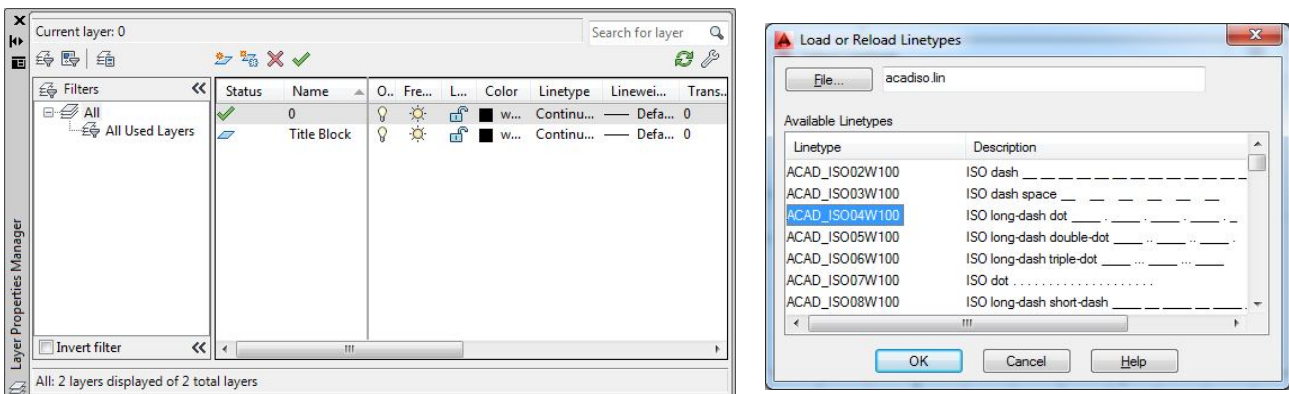


Figure 5.9 – Layer Properties Manager

4. Create new layers – Solid 2 and Solid 3.
Choose any Color and Lineweight 0,3 mm for the layers (Fig. 5.10).

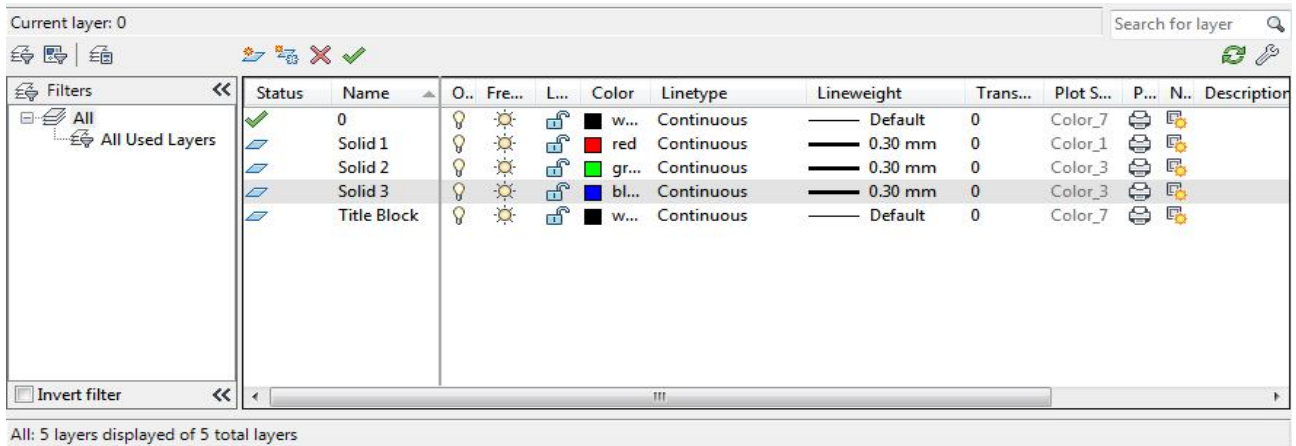


Figure 5.10 – Layer Properties Manager with nessery layers

5. Select the layer **Solid 1**. On the **View Controls** choose **SW Isometric**. On the **Visual Style Controls** choose **Shaded with edges** (Fig. 5.11).

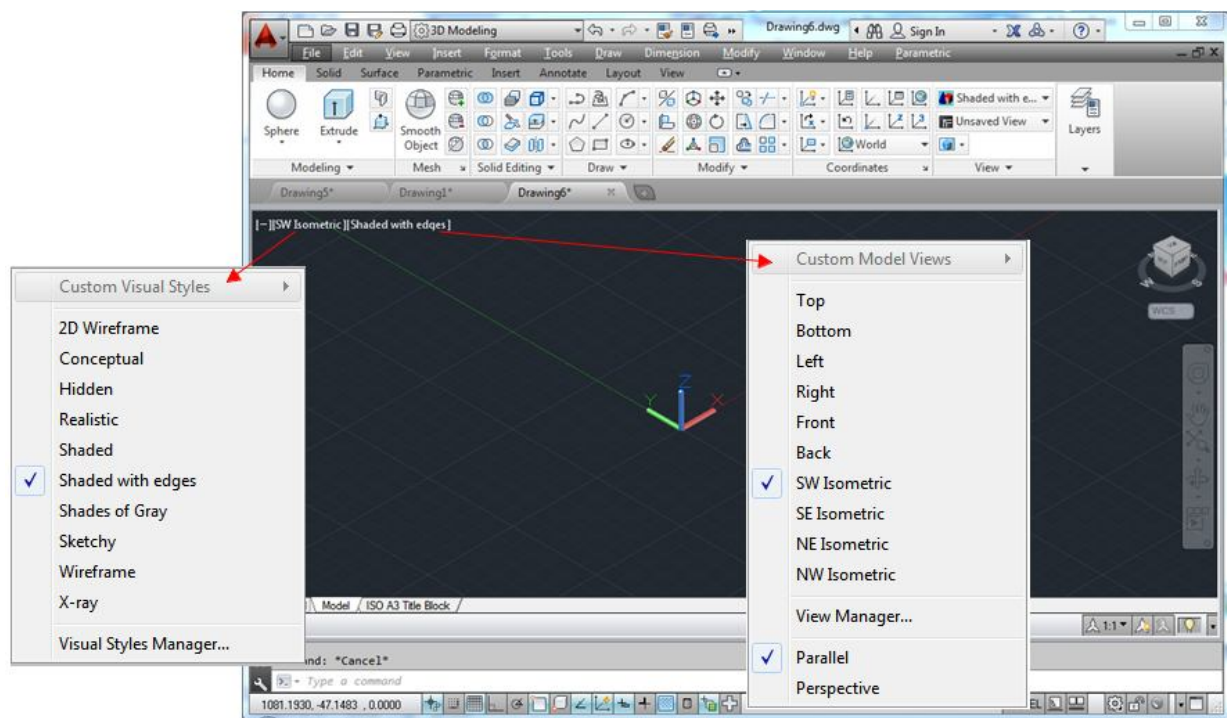



Figure 5.11 – Setting the visual style and view of the model

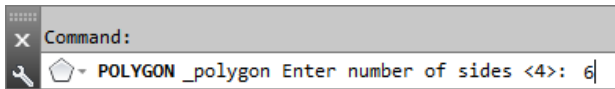
- Activate **Grid Display (F7)** at the bottom of the screen (Fig. 5.12).



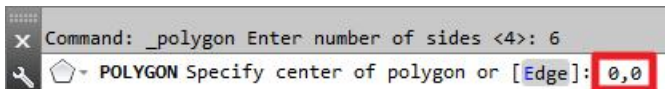
Figure 5.12 – Turning on the grid

6. Draw a polygon (Fig. 5.13):

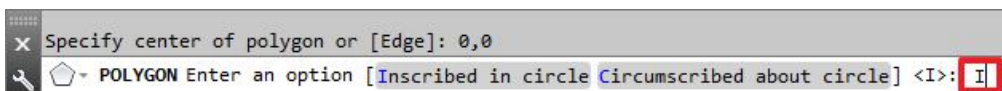
- click on the Ribbon panel **Draw** → **Polygon** ;
- in **Command** menu select the required number of vertices (3, 4, 5 or 6→) from the keyboard and then click button **Enter**;



- specify **center** of polygon (0,0) → **Enter**;



- **Inscribed in circle** or **I** → **Enter**;



- specify **radius** of circle (50 mm) → **Enter**.

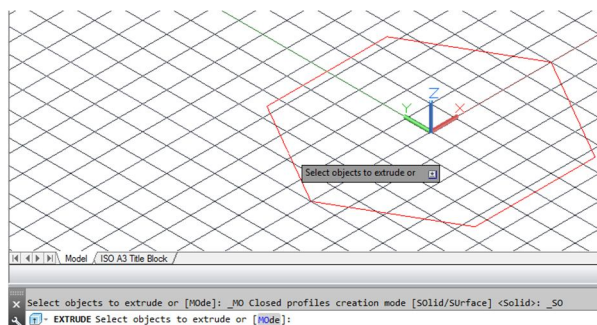
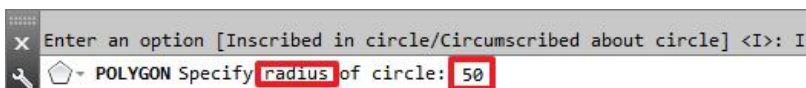



Figure 5.13 – A hexagonal polygon

7. Click **Home** → **Extrude** .

Select object (polygon) → **Enter** → Specify height of extrusion (100 mm) → **Enter** (Fig. 5.14).

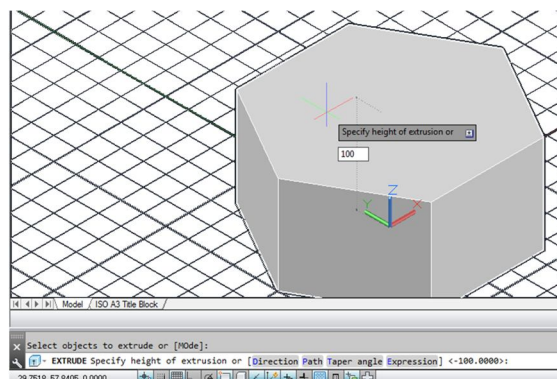





Figure 5.14 – Extrusion operation

8. Click **USC**  to change the point of the origin (Fig. 5.15).

Select the layer **Solid 2**. Draw the sketch of horizontal **hole**. For example, draw

CIRCLE  → Specify center (25, 50), radius of circle (30 mm) → **Enter**

Click  → Select object (green circle) → **Enter** (Fig. 5.16).

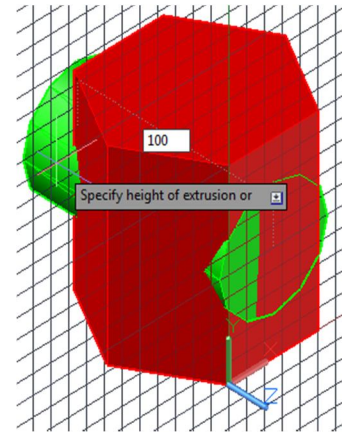
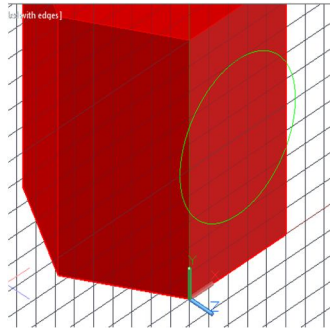



Figure 5.15 –
Change the point
of the origin

Figure 5.16 – Extrusion operation of cylinder

9. Click **Solid, Subtract**  → Select **Solid 1** → **Enter**. Then select **Solid 2** → **Enter** (Fig. 5.17).

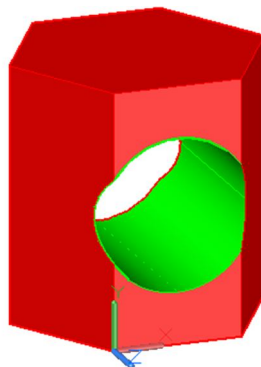


Figure 5.17 – Subtracting of object Solid 2

10. Repeat the steps 8 and 9 for a vertical hole **Solid 3** (Fig. 5.18).

11. Save your file.

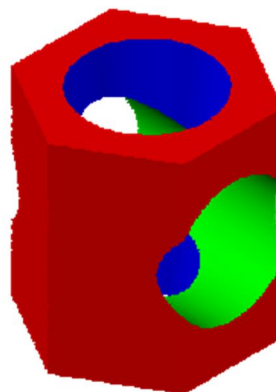


Figure 5.18 – Subtracting of object Solid 3

5.3 Creating a 2D drawing from a 3D model

In this unit a 2D drawing creation from 3D model will be described.

1. On the top of screen choose **Drafting & Annotation**.
2. Open Layout ISO A3 Title Block.



3. Open **Home** → **Layers**, put the button  – **Layer Properties** (Fig. 5.19).

Create new layer MD_Visible, put the button :

- Name – MD_Visible;
- Color – black;
- Linetype – continuous;
- Lineweight – 0,6 mm.

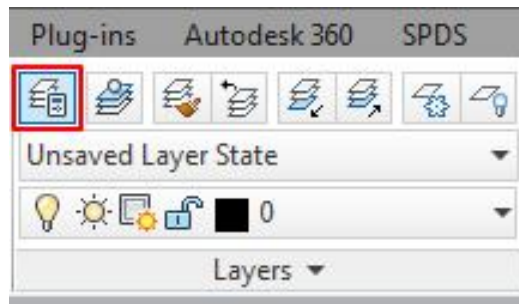


Figure 5.19 – Layers panel

Create new layer MD_Dimensions, put the button :

- Name – MD_Dimensions;
- Color – black;
- Linetype – continuous;
- Lineweight – 0,2 mm (Fig. 5.20).

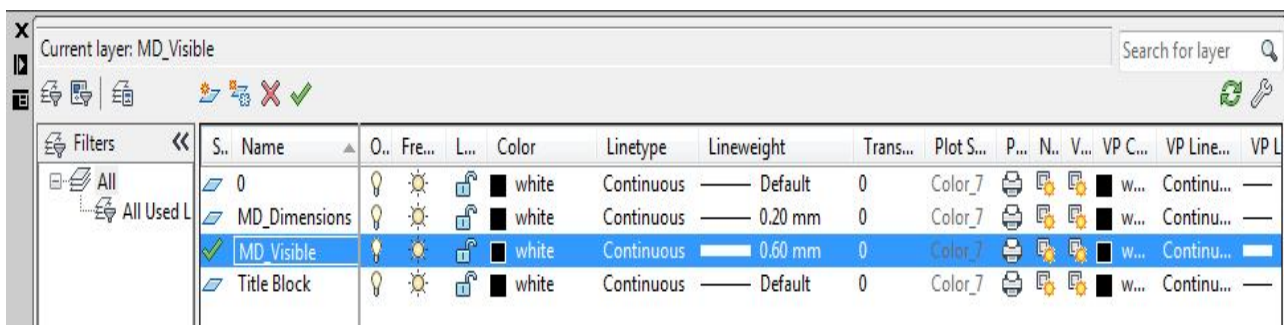


Figure 5.20 – Layer properties manager

Note 3 points, as shown in Figure 5.24, and move it up with mouse to the top part of a sheet. We place a frontal view over the top view and click **Enter** twice (Fig. 5.25).

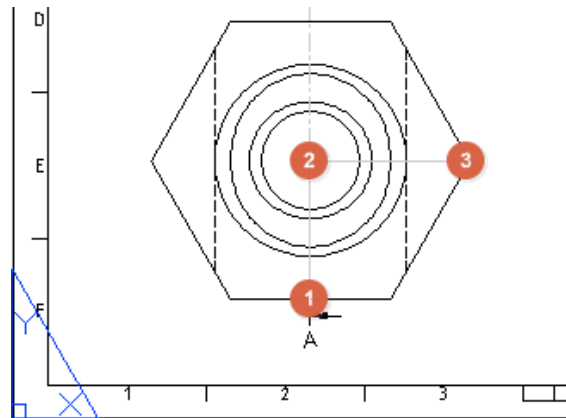


Figure 5.24 – Points creation of section

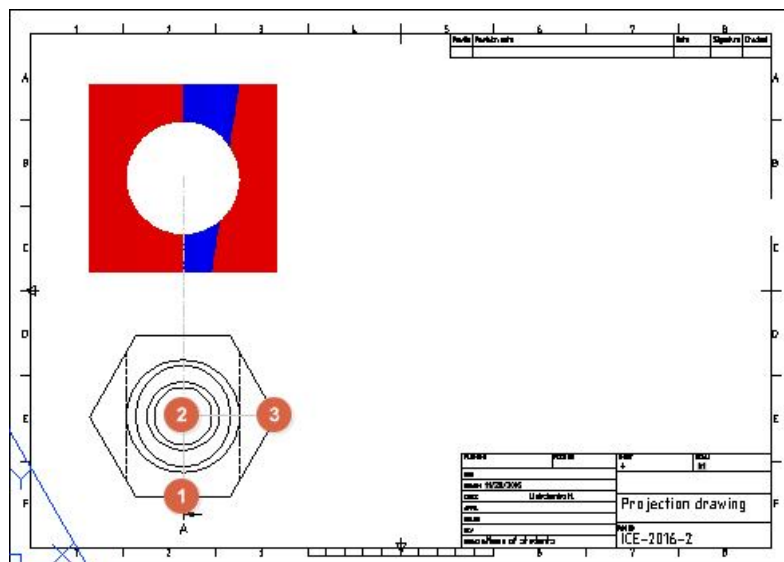


Figure 5.25 – Placing of frontal and top views

6. We start creation of the third view. Click on top view again and select on the **Panel Titles** the **Section** → **Half**. Draw the second line → Place on the right side of the first view, press the button **Enter** twice (Fig. 5.26).

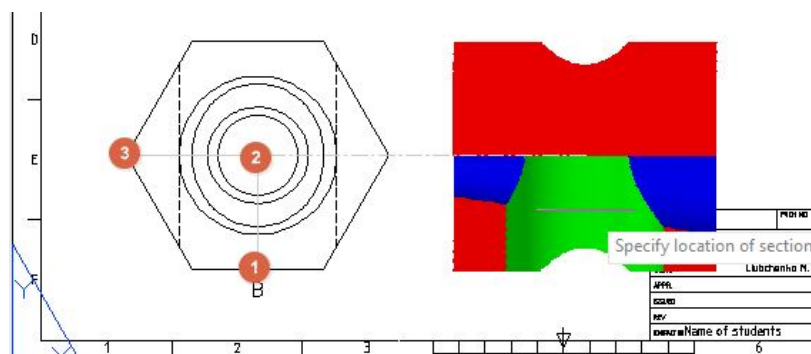
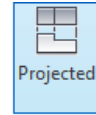


Figure 5.26 – Placing of left side view

Rotate the third view on 90 degrees and place on right side of second view.



Projected

Select third view and do isometric view using button direction to left way. Move the isometric view (Fig. 5.27, 5.28).

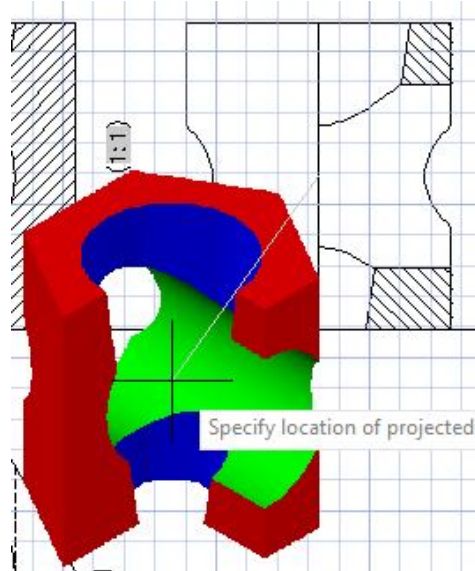


Figure 5.27 – Placing of isometric view

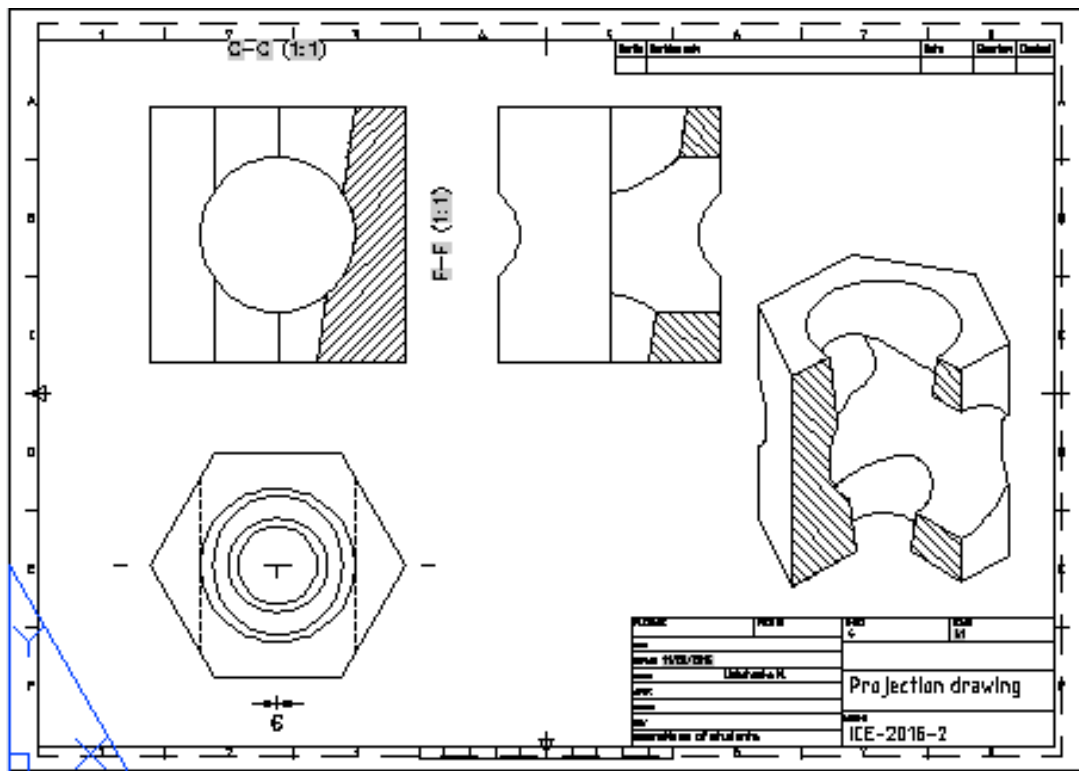


Figure 5.28 – Location of the views on the drawing space

7. Create new layers of Dimensions and Axes. Menu Annotate → Dimensions. Make necessary dimensions and axes for 3 principal views.

8. Fill on a title block (Fig. 5.29), save the file and print the drawing size A3 (Fig. 5.30).

FILE NAME	FSCM NO	SHEET 4	SCALE 1:1
SIZE			
DRAWN 11/28/2016			
CHECK Liubchenko M.	Projection drawing		
APPR.			
ISSUED			
REV	DWG NO		
CONTRACT NO Name of students	ICE-2016-2		

Figure 5.29 – Title block

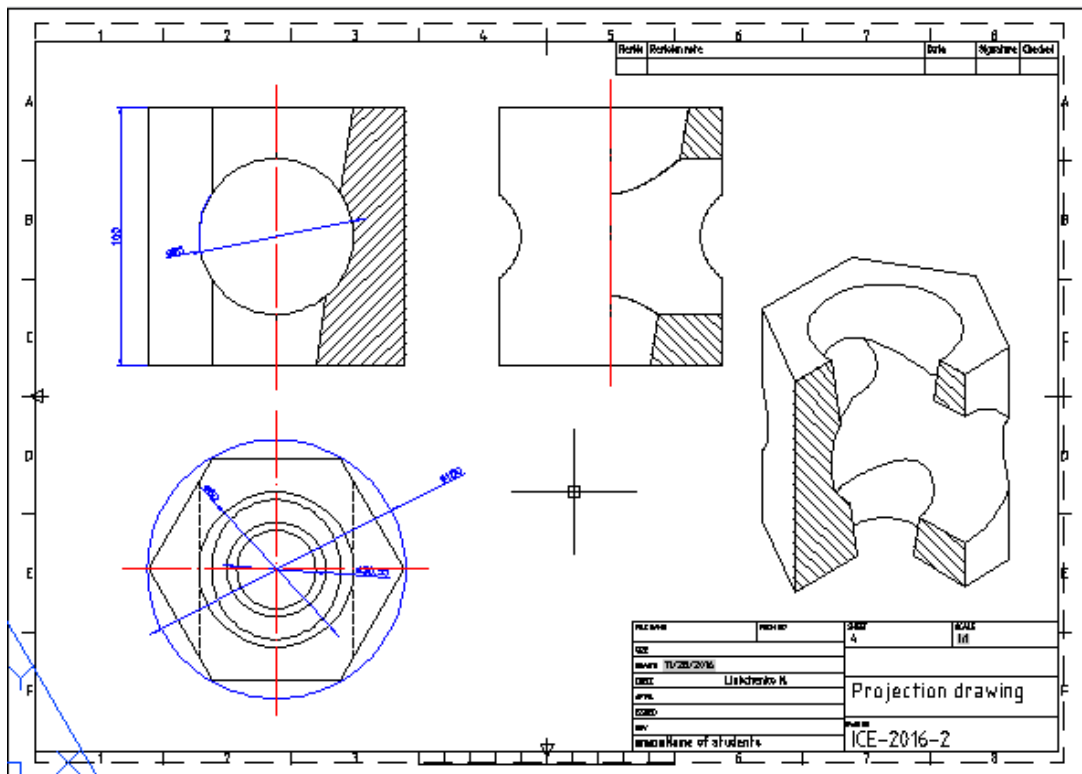
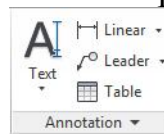


Figure 5.30 – Example of drawing

9. A Title sheet of an Album of the tasks.

Open or create new Layout – Title sheet. In ribbon menu open **Annotate**.



Use command **Text** to write a Title sheet.

Size of drawing is A3. **Text style** – GOST type B, inclined. Type the text using example in Figure 5.31.

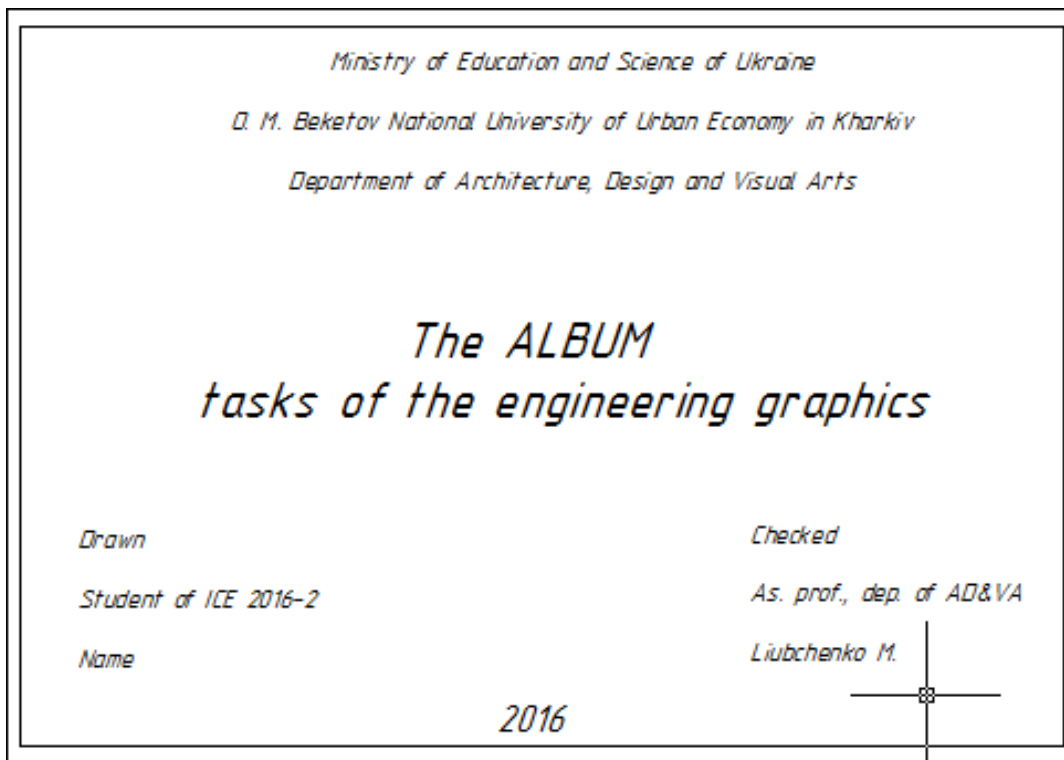
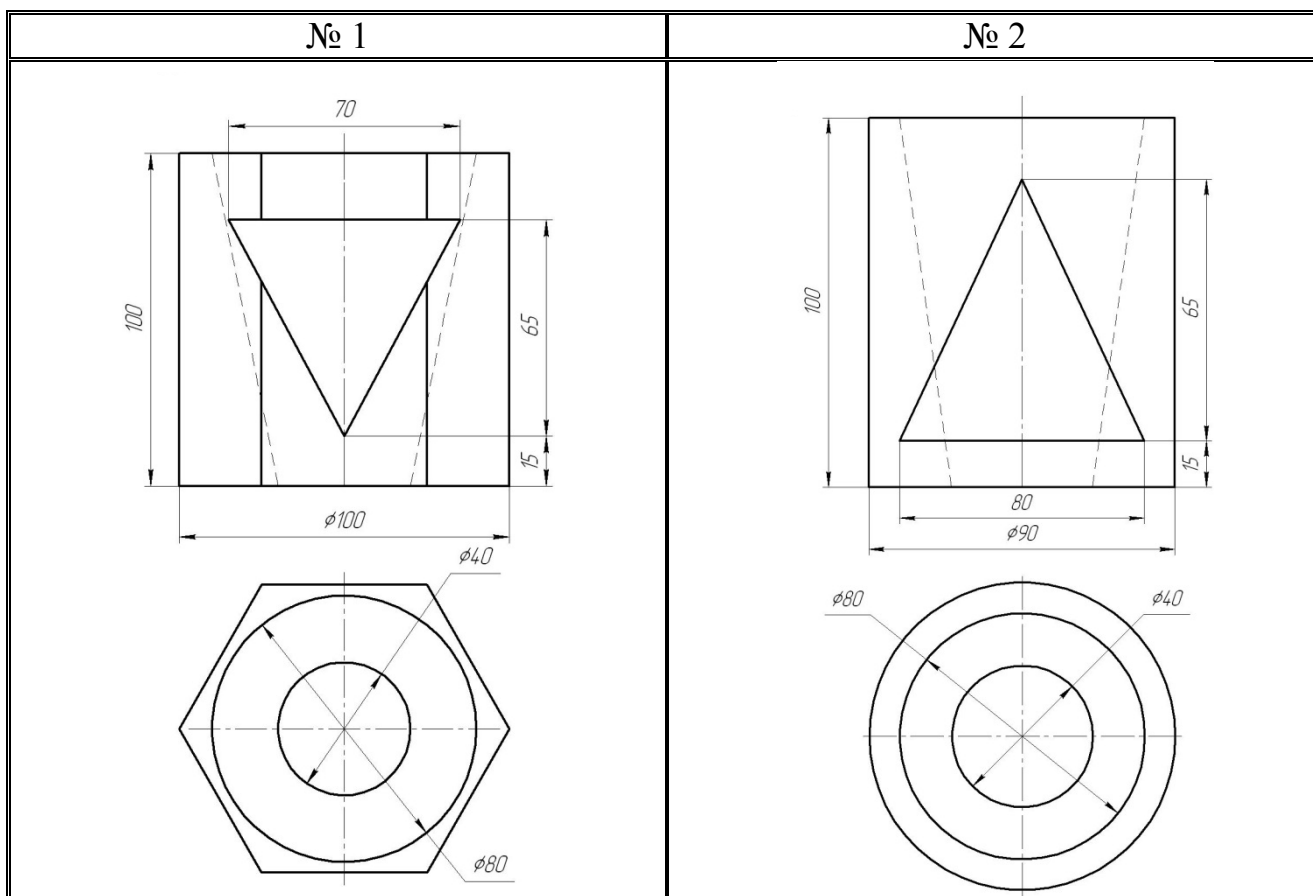
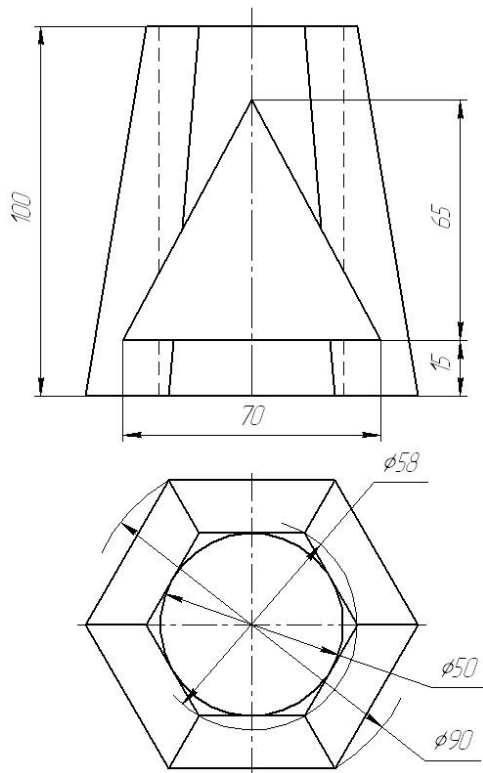


Figure 5.31 – Example of title sheet

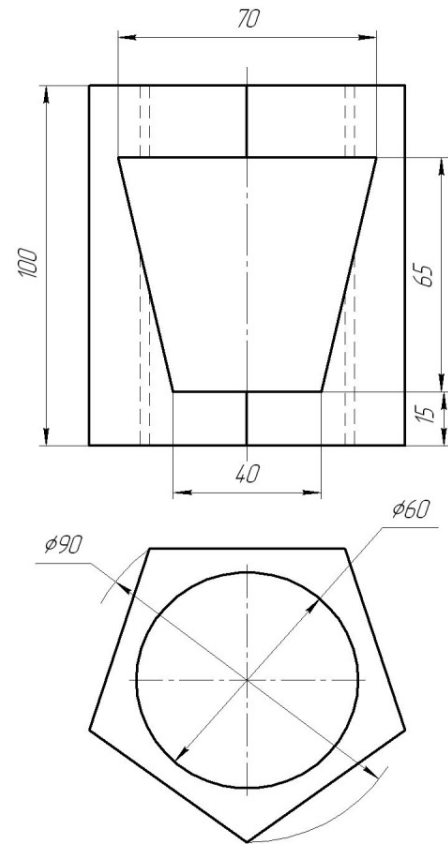
5.4 Variants for the task 5



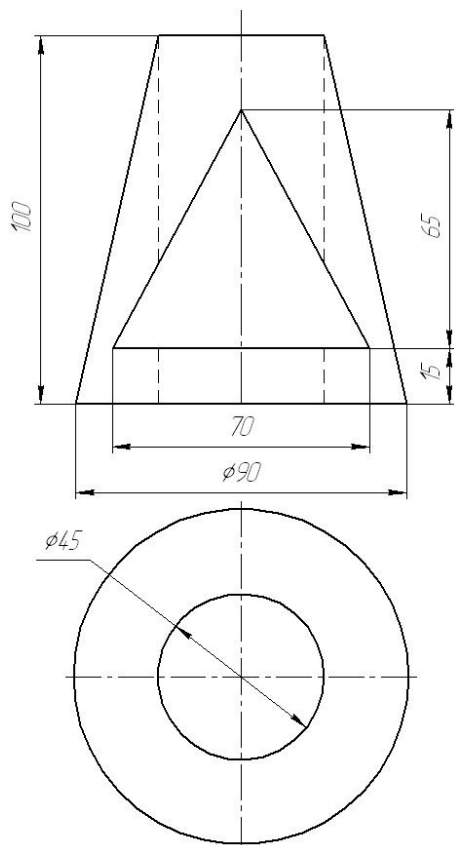
№ 3



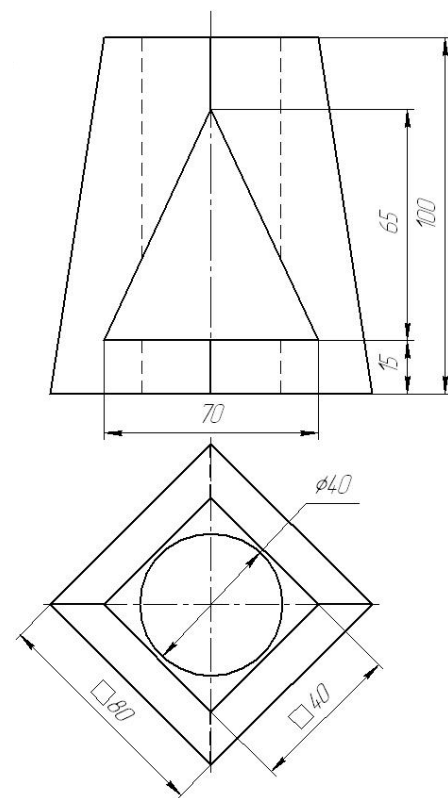
№ 4



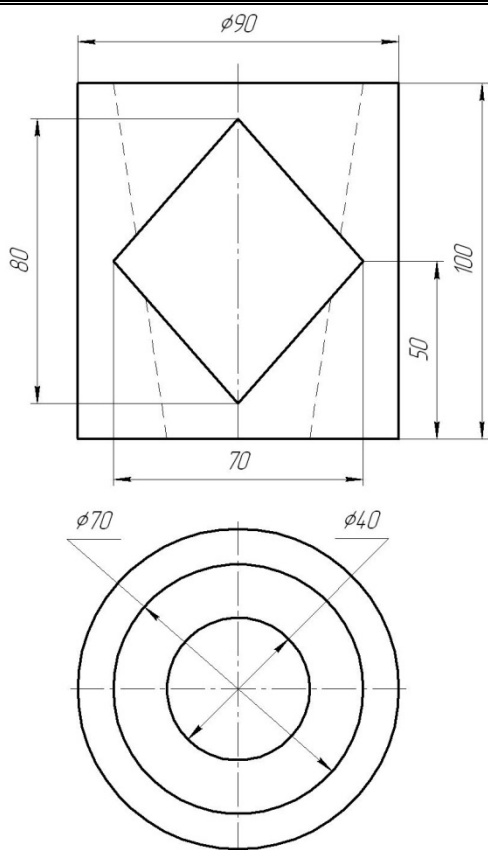
№ 5



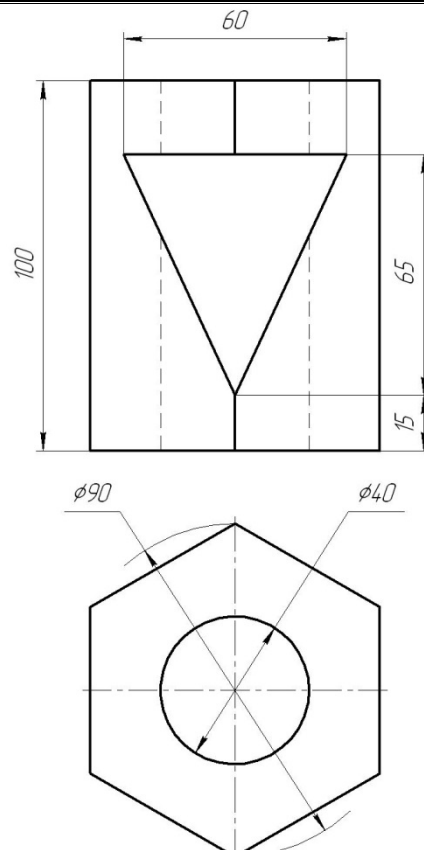
№ 6



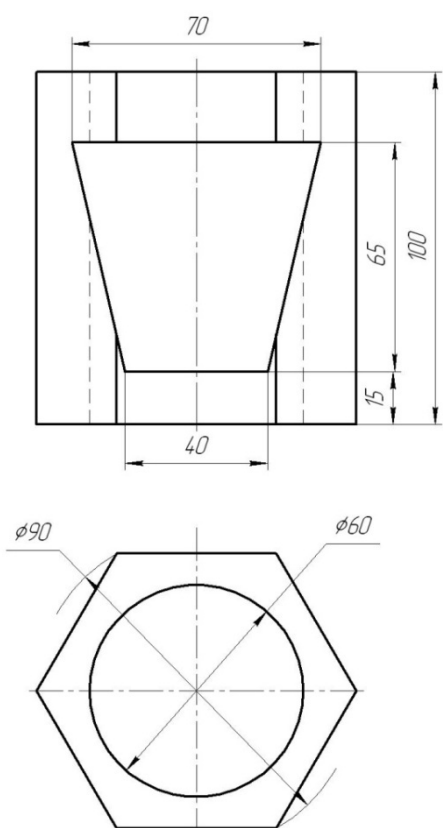
№ 7



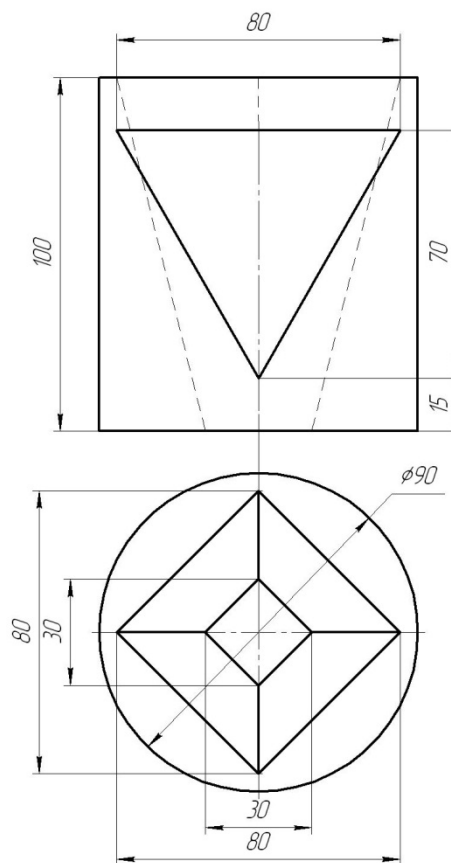
№ 8



№ 9



№ 10



6 CONSTRUCTION DRAWINGS AND ELEMENTS OF THE BUILDING

6.1 Drawings of the building plan

6.2 Section drawings

6.3 Elevation drawings

6.4 Examples of the task 6

6.5 Variants for the task 6

6.1 Drawings of the building plan

The plan of the building is called the image of the building, mentally dissected by a horizontal plane at the level of window and door openings (about 1 m) and projected onto the horizontal plane of projection. The plan shows what is in the cutting plane and what is underneath it.

On the plan of the building show window and door openings, the location of the stairs, partitions and capital walls, built-in cabinets, sanitary-technical equipment and other. The plan placed under the elevation in the flat connection with it.

The position of all structural elements is determined by reference to the coordination axes.

Outside the building contour is wrote the size of window and door openings “in the light” and spaces between them (the first dimensional chain), coordination between axles (second dimensional chain) and the axis (the third dimensional chain).

Internal dimensions of areas, thickness of walls and partitions should be put on internal dimensional chains. They spend at least 8...10 mm from a wall or partition. Also bind all the outline main walls to the axes.

Floor space is put down in the lower right corner of the plan of the premises in square meters without designation of units with two decimal places and a bar beneath.

The plans show what direction the door opens. Exterior doors from the street to the house should open outwards, and the door from the stairs to the apartment is inside the apartment. Opening the other doors is depended on the convenience of planning and operation.

Sign of windows and external doors should be put on the outer side of the wall. On the open plan line shows the clipping plane for the corresponding section (Fig. 6.1).

A building plan is drawn in the following order:

- conduct longitudinal and transversal coordination axis;
- draw all external and internal walls, partitions and columns;
- produce a breakdown of window and door openings in the external and internal walls and partitions, conditionally show opening doors;

- draw stairs, sanitary appliances, built-in wardrobes, mezzanine, balcony fences and other elements;
- do the necessary external and dimension lines show the cutting line;
- write down all sizes, make appropriate titles, check the drawing;
- make a final outline.

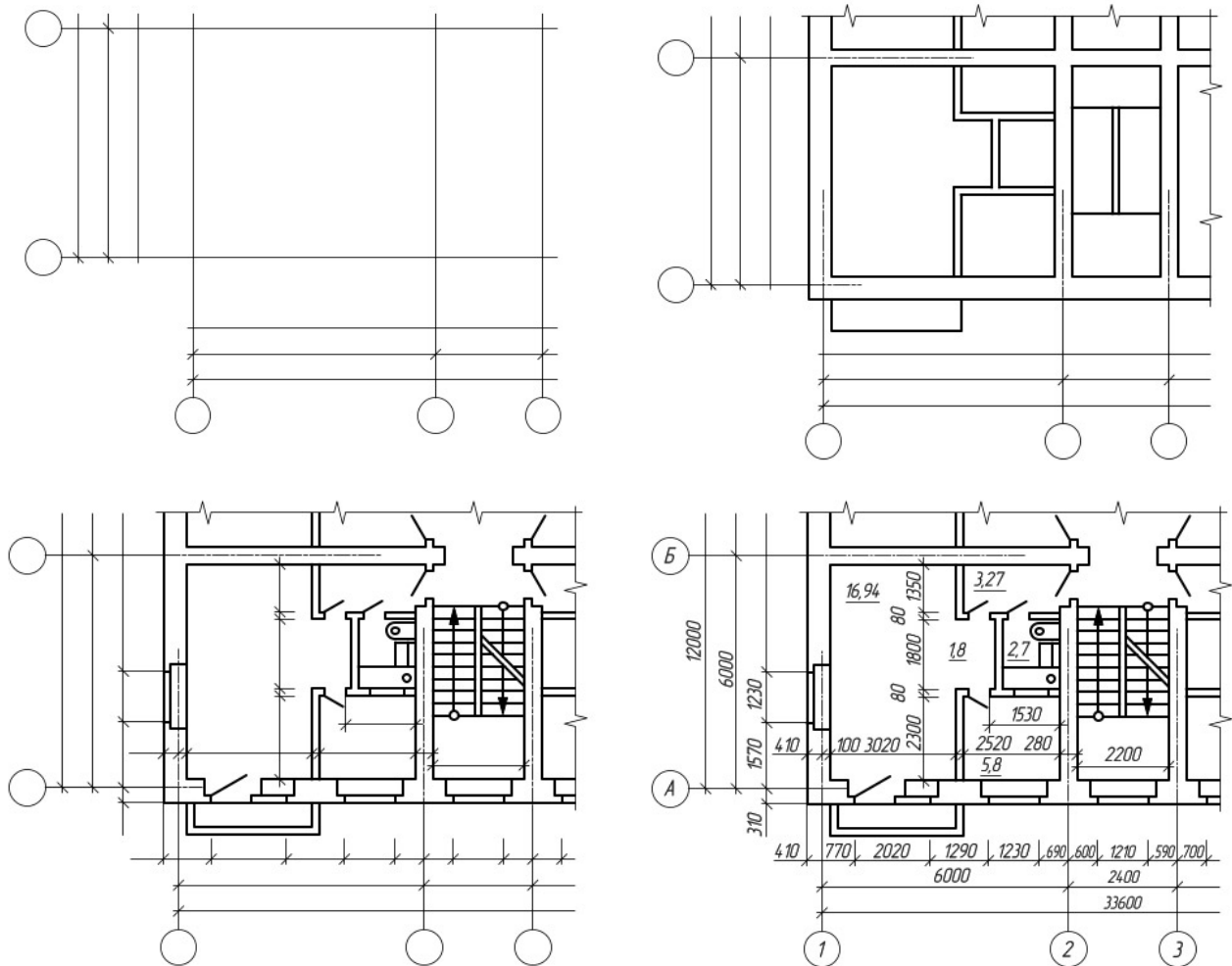


Figure 6.1 – Stages of building plan drawing

Contours of cuts and sections operate continuous main line. Elements that do not fit in the plane of section are performed by a thin line.

6.2 Section drawings

A sectional image of the building is called section. It is view mentally dissected vertical plane and projected onto the horizontal projection plane. Direction of the cutting plane is marked on the floor plan as line with arrows at the ends, showing the gaze direction. This view is signed as Section 1–1.

On the cuts visible contour lines is performed a continuous thin line. On sections coordination axes endure down and affix label sizes between adjacent axes. Position of structural elements height is determined by the elevations and dimensions,

which appears on the remote lines levels of the corresponded elements. Inside the cut are marked height floors, doors and windows, as well as elevations and floor levels stairwells.

On the exterior side of the cut at a distance of 12–15 mm make a dimensional line, show the size of the window and door openings. Level sizes are drawn at a distance of 10–15 mm from the line. Also the marks are applied to the floor stairwell in the vestibule, entrance areas – one step above the sidewalk. The level of these sites increases towards a flight of stairs, so that rainwater does not fall into the stairwell. The section drawings are shown in Figure 6.2.

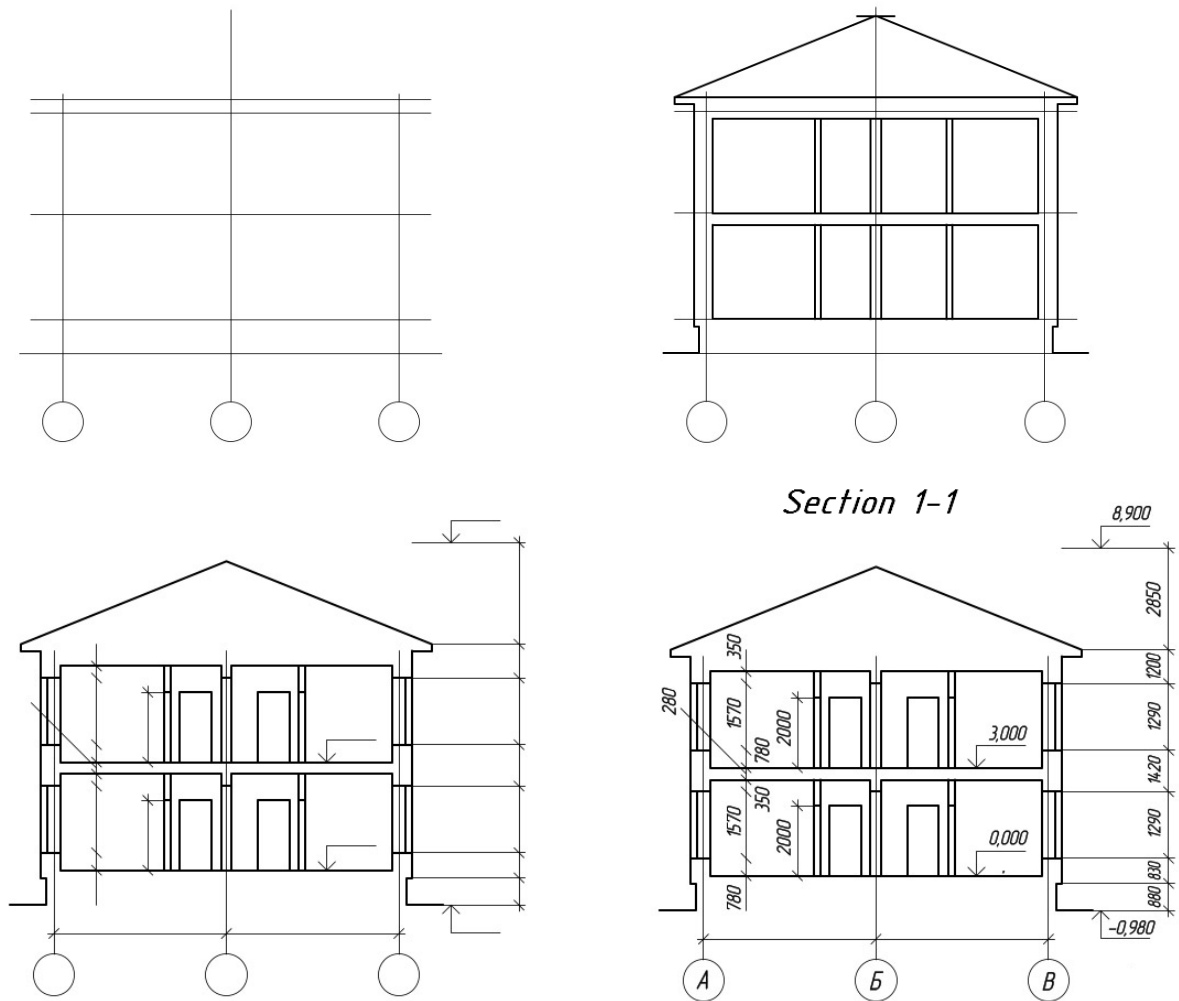


Figure 6.2 – Stages of building section drawing

A building section is drawn in the following order:

- draw coordination axes main load-bearing structures and perpendicular to them, horizontal lines of levels: land surfaces, floor of all floors and the attic floor and the top of the cornice;
- contours applied for exterior and interior walls, partitions, heights of intercommunication and attic floors and roof ridge, cornice and plinth, roof level;

- the windows and doors in the exterior and interior walls and partitions, visible door openings and other elements located behind the cutting plane show;
- show extension and dimension lines, circles marking axes and signs elevations;
- produce the final outline, dimensions and elevations make explanatory inscriptions and indicate the name of the section.

6.3 Elevation drawings

Types of building views in the front, rear, right and left are called elevations. Elevations give an idea of the image of the building, its overall shape, size, number of floors, the presence of balconies and loggias. View of the building from the street called the main elevation.

In the elevation drawings are drawn the location of windows, doors, balconies, door trims, etc. Dimensions are not applied on elevations but only the extreme axes are shown on it. The right or left a ground line, the top and bottom openings, eaves, top roof are represented on this drawing.

Elevations are usually performed in scale 1:100, 1:200 (civil buildings) and 1:200, 1:500 (industrial buildings). Complex view elevations are in the fragments in scale 1:10, 1:20. The elevation drawings are shown in Figure 6.3.

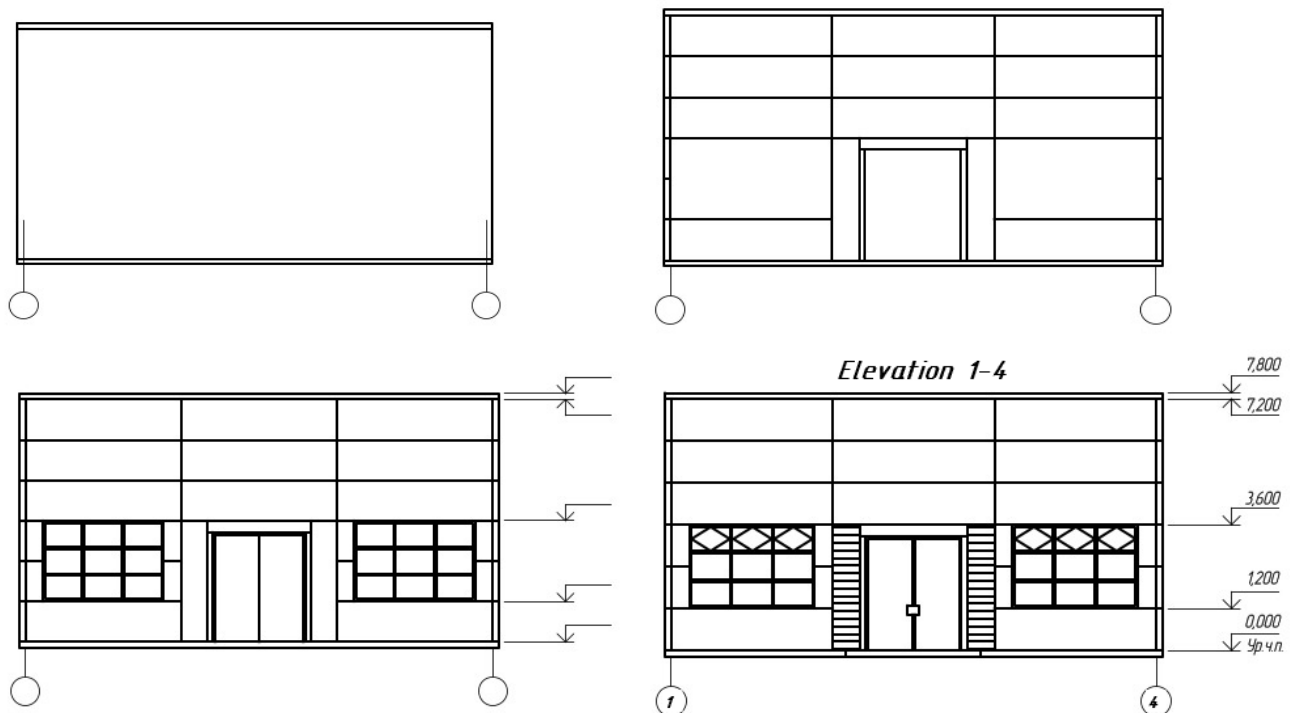


Figure 6.3 – Stages of building elevation drawing

A building elevation is drawn in the following order:

- draw the axis and the outline of the building;
- draw the windows and doorways, balconies, canopies plates, cornice and others architectural elements;

- draw the window frames, doors, fences balconies, vents and chimneys on the roof, write down marker icons;
- applied levels of the appropriate heights, marked focal axis;
- after verification of compliance with the plan and make the final circuit.

Draw the main line of the ground. Land line make thickened line that goes beyond the elevation view. On the architectural drawings on walls sometimes show shadows and elements entourage.

Sometimes necessary information can be conveyed without showing the interior construction. A large scale may be all that is needed to show the necessary details.

Many details are best shown by combining elevations and sections or by using isometric drawings.

6.4 Examples of the task 6

There are examples of the task in Figure 6.4 – 6.8.

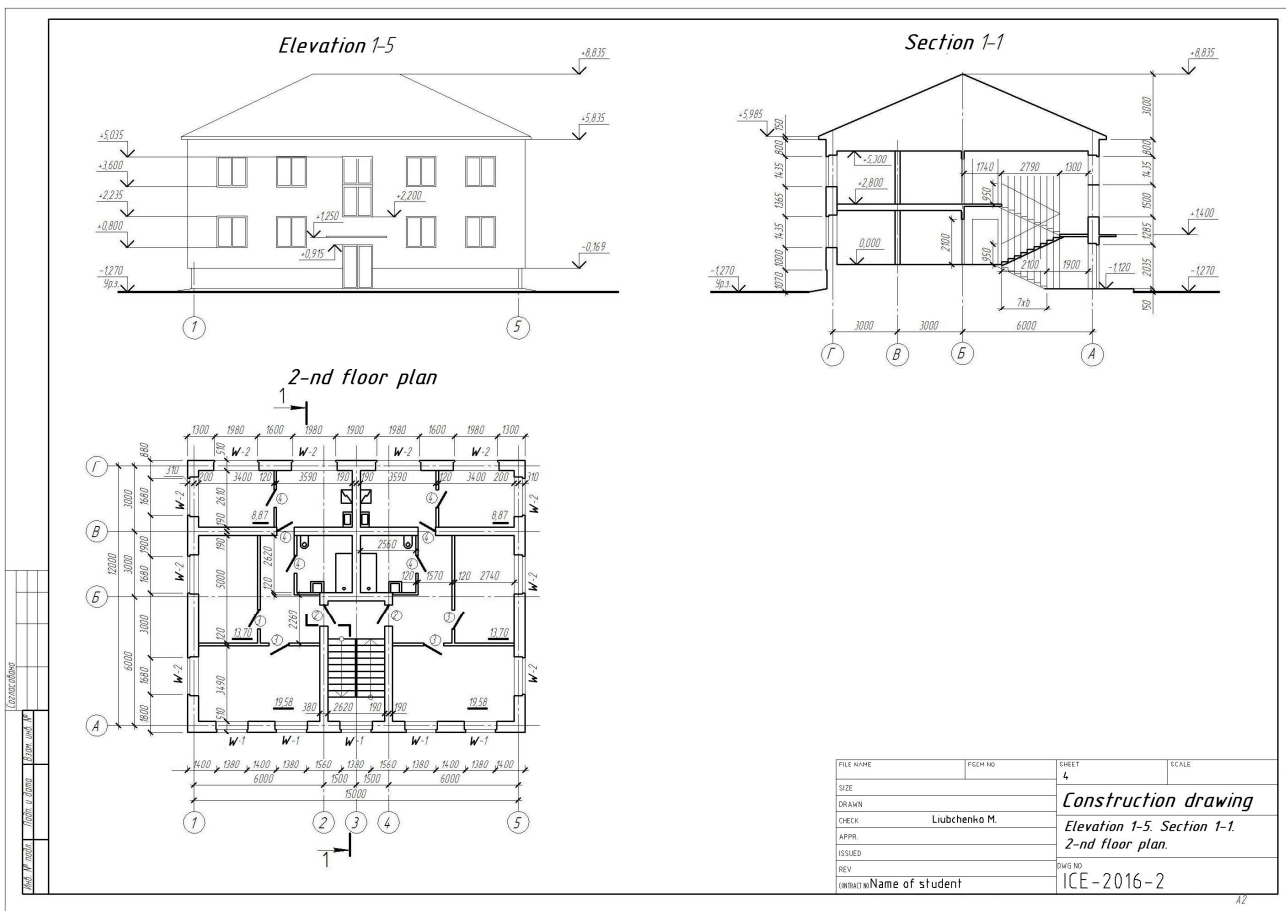


Figure 6.4 – Construction drawing

1-st floor plan S 1:100

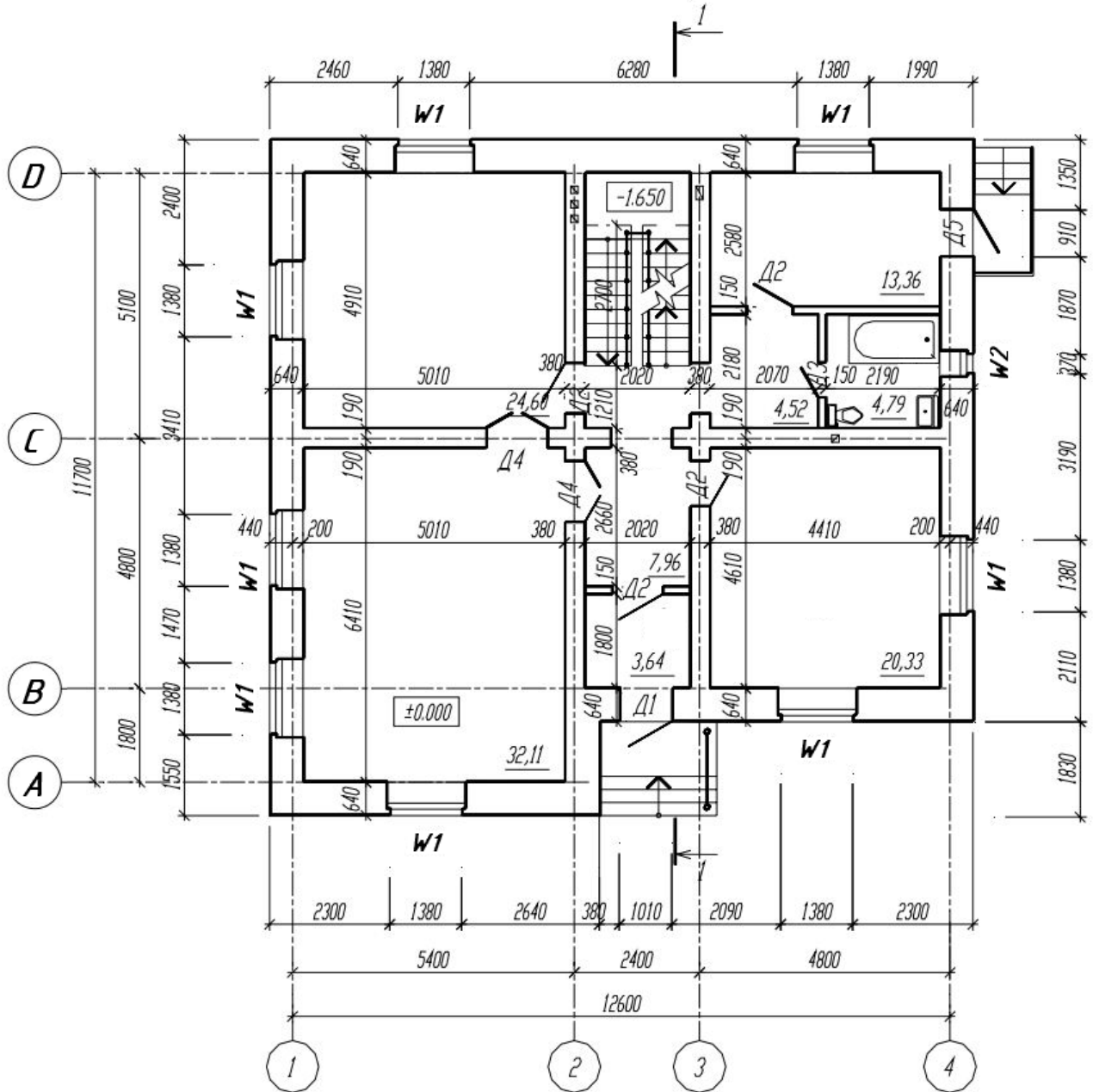


Figure 6.5 – Example of 1st floor plan (scale 1:100)

Elevation 1-4 S 1:100

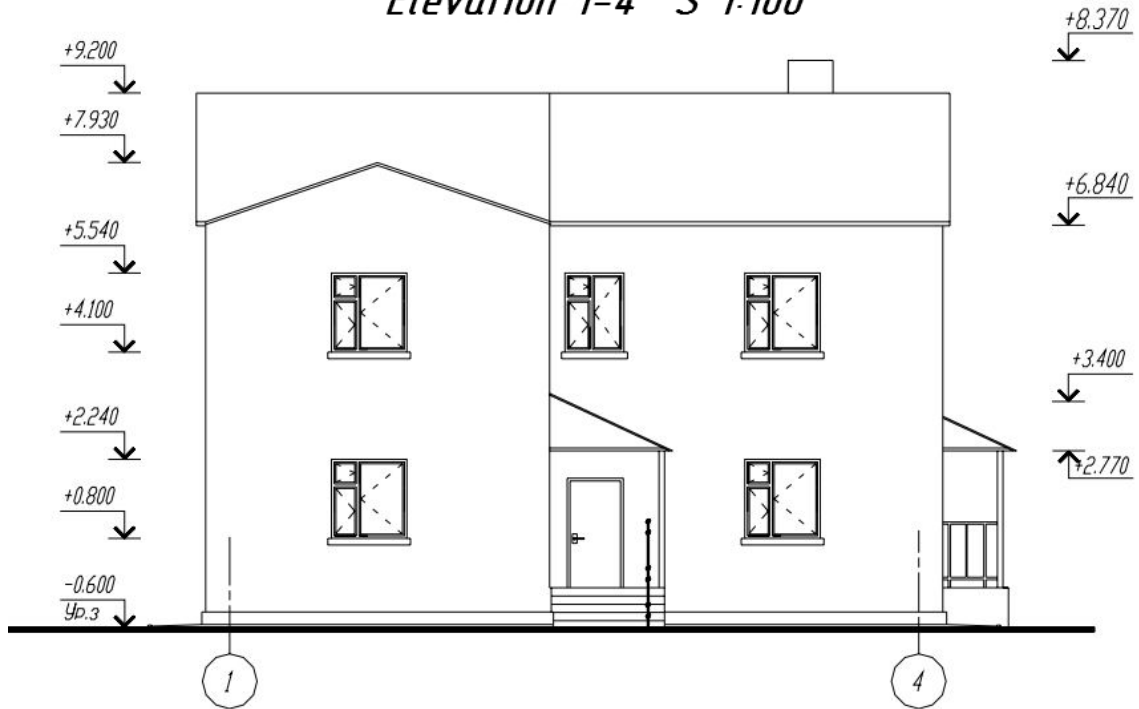


Figure 6.7 – Example of elevation 1-4 (scale 1:100)

Section 1-1 S 1:100

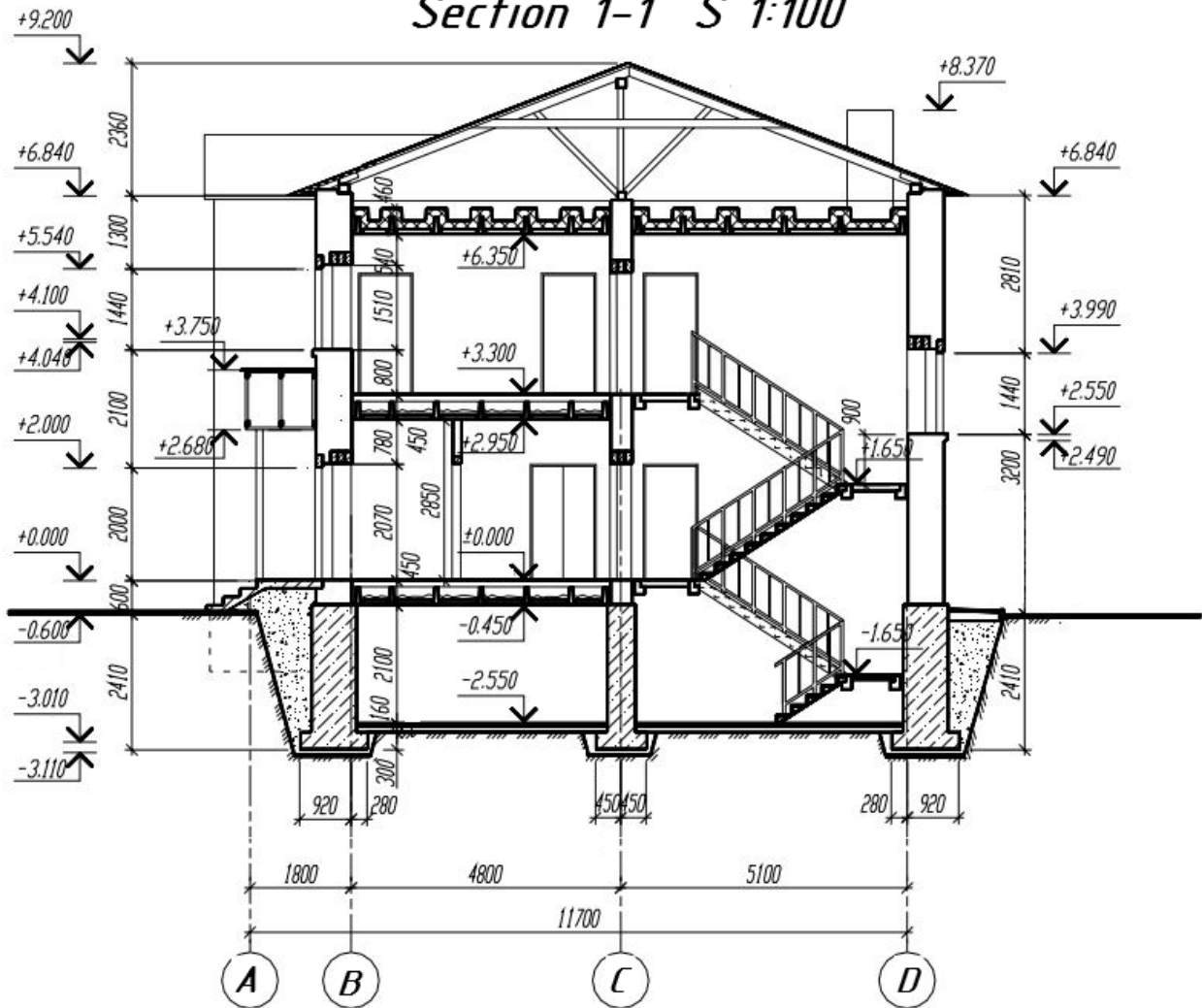
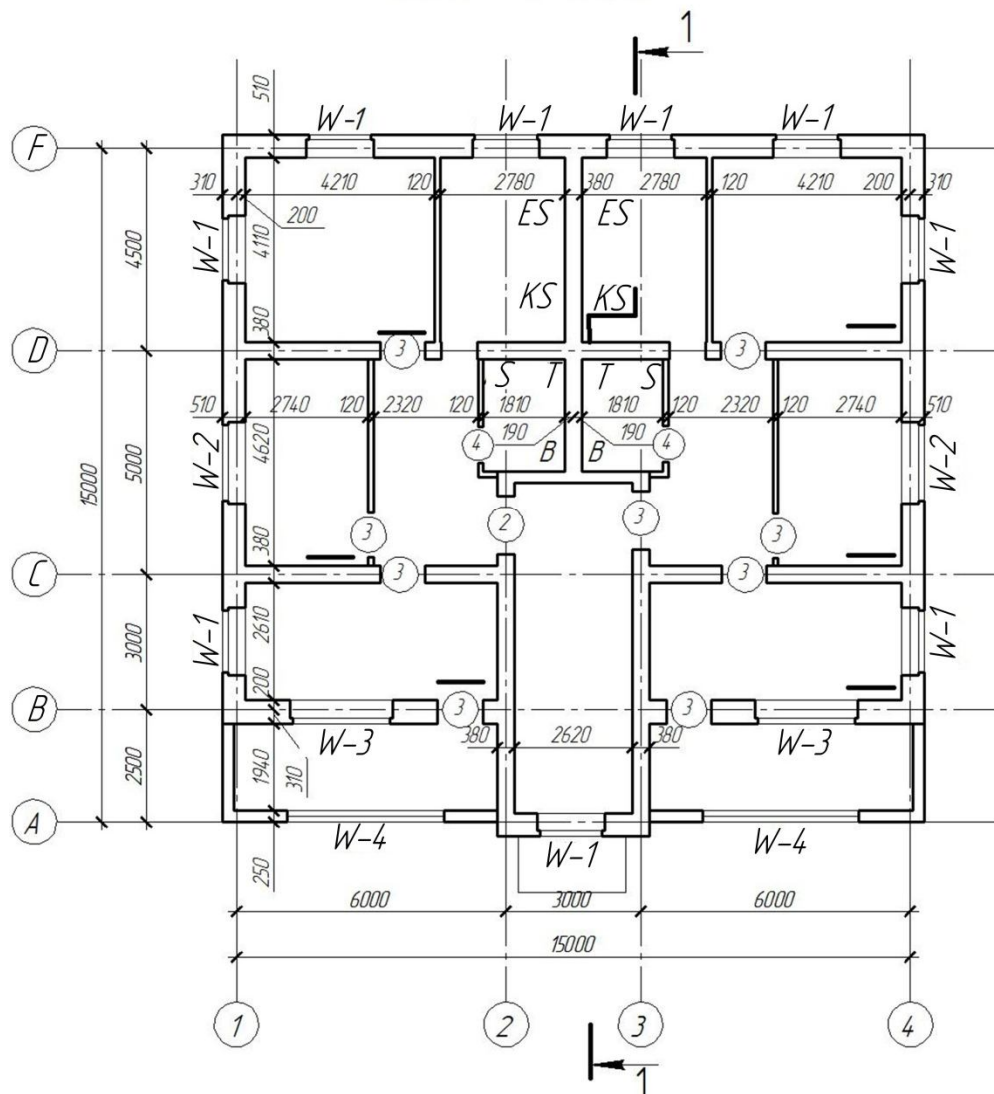
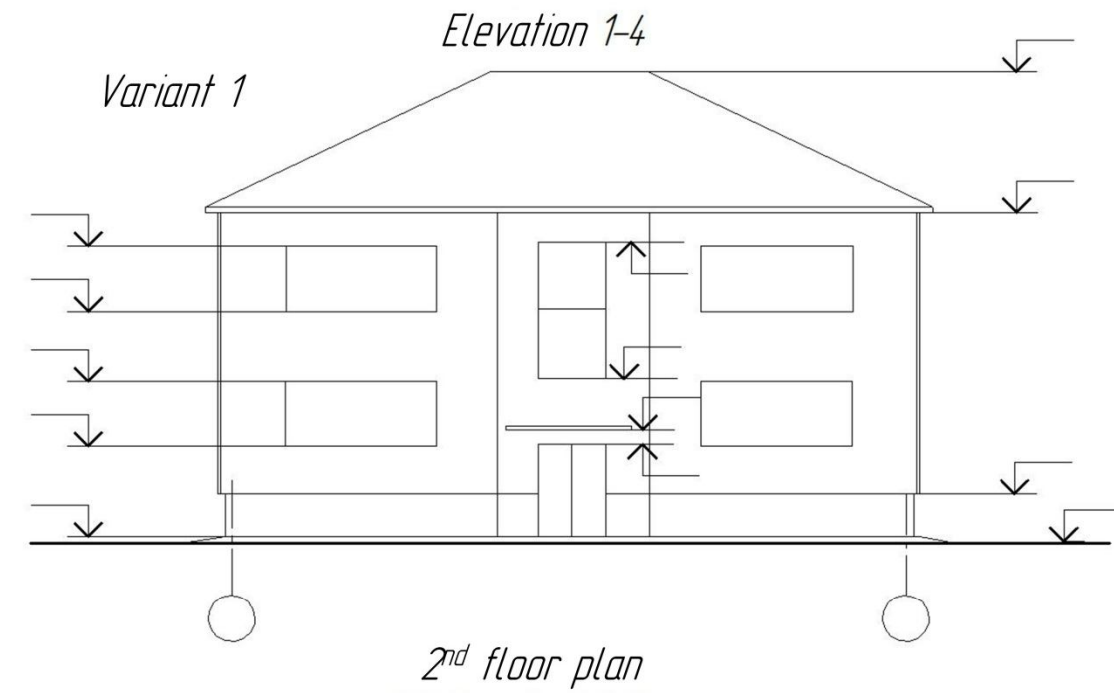
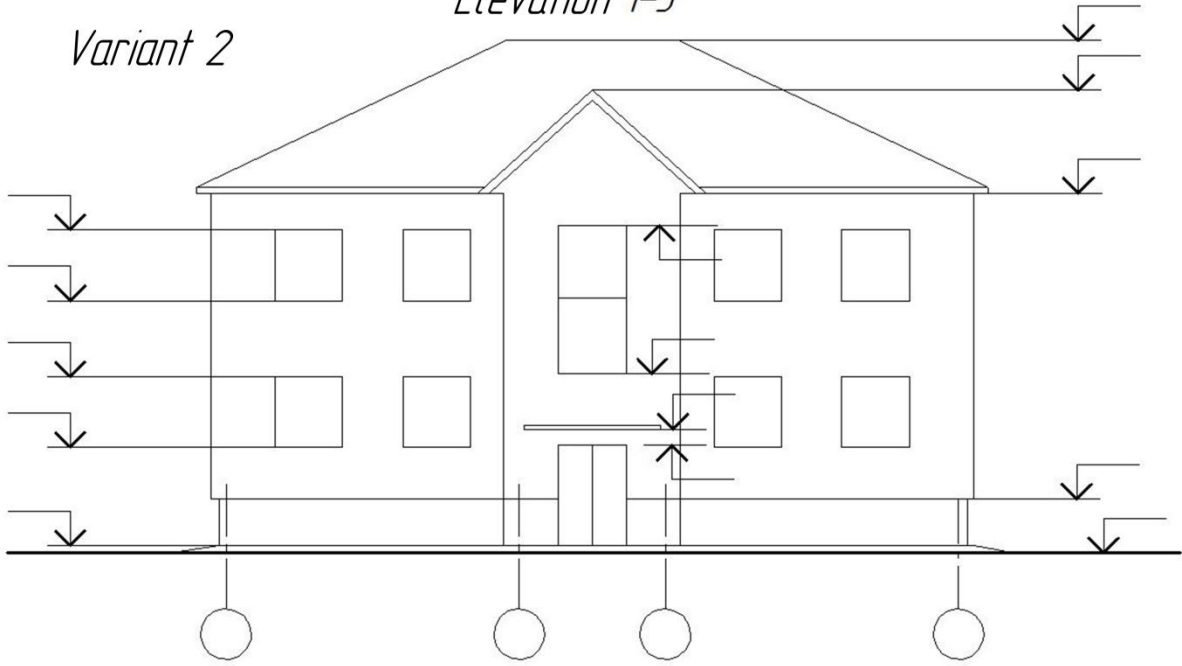


Figure 6.8 – Example of section 1-1 (scale 1:100)

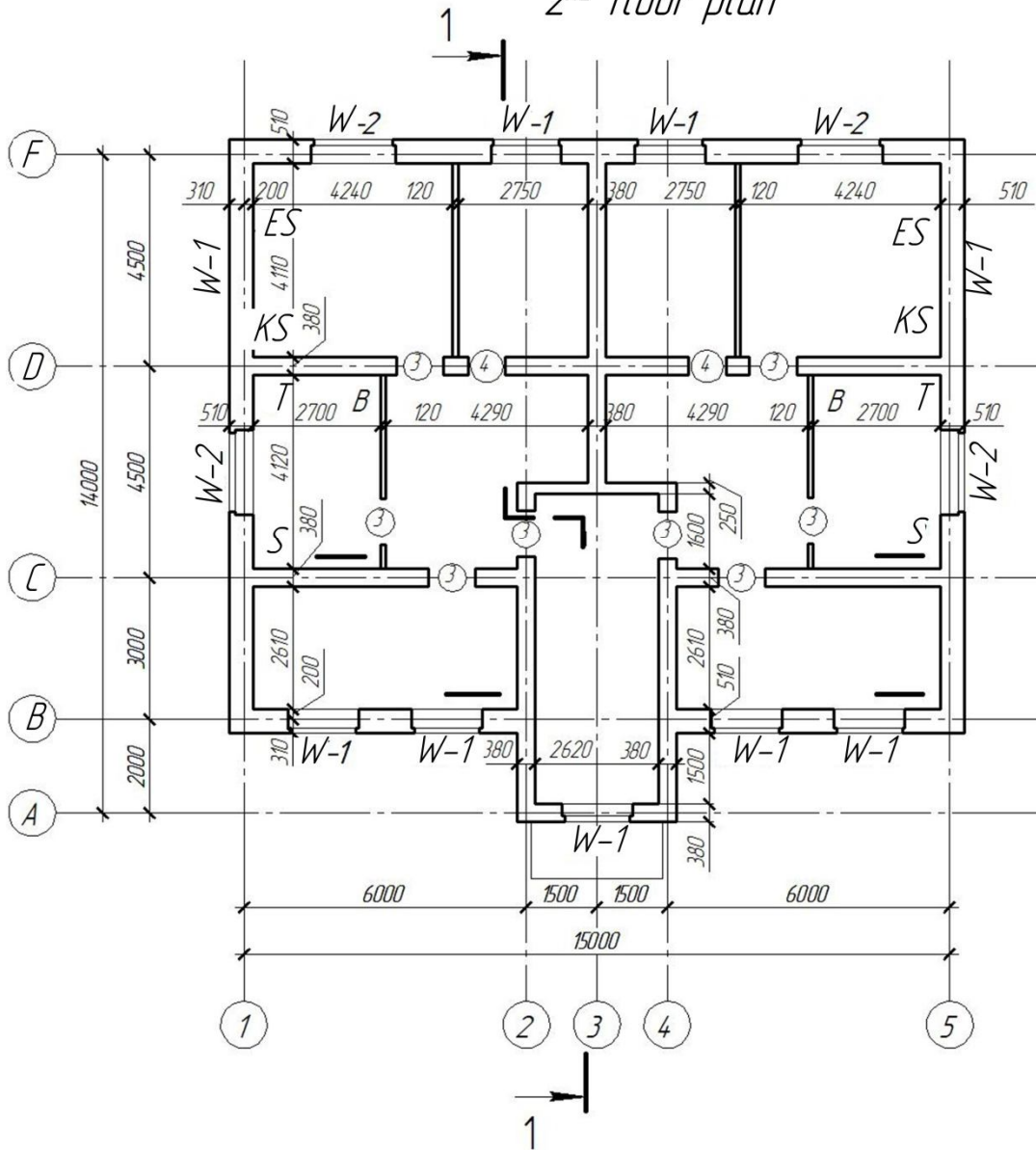
6.5 Variants for the task 6

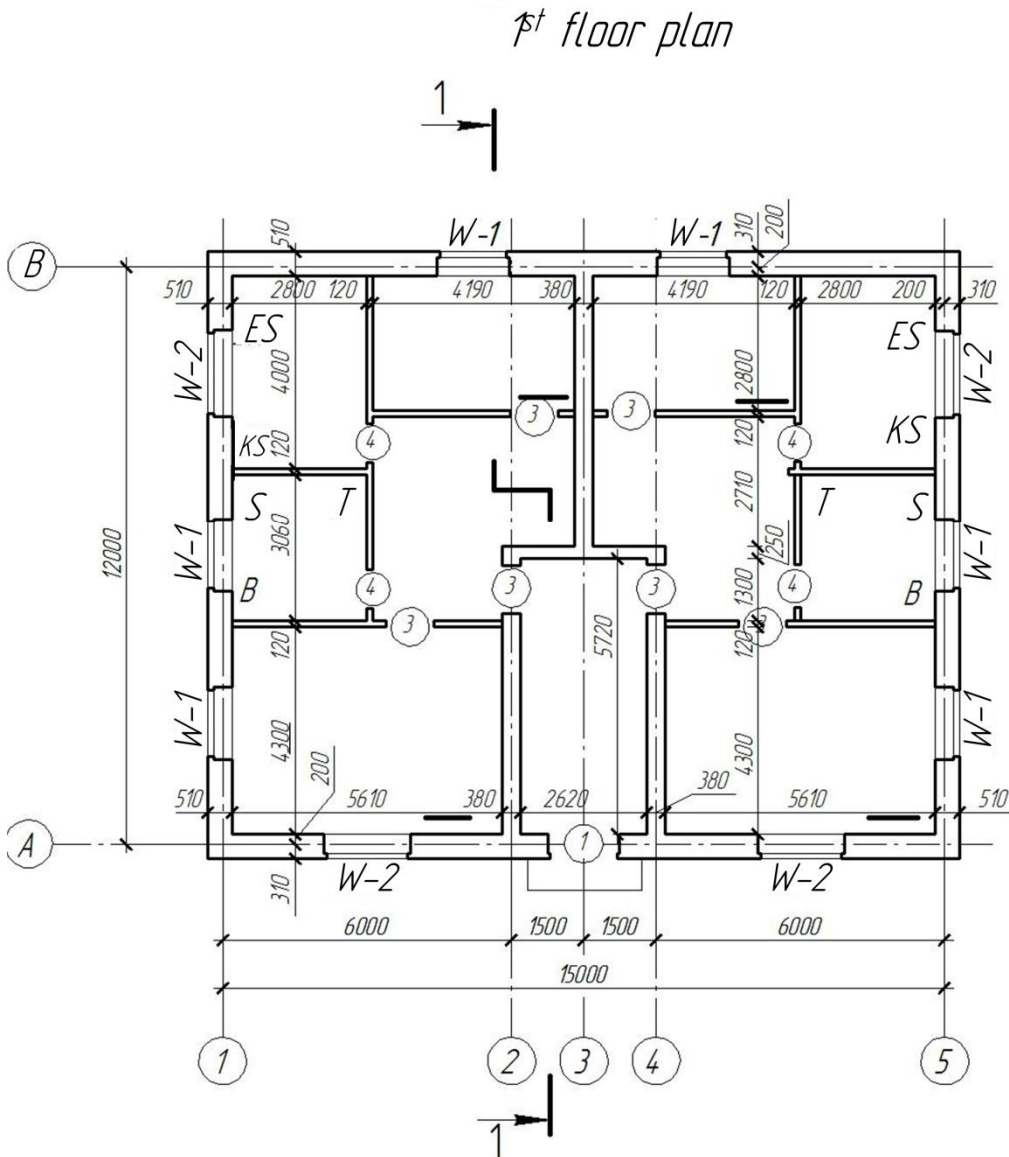
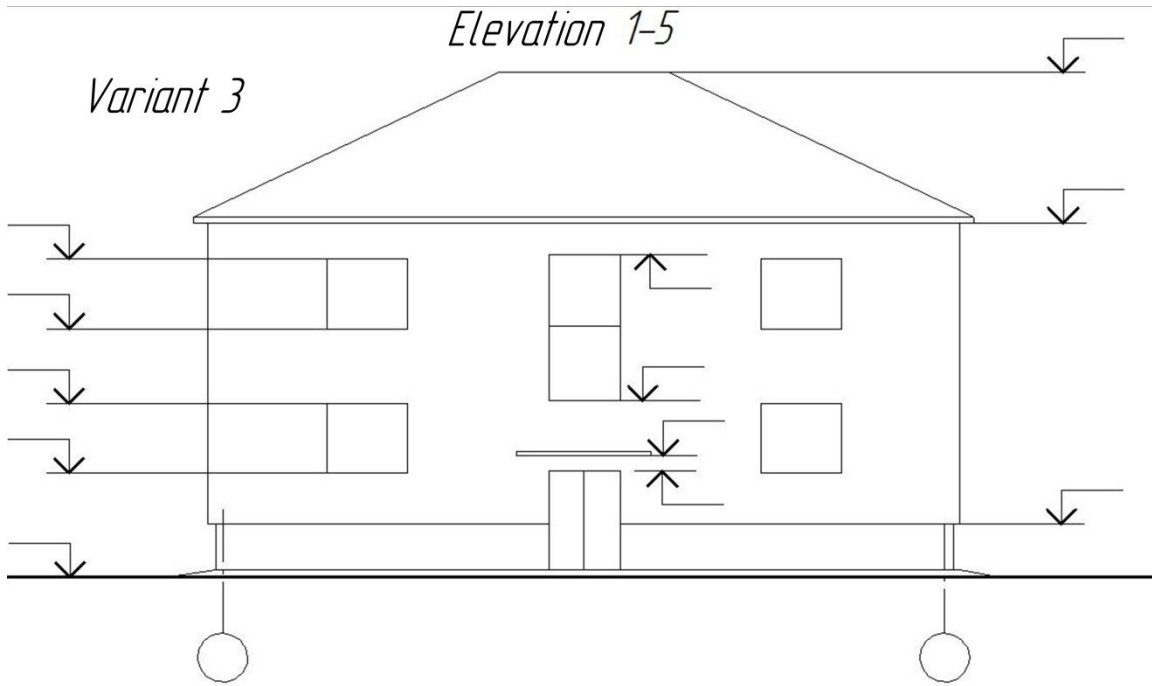


Variant 2
Elevation 1-5



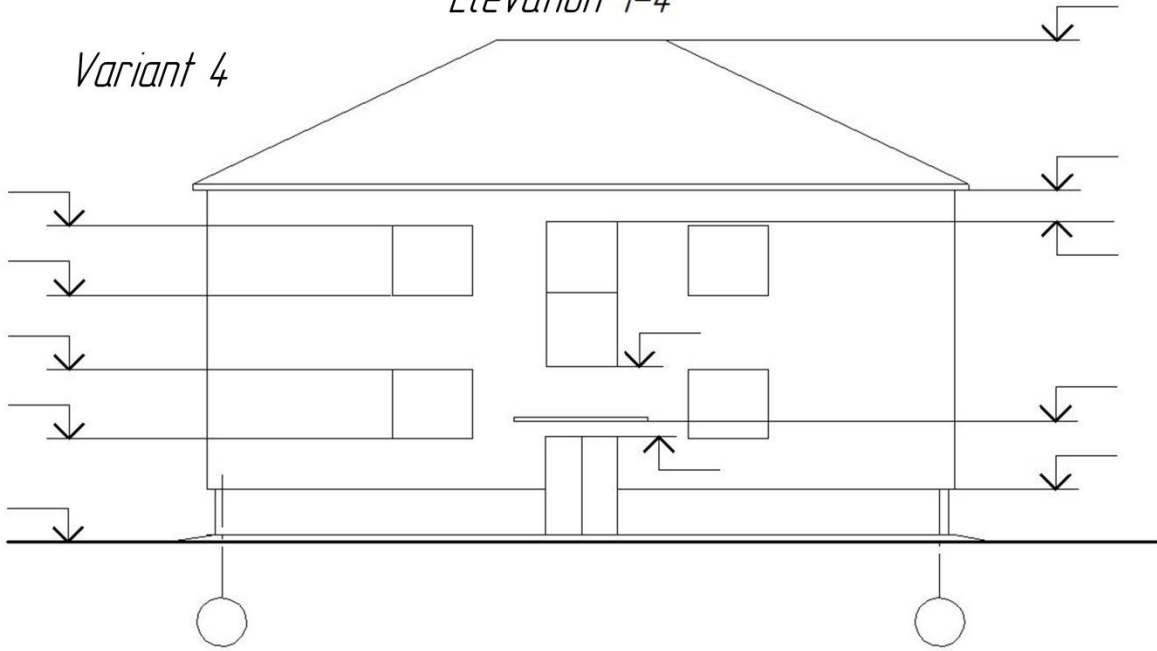
2nd floor plan



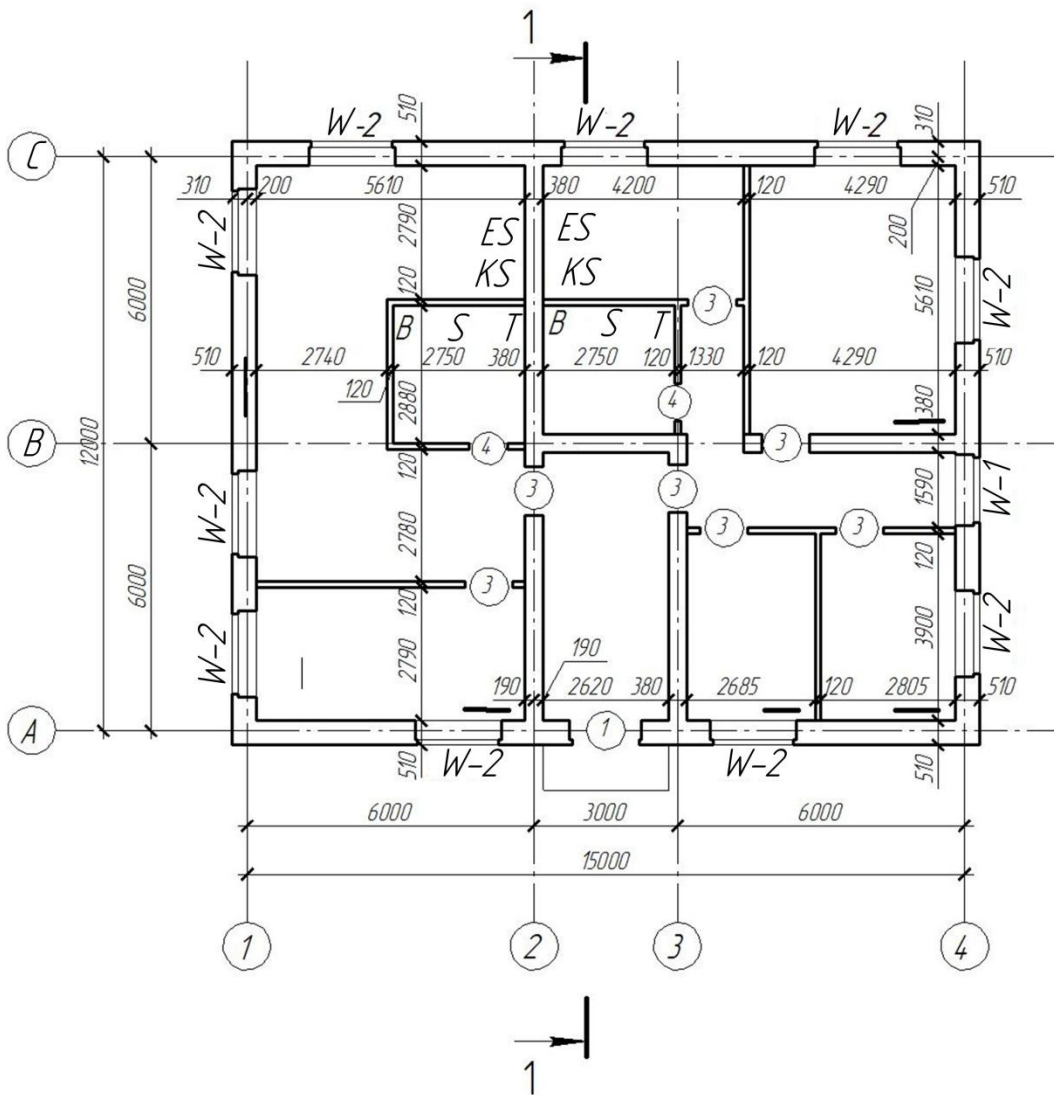


Elevation 1-4

Variant 4

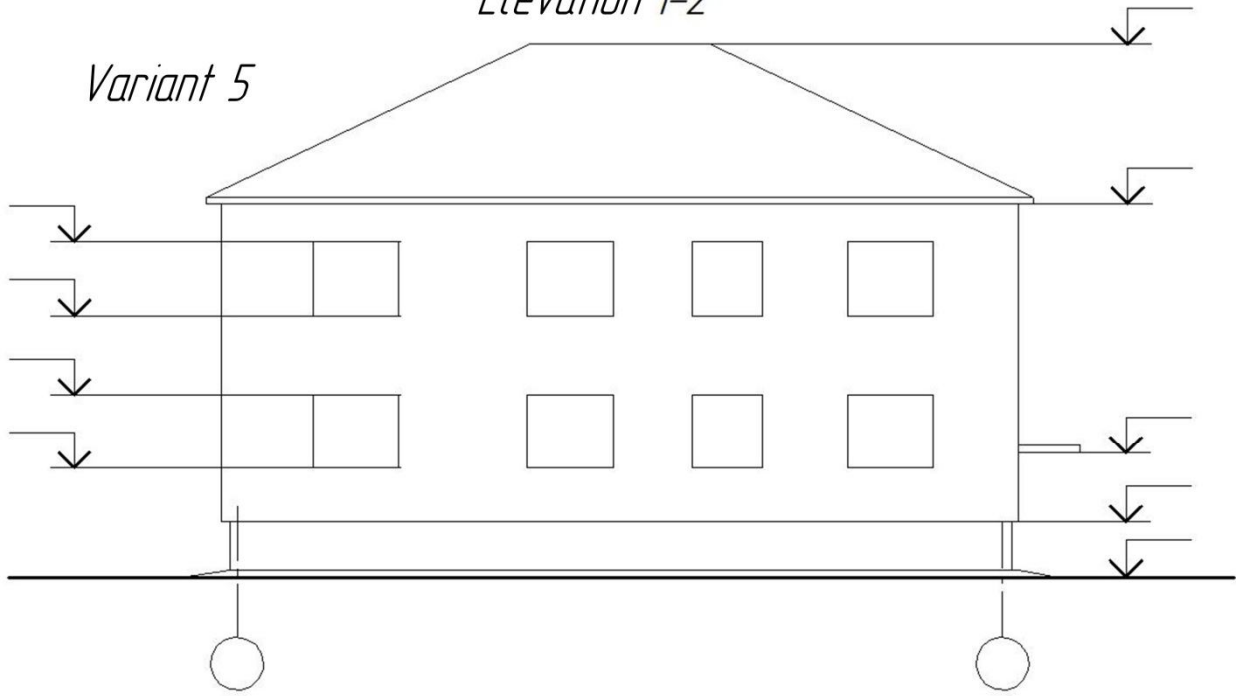


1st floor plan

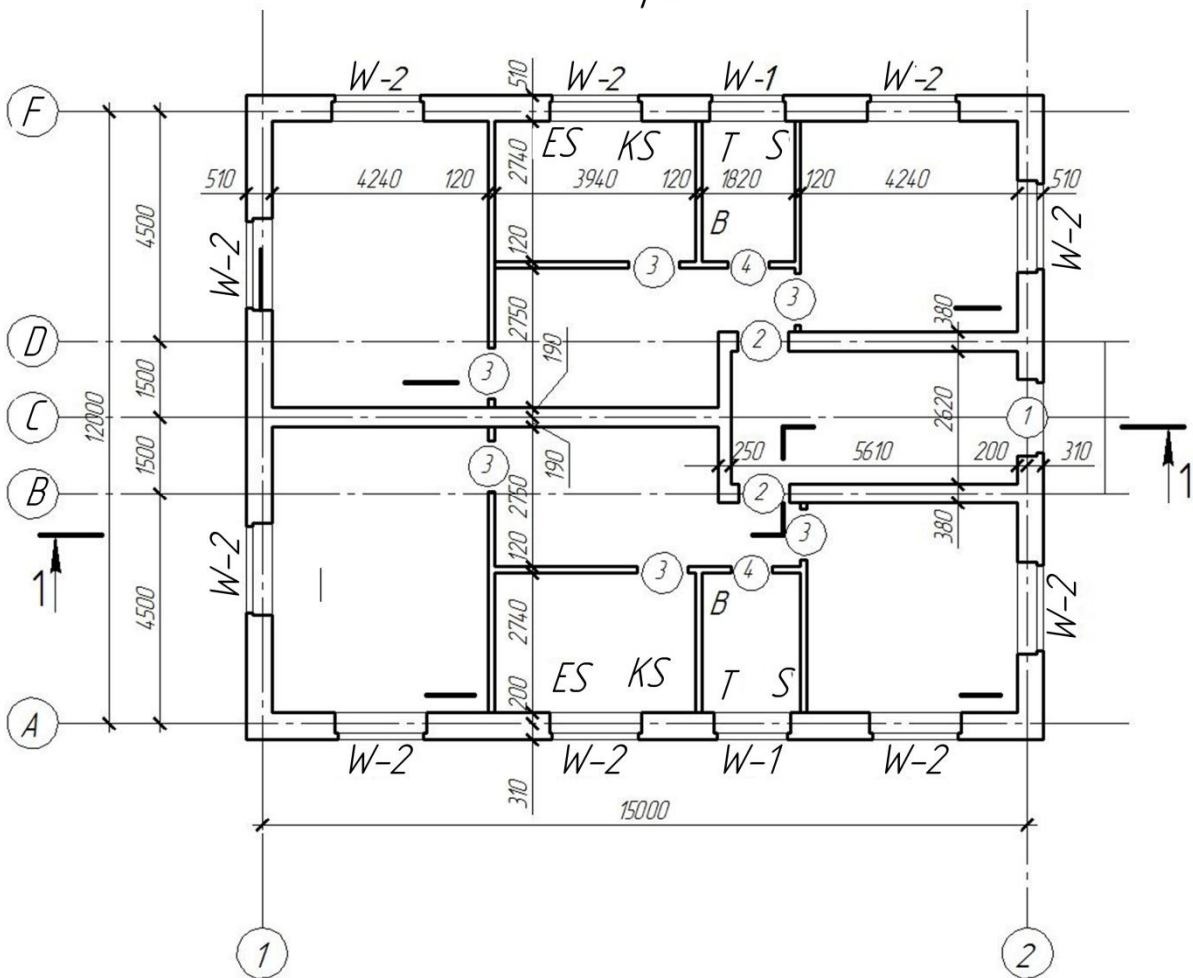


Elevation 1-2

Variant 5

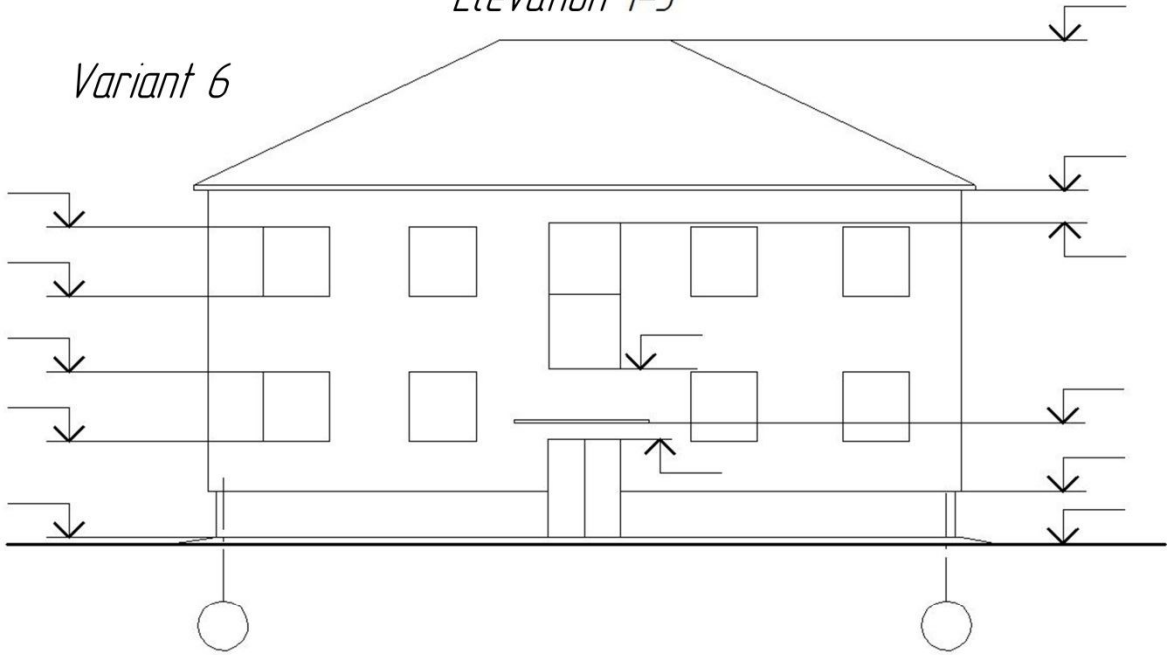


1st floor plan

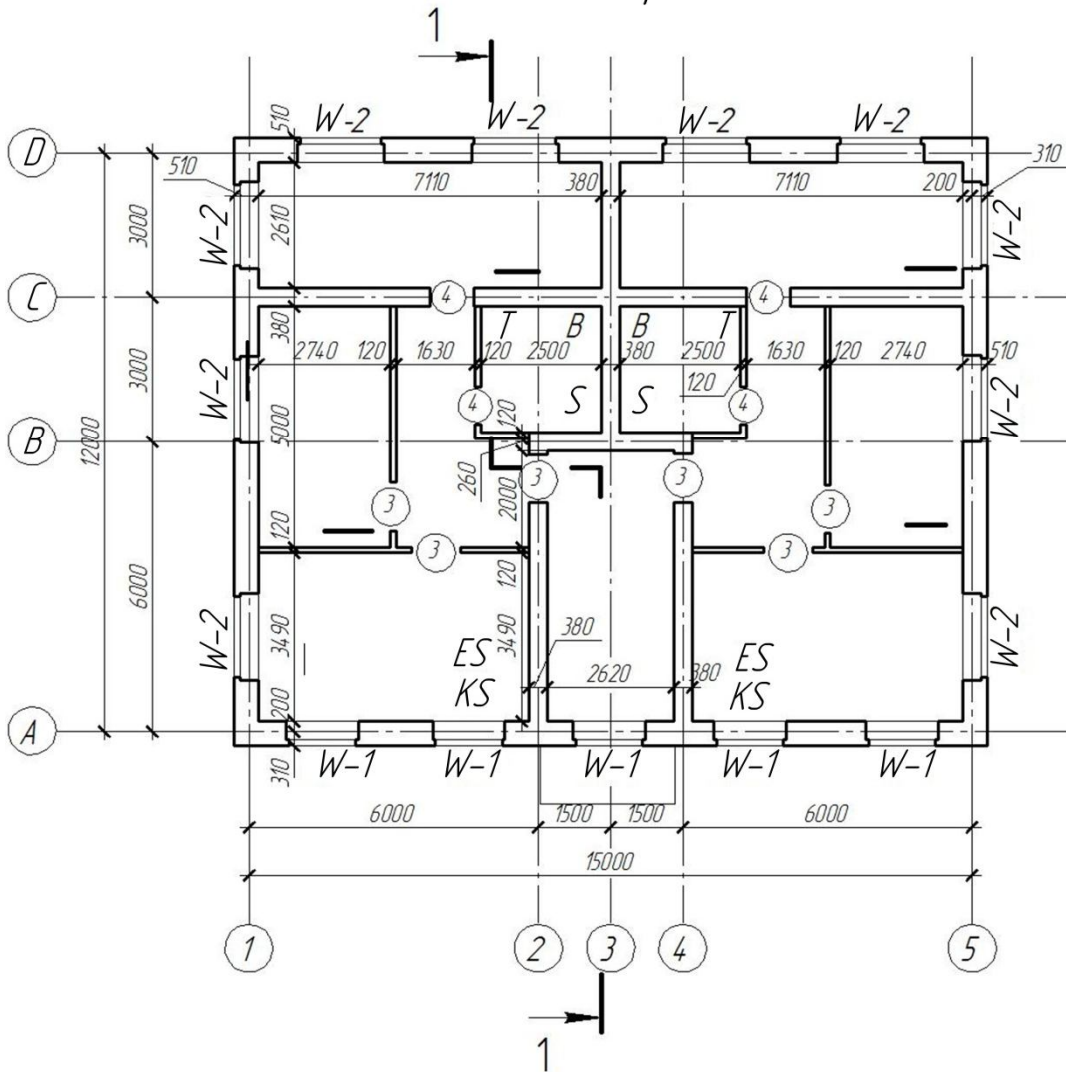


Elevation 1-5

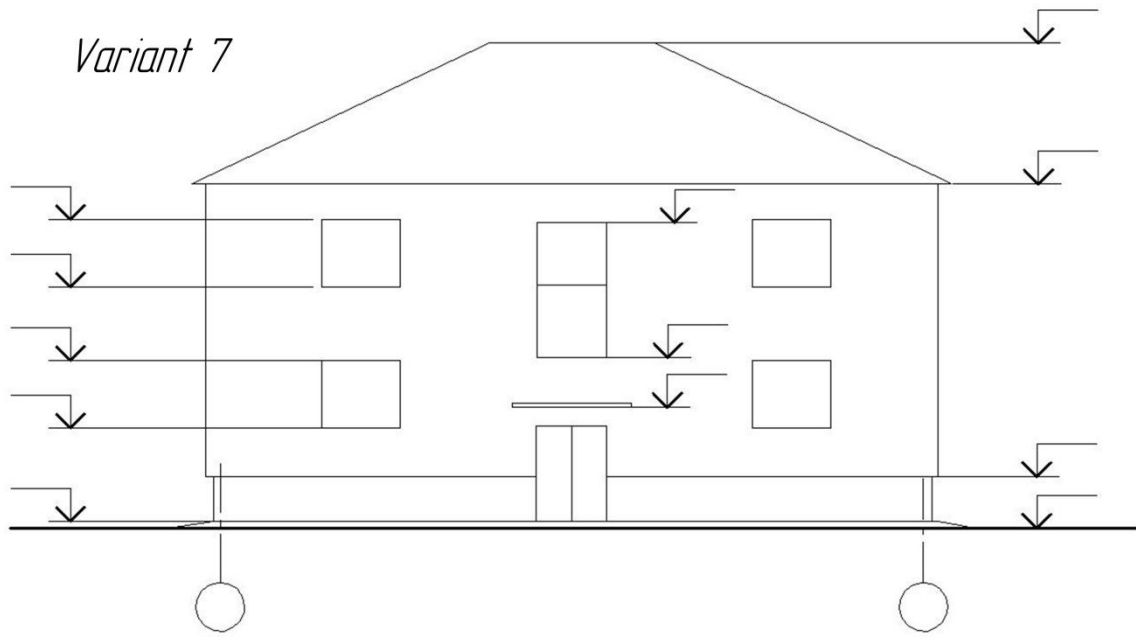
Variant 6



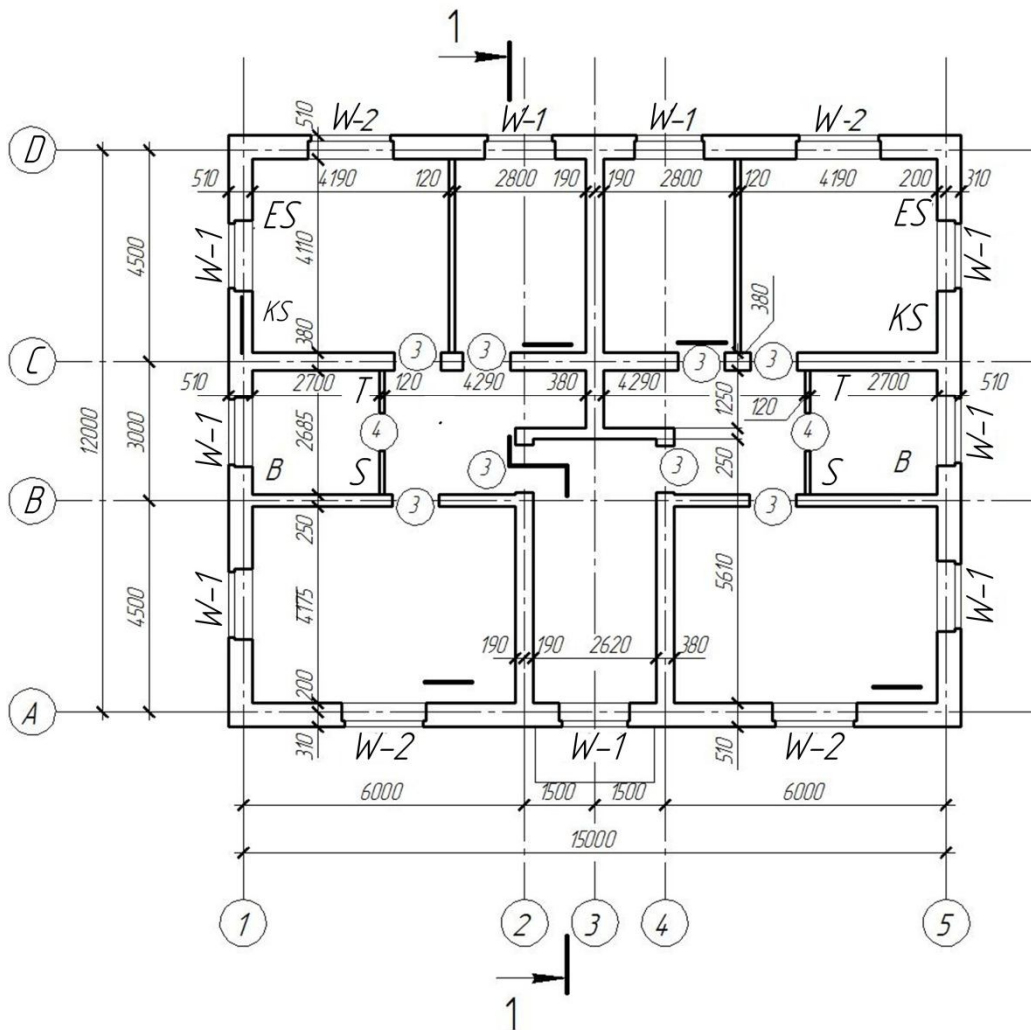
2nd floor plan



Elevation 1-5

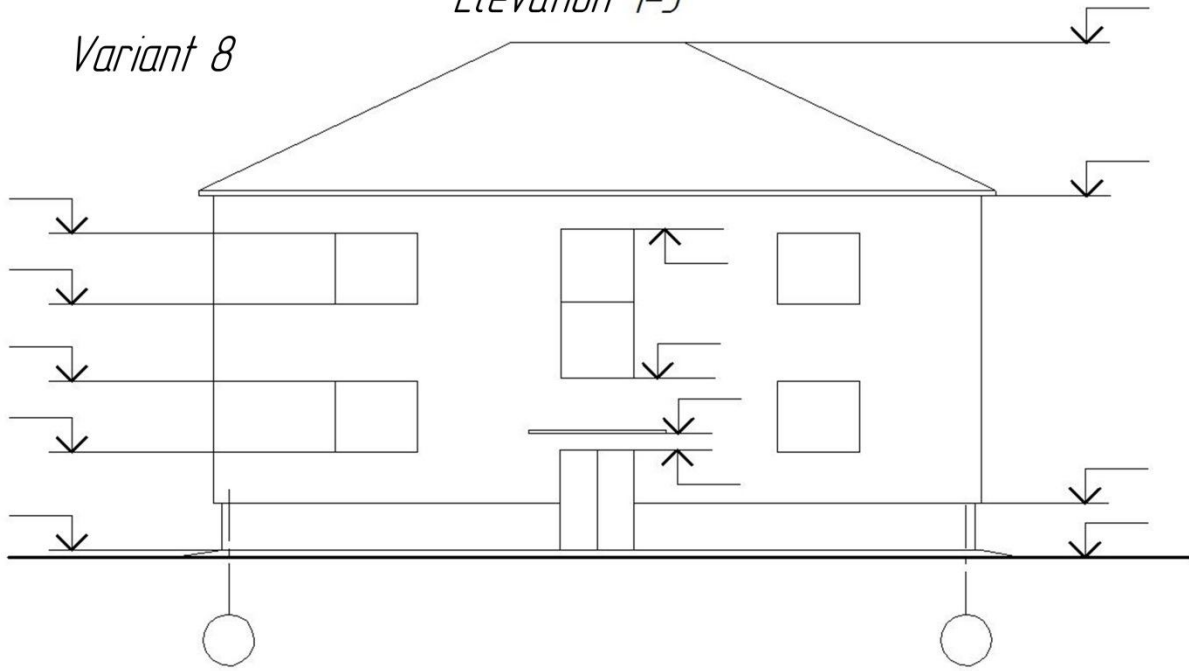


2nd floor plan

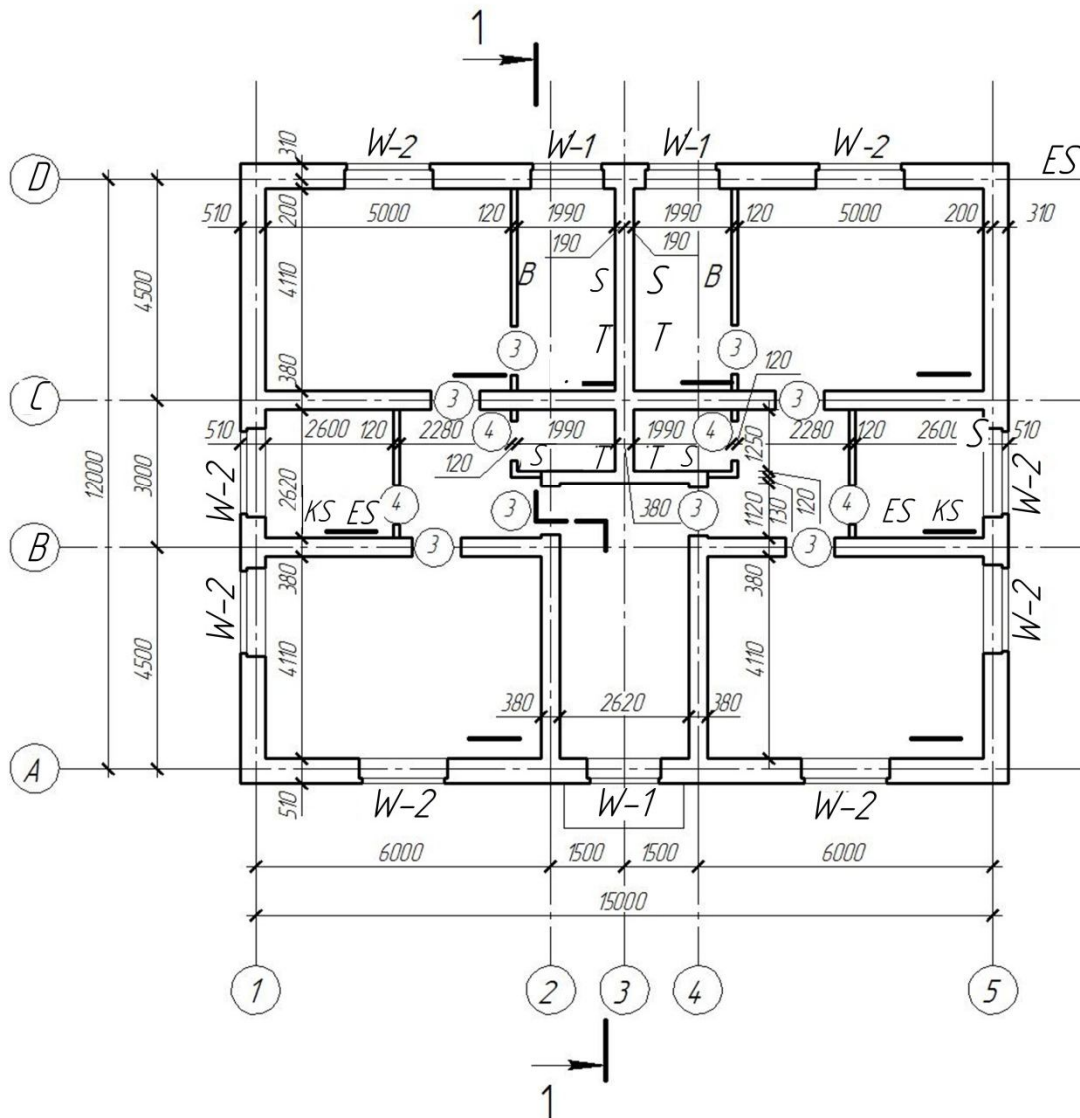


Elevation 1-5

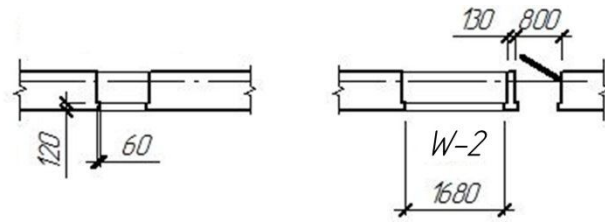
Variant 8



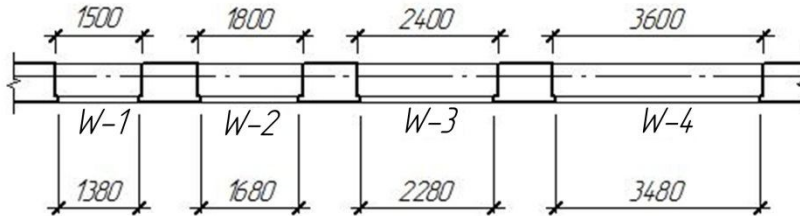
2nd floor plan



Explanation for the task



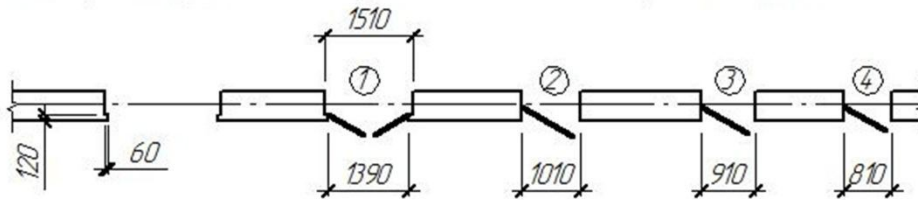
Windows



Doors

Outside door

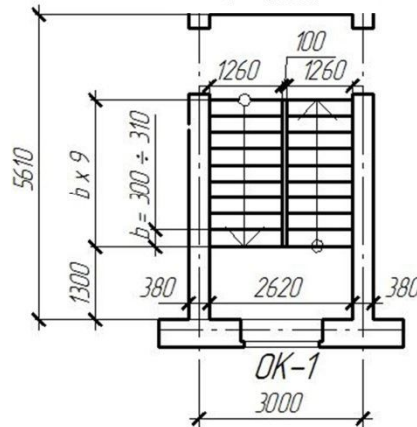
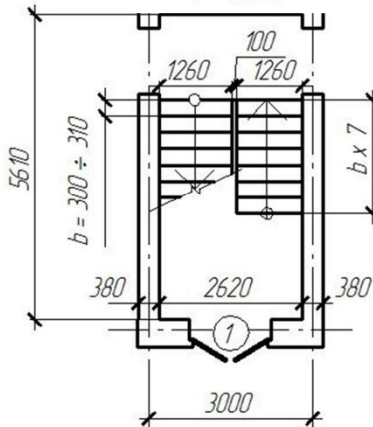
Inner door



Stairs

Stairs on the 1st floor

Stairs on the 2nd floor



Sanitary-engineering devices

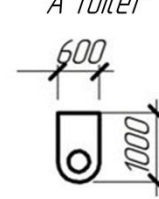
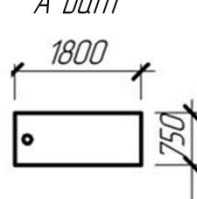
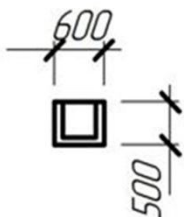
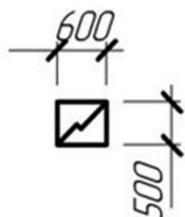
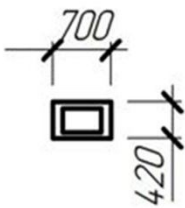
A kitchen sink

An electric stove

A sink

A bath

A toilet



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3. Інженерна та комп'ютерна графіка : Підручник / В. Є. Михайленко та інші. – Київ : Вища школа, 2000. – 341 с.
4. Потемкин А. К. Инженерная и компьютерная графика / А. К. Потемкин. – Москва : ДМК Пресс, 2001. – 592 с.

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з курсу

«ІНЖЕНЕРНА ГРАФІКА»

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освітнього рівня «бакалавр»
спеціальності 192 – Будівництво та цивільна інженерія)*

(Англ. мовою)

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За авторською редакцією

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