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DESCRIPTIVE GEOMETRY COURSE ADDRESED TO THE CIVIL ENGINEERING STUDENTS AT ODESSA STATE ACADEMY

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Abstract: Descriptive Geometry and engineering graphics is one of the educational disciplines that forms the basis of engineering education. Unfortunately, in many schools such subject as drawing is classified as a secondary one, and only spare time is assigned to the study of drawing. On the one hand, teachers have to explain the course to the audience that is completely unprepared for spatial thinking. On the other hand, on an equal footing they have to teach graphic principles: how to correctly draw parallel lines, construct perpendiculars, divide circles into the required number of equal parts and so on. In this work, some attempts are made to illustrate the ways of solving particular problem, based on the course being taught and the scientific and methodological researches conducted by the teachers of the department.

Keywords: transformation, developments of surface, topographic projection, perspective, shadows

1 Introduction

Descriptive geometry and engineering graphics is one of the educational disciplines that forms the basis of engineering education. The course is necessary for training of engineers of all specialties as it teaches methods of depicting objects and general drawing rules and promotes the development of spatial imagination.

Unfortunately, in many schools such subject as technical drawing is classified as secondary one, and only spare time is assigned to its study. As a result people with rather weak level of graphical training get enrolled to technical universities.

The practice has shown that during the period of adaptation to the system of higher education, when mastering the course of descriptive geometry and, first of all, when performing graphic works, students experience considerable difficulties. On the one hand teachers have to explain the course to an audience that is completely unprepared for spatial thinking and on the other hand, on an equal footing, they are required to teach graphic principles: how to correctly draw parallel lines, construct perpendiculars, divide circles into the required number of equal parts and so on.

Obviously, the biggest problem is how to raise the numbers of hours assigned to the descriptive geometry course in order to enable mastering the necessary range of content. Over the past 20 years practical classes of the discipline in all faculties have been reduced by half and the number of lectures decreased at some faculties. In these conditions, with the traditional approach, it is difficult not to touch upon the basic principles of the course in its presentation. We have to look for additional reserves. In this work, attempts are made to illustrate the ways to solve the problem, based on the course being taught and the scientific and methodological researches conducted by the teachers of the department.

Nowadays, the course of descriptive geometry at the Civil Engineering specialty (Faculty of Construction, Faculty of Sanitary Engineering, Faculty of Hydraulic Engineering), consists of 32 hours of lectures, 32 hours of practical classes and additionally of 8 hours of consultations

All graphic assignment are executed on A3 size of drawing paper. These formats contain the initial data of individual tasks, the tables ready for their completion, the basic initial data is provided. This allows each student to significantly reduce the time for the task. From the initial data, a student can perform the task individually (after class) or perform one variant in the classroom.

Samples of all tasks with a detailed description of their implementation are contained in the departmental guidelines [1, 2]. Students take options for 1 and 2 assignments from a methodical instruction developed by the department. Options for subsequent assignments are developed and printed in A3 sheet size.

2 Teaching methodology

The first sheet contains the problem of the construction of polyhedral surfaces in both in a three-view orthographic projection and in axonometric projection. (Fig. 1). An obligatory condition in the task is to fill the table on the right, in which the positions of the edges of surfaces that are to be determined in relation to the principal projection planes. Also, the student must set three arbitrary points on three planes and in view - one on the edge, and two on the faces (visible and invisible).

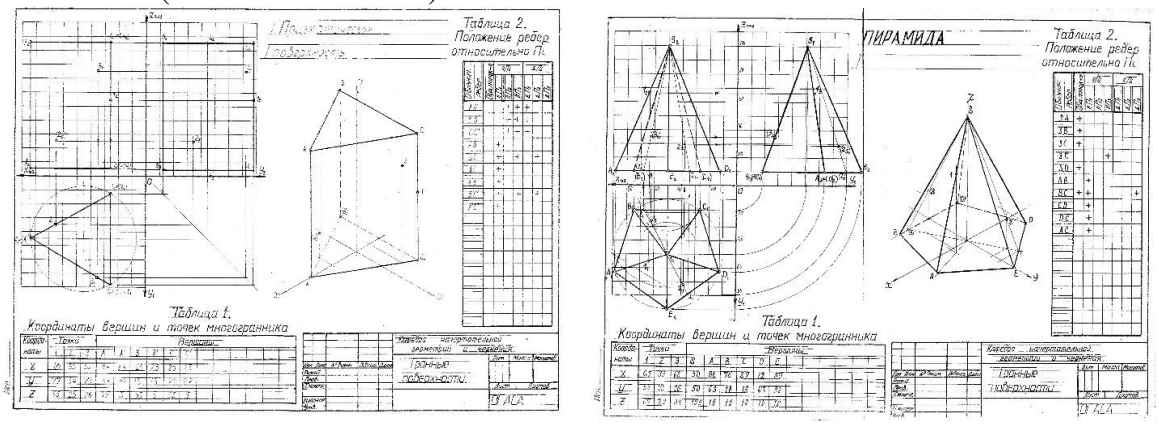

Figure 1: Examples of the performance of the work "Polyhedral surfaces"

The second sheet contains the problem of two polyhedrons' intersection the intersection of the polyhedral surfaces, one of which is in a special position in reference to the principal projection plane. (Fig. 2a). Two tables must be filled: one with vertices coordinates and the other with the data characterizing the position of the surfaces in space required. The third sheet contains the problem of two surfaces of revolution and their line of intersection (Fig. 2b). As in the previous task, a table that indicates the position of the surfaces is filled. In solving this and previous problems, the emphasis has been put on the fact that in one projection plane the line of intersection coincides with the projected surface, while in the other projection plane it shows as either a spatial broken line (Fig. 2a) or a spatial curve (Fig. 2b).

a) b)

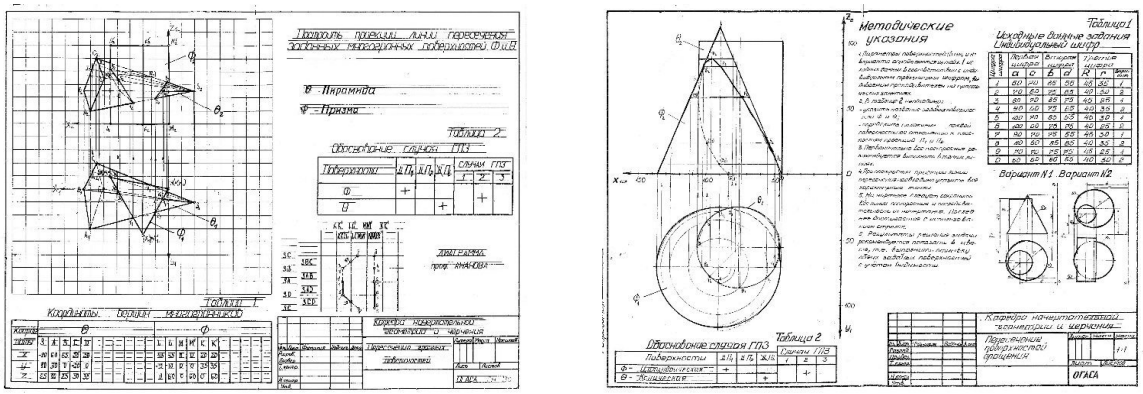

Figure 2: Examples of the performance of the work "Intersection of the surfaces": a) intersection of two polyhedrons, b) intersection of two surfaces of revolution

The fourth sheet topic is “Auxiliary views - application” (Fig. 3). In total, five different metric tasks are considered in the trihedral pyramid, and the student, in his version, solves only three. The list of tasks proposed in the assignment can be as follows: 1. Determine the base point of a normal line dropped from the top to the base; 2. Determine the natural size of the base; 3. Determine the shortest connector between two given skew lines; 4. Determine the angle between the crossing lines; 5. Determine the values of the dihedral angle at the edge.

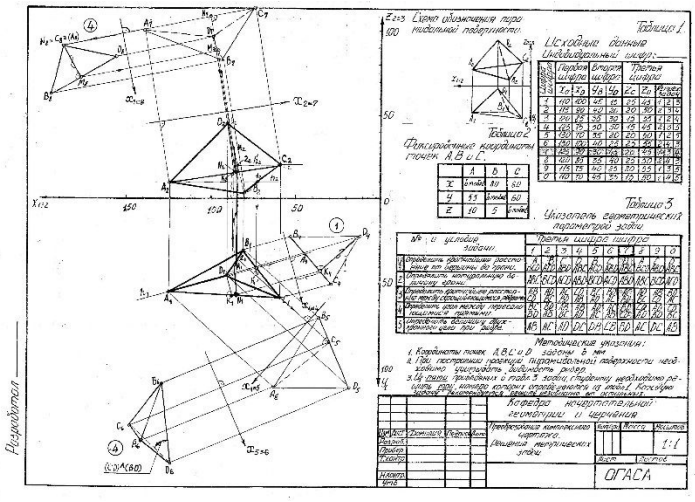

Figure 3: The example of the performance of the work -“Auxiliary views - application”

The next work is entitled: “Coted projection (Topographic projection)” (Fig. 4). The task consists of a top view of a building which must be designed in a given construction site that has been described by contour lines of the excavation work. In addition to a plan view of a construction site, a graph of the scale of slopes and a profile specified on the plan are drawn. This is quite a large burden of work assigned – to one lesson, but directly related to the construction industry. Also in this work, emphasis has been put on the fact that projections with numerical marks take place only when designing engineering structures that are much larger in the horizontal direction than in the vertical direction or in fact they are used only for earthwork drawings.

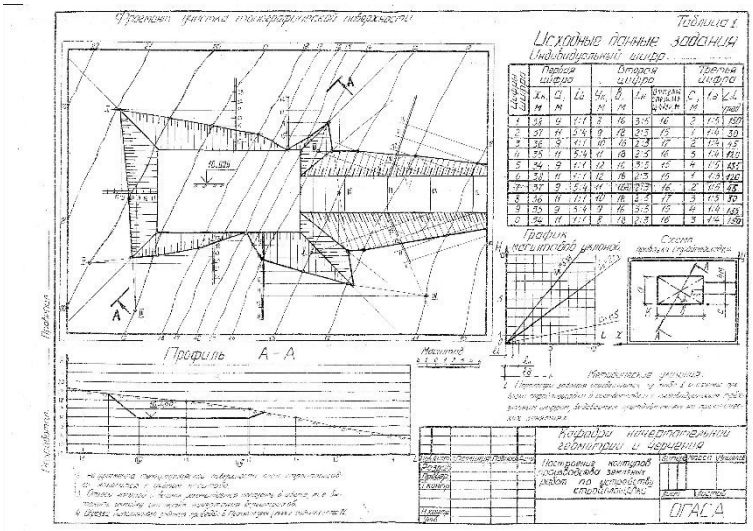

Figure 4: The example of the performance of the work “Topographic projection”

The sixth work consists of two sheets of A3 format and two lessons are devoted to it, this is the section "Developments of surfaces" (Fig. 5). According to the assignment, it is necessary to construct the projections of the pipeline design itself, and then to construct the developments of all its elements. It can be said that this is the most time-consuming work in the course, the particular difficulty lies in finding the intersection line of two surfaces circumscribed over the sphere and in constructing a development of truncated cone. It should be noted that this work greatly improves the graphic skills of students. Having completed described above assignments, any student can easily operate with a compass and a ruler.

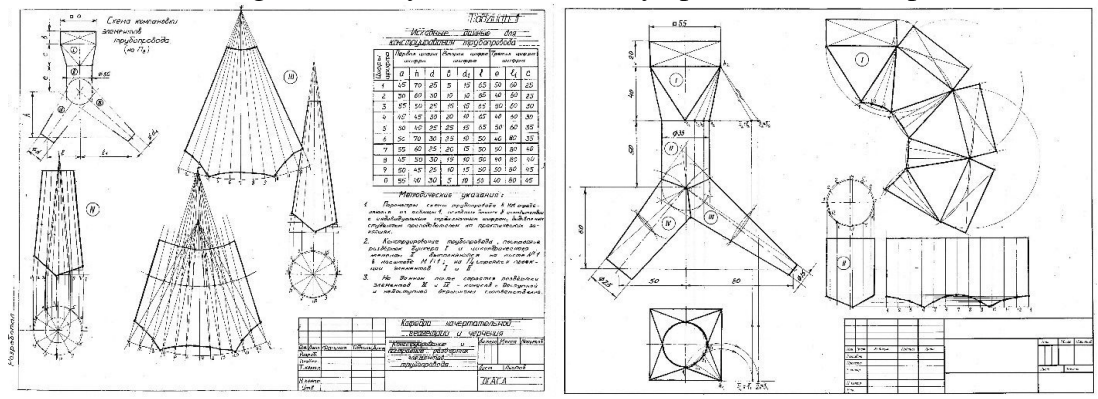

Figure 5: Examples of the performance of the work "Developments of surfaces"

The seventh work is devoted to the section "Perspective". This and the subsequent sheet are made by students only of the Faculty of Civil Engineering. It should be noted that the department has a tendency to explain different methods on this topic. Some of the teachers explains how to draw a perspective view with the use of two vanishing points (Fig. 6a), some by Gauk's method (Fig. 6b). To some extent, this allows to show to students the variety of descriptive geometry problems and methods of 3D space representation. In this work, the attention of students is drawn to the fact that the basis for the perspective is a central projection method, which is fundamentally different from the method of Mongean projection.

a) b)

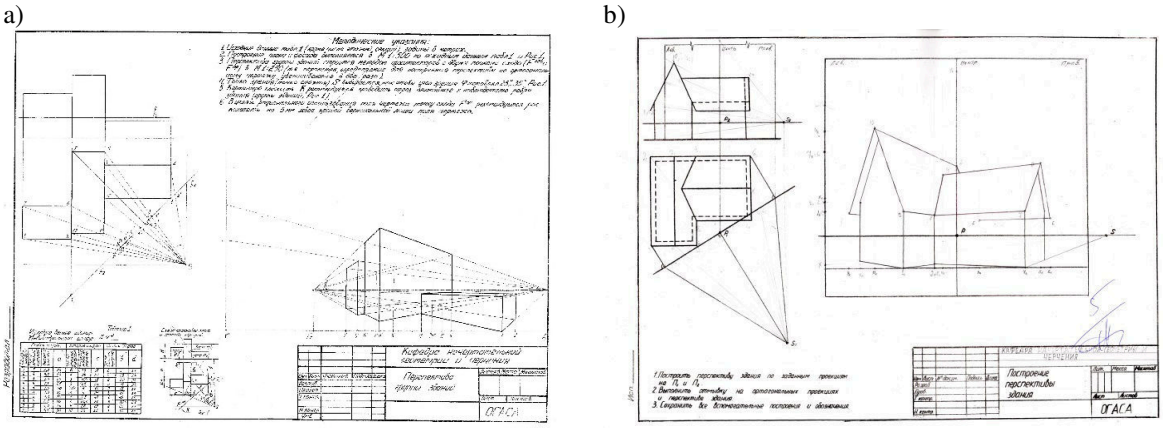

Figure 6: Examples of the performance of the work "Perspective": a) perspective with two points of descent, b) Gauk's method

The last work is devoted to the section "Shadows in orthogonal projections" (Fig. 7). We can say that this is the students' favorite work. First, they have already learned to draw well, and secondly the graphic part is simple enough.

a) b)

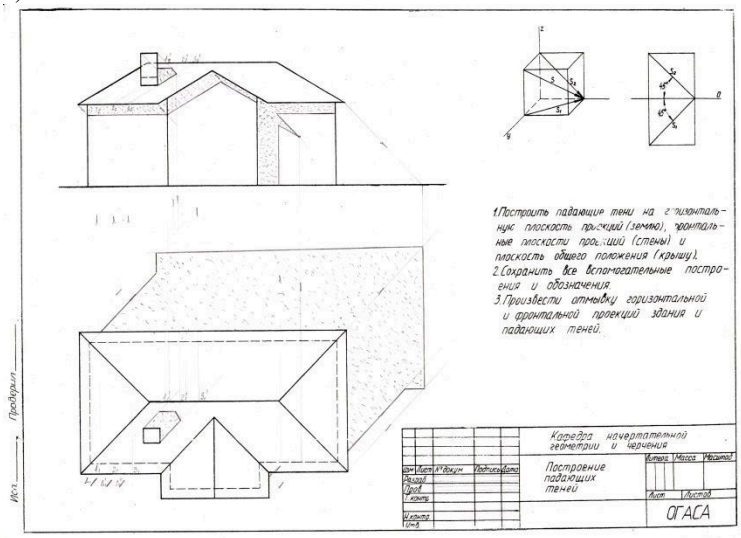

Figure 7: The example of the performance of the work "Shadows in orthogonal projections"

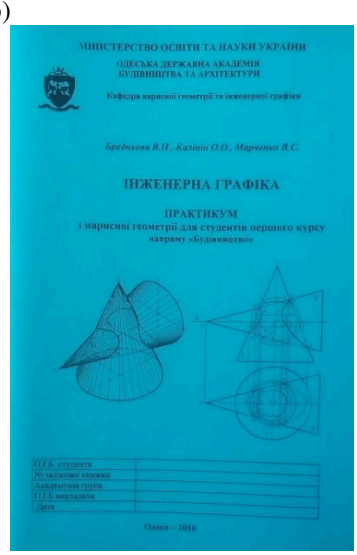

Figure 8: The problem book

It should be noted that along with the drawings, students must solve all the tasks in the problem book on descriptive geometry (Fig. 8) [4]. It includes about 70 tasks. The peculiarity of the problem book is that it contains tasks that are not carried out in graphic works. This is the finding of points on different surfaces, and the solution of metric problems without the transformation of the complex drawing, and the intersection of non-projecting surfaces. The problem book is checked twice during the semester only when summarizing the subtotals.

The student must bring a bound up album of drawing assignments and a completely solved problem book for the exam. Otherwise the student is not allowed to take the exam. As a rule those students who are admitted to the exam can count to be granted with the final grade equal to – at least – 3 (satisfactory), because the already passed stage gives certain knowledge in the discipline. However, many students get prepared for the final exam as they want to get higher final scores and since they already have a fairly good spatial imagination and a complete understanding of the discipline.

A separate topic at the department is the Olympiad on Descriptive Geometry. In the academy various competitions are held in various subjects and the prize-winners of these so called "Olympiads" go to the state level Olympiad. At the Department of Descriptive Geometry, the Olympiad takes place in December. Before the Olympiad the teachers of the department conduct four special classes, where they show more complex assignments. Any student can take part in the Olympiad, but as a rule each teacher recommends the best students in his/her group. At the Olympiad there are only three problems to be solved and these cover the contents where logic must be used while solving them. Then these tasks are discussed in detail in practical exercises. It should be noted that the prize-winners get good final grades in the Descriptive Geometry subject and they are recommended to the dean's office as the best students in a subject.

3 Conclusions

It is generally accepted that after completing the 4-month course of consultations, 16 lectures, 16 practical classes, 8 drawings, 1 problem book and 1 exam, the freshmen are well prepared to master the subsequent disciplines containing the graphic part. After all, with the knowledge on descriptive geometry, they reach the necessary level of spatial thinking and mastered graphic skills.

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KURS GEOMETRII WYKREŚLNEJ DLA STUDENTÓW KIERUNKU BUDOWNICTWO NA UNIWERSYTECIE BUDOWNICTWA I ARCHITEKTURY W ODESSIE

Geometria wykreślna i grafika inżynierska należą do dyscyplin akademickich, które stanowią podstawę edukacji inżynierskiej. Niestety, w wielu szkołach przedmiot taki jak rysunek jest traktowany jako drugorzędny i na jego realizację przydziela się mało czasu. Nauczyciele akademiccy z jednej strony mają realizować program ze studentami zupełnie nieprzygotowanymi do myślenia przestrzennego, a z drugiej strony nauczyć ich podstaw grafiki: jak rysować linie równoległe, odwzorowywać obiekty w danym rodzaju rzutu, dzielić koła na wymaganą liczbę równych części i rozwiązywać wiele podobnych problemów. W niniejszym opracowaniu autorzy podejmują próbę zilustrowania prowadzonego kursu przez podanie przykładów problemowych zadawanych studentom do rozwiązania oraz przedstawienia metodologii prowadzonych zajęć.