MINISTRY OF EDUCATION AND SCIENCE OF UKRAINE

O. M. BEKETOV NATIONAL UNIVERSITY
of URBAN ECONOMY in KHARKIV

METHODOLOGICAL RECOMMENDATIONS

for practical and independent work
on the discipline

"DESCRIPTIVE GEOMETRY AND ARCHITECTURAL GRAPHICS"

(for first-year full-time foreigner students first (bachelor's) level of higher education specialty 191 – Architecture and town-planning)

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CONTENT

INTRODUCTION

The discipline “Descriptive Geometry and Architectural Graphics” is designed for first-year full-time foreigner students specialty 191 – Architecture and town-planning. The course consists of 14 topics that consistently reveal practical skills for the successful development of other disciplines and the design of objects of different levels.

The **purpose** of teaching the discipline “Descriptive Geometry and Architectural Graphics” is the formation of students’ competencies that is to provide the development of spatial imagination and constructive-geometric thinking, the development of abilities for analysis and synthesis of spatial forms and relationships based on graphic models of space, practically implemented in the form of drawings of specific spatial objects.

The **task** of studying the discipline “Descriptive Geometry and Architectural Graphics” is to acquaint students with the means of architectural graphics; learn to operate with basic geometric shapes, from which complex architectural forms are formed; to initiate with the basic ways of construction of contours of shadows of various geometric shapes and compositions in orthogonal projections, axonometric and perspective.

Students must **be able** to: use the acquired knowledge and skills as a means of project activities; have **competence**: apply modern tools and methods of engineering, art and computer graphics used in architectural and urban design; apply artistic and compositional principles in architectural and urban design.

Know the basic rules of depicting spatial objects on the planes of projections, methods of constructing projection images.

Be able to use graphic models on the plane to obtain a representation of spatial figures.

Be able to solve various problems by methods of descriptive geometry.

Be able to draw axonometric and perspective images of objects.

Know the basic principles of shadow theory and be able to draw shadows in orthogonal projections, axonometric and perspective.

Practical work consists of graphic tasks and diagrams in accordance with the main stages and purpose of practical classes with their further discussion and independent design in the appropriate graphic form.

The independent work to graphic work of studying the discipline is a series of graphic tasks performed on the topics of practical classes.

1 THE DISCIPLINE CONTENT ACCORDING TO THE CONTENT MODULES AND THEMES

The discipline “Descriptive Geometry and Architectural Graphics” consists of two modules and six content modules, which are divided into educational elements.

Descriptive geometry is the science of methods for constructing images of spatial forms on a plane. Descriptive geometry and its methods are used in various fields of science and technology: in engineering, architecture, construction, and visual arts. The main projection method is orthogonal projection. This method is based on the projection of a spatial object into two mutually perpendicular planes by rays perpendicular (orthogonal) to these planes. In the construction and architecture, perspective projections are widely used in the depiction of projected industrial and residential buildings, city squares and streets, railway stations, interiors of metro stations and passenger halls, bridges and overpasses, various roads. These projections provide an opportunity to get visual images of engineering structures, which most accurately convey the real visual perception of a person.

There is heuristic value to studying descriptive geometry. It promotes visualization and spatial analytical abilities, as well as the intuitive ability to recognize the direction of viewing for best presenting a geometric problem for solution. A branch of geometry in which three-dimensional figures, as well as methods for solving and investigating three-dimensional problems, are studied by representing them in the plane. Such representations are constructed by means of central or parallel projection of the figure (nature, an object, an original) on the plane of projection.

The main purpose of these applications is represented by the development and improvement of the spatial ability of the students such as to enable the understanding of the basic elements of the descriptive geometry. The study of the descriptive geometry starts with elements on projection systems, focusing then on the orthogonal projection. The basic elements of the descriptive geometry, starting with the point and continuing with the line and the plane are then considered. The connection between the spatial representation and the appropriate orthogonal drawing of the element considered is essential for the students to understand the problem presented.

1.1 The program of the discipline

Module 1 Basics of orthogonal drawing. Specifics of architectural graphics.

Content module 1.1 Rectangular projections of elementary geometric shapes.

The content module gives the basic concepts of architectural graphics. Geometric principles of object formation as systems are considered. The method of orthogonal projection on two and three perpendicular planes of projections is studied. Projections of elementary geometric objects – points, lines, planes, and their location in space are studied. Positional and metric problems of descriptive geometry are solved.

Theme 1.1.1 Introduction. Basic concepts of architectural graphics. Geometric principles of forming objects as systems. Monge's method. Projections of elementary geometric figures.

Theme 1.1.2 Positional and metric properties of projections of pairs of geometric figures.

Content module 1.2 Geometric shaping of surfaces of different shapes.

The content module gives the basic concepts of surfaces, their classification and principles of formation. straight-line and curved surfaces are considered separately. Conventional forms of object modulation are shown on the example of simple geometric shapes. Methods of construction of points on surfaces of various forms and methods of construction of lines of intersection of surfaces are studied.

Theme 1.2.1 General information about surfaces. Determination of the surface. Edge surfaces. Curved surfaces. Surface rotation.

Theme 1.2.2 Points on surfaces and construction of lines of intersection of surfaces.

Content module 1.3 Construction of shadows on orthogonal drawings and details of architectural objects.

The content module provides the theoretical basis for the construction of shadows in orthogonal projections. The shadows of the basic geometric figures are drawn. Methods of constructing shadows are considered. The shadows of the surfaces of rotation are considered separately. The principles of construction of shadows on architectural details and fragments of buildings and constructions are studied.

Theme 1.3.1 Theoretical bases of shadow construction in orthogonal projections. Basic methods of constructing shadows.

Theme 1.3.2 Shadows on the facades of buildings and structures.

Theme 1.3.3 Shadows of rotating surfaces.

Module 2 Axonometric. Perspective

Content module 2.1 Axonometric. Shadows in axonometric.

The content module gives the essence of the method of obtaining axonometric images. Standard axonometric projections are considered. The principles of construction of axonometric of geometric objects are studied. The principles of shadow construction in axonometric are considered. Shadows of basic geometric shapes. Shadows of architectural objects and details. The isometric of a group of geometric bodies and a conditional architectural structure on separate sheets of

watercolour paper is built, shadows are built and works are decorated with watercolour paints.

Theme 2.1.1 The essence of the method. Standard axonometric projections. Principles of construction of axonometric images. Axonometric of basic geometric shapes and their compositions.

Theme 2.1.2 Principles of drawing shadows in axonometric. Shadows of basic geometric shapes and their compositions. Shadows of architectural objects and details.

Content module 2.2 Perspective.

The content module provides the geometric basis for constructing a perspective. Perspective of a straight line, point, plane. Methods of drawing a circle perspective. Ways of drawing perspectives of objects, perspectives of an interior are studied. The perspective of details and architectural fragments is considered. Perspectives of conditional architectural constructions and interiors are created by the studied methods on separate sheets of watercolour paper.

Theme 2.2.1 Terms. Perspective of elementary geometric objects. Methods for constructing the perspective of a circle.

Theme 2.2.2 Ways to draw a perspective.

Theme 2.2.3 Perspective of details and architectural fragments. Interior perspective.

Content module 2.3 Drawing shadows in perspective of complex architectural objects.

The content module gives the principles of drawing shadows in perspective. Shadows with parallel rays and different locations of the light source. Shadows of rotating surfaces. Shadows in the interior. Shadows in the perspective of architectural details and fragments are considered. Students draw shadows in perspective on previously done work.

Theme 2.3.1 Principles of drawing shadows in perspective. Shadows with parallel rays of light. Schemes for constructing shadows at different positions of the light source.

Theme 2.3.2 Shadows in the perspective of architectural details and fragments. Building shadows in the interior.

2 PLAN OF PRACTICAL LESSONS

2.1 Module 1 The practical classes of the content module 1.1 Rectangular projections of elementary geometric shapes

Themes of the practical classes:

1. Three- projection complex drawing of a point, a straight line. Direct position lines. Execution of a graphic task (epure, diagram) № 1.

2. Complex drawing of the plane. Mutual position of a line and a plane, two planes. Drawing a diagram № 2 and a diagram № 3.

2.2 The practical classes of the content module 1.2 Geometric shaping of surfaces of different shapes

Themes of the practical classes:

3. Projections of basic geometric shapes. Points on the surfaces of geometric shapes. Drawing a diagram № 4. Construction of the actual sectional size of the shapes by an inclined plane. Drawing a diagram № 5.

4. Method of section planes for drawing line of intersection of two surfaces. Drawing a diagram № 6. Determining the visibility of shapes areas.

2.3 The practical classes of the content module 1.3 Construction of shadows on orthogonal drawings and details of architectural objects

Themes of the practical classes:

5. Shadows of elementary geometric shapes. Real and imaginary shadow. Determining the breaking point of the shadow. Drawing a diagram № 7.

6. Shadows of prismatic shapes and surfaces of rotation. Drawing a diagram №8.

7. Shadows on the stairs. Shadows from cornices. Shadows in niches. Drawing a diagram № 9.

2.4 Module 2. The practical classes of the content module 2.1 Axonometric. Shadows in axonometric

Themes of the practical classes:

1. Drawing of isometric of a conditional architectural construction by means of a secondary horizontal projection. Graphic work № 1, A3 format of watercolour paper.

2. Drawing of isometric of a group of geometric shapes by secondary horizontal projection. Graphic work № 2, A3 format of watercolour paper.

3. Drawings of shadows on the made works № 1 and № 2. Defining own and falling shadows.

2.5 The practical classes of the content module 2.2 Perspective

Themes of the practical classes:

4. Drawing a perspective by moving the picture in parallel. Graphic work № 3, A3 format of watercolour paper.

5. Drawing perspectives by architects. Graphic work № 4, A3 format of watercolour paper.

6. Drawing a perspective by the grid method. Graphic work № 5, A3 format of watercolour paper.

7. Drawing the perspective of stairs. Graphic work № 6, A3 format of watercolour paper.

8. Drawing a vase perspective. Graphic work № 7, A3 format of watercolour paper.

9. Drawing the perspective of the cornice. Graphic work № 8, A3 format of watercolour paper.

10. Drawing an interior perspective. Graphic work № 9, A3 format of watercolour paper.

2.6 The practical classes of the content module 2.3 Drawing shadows in perspective of complex architectural objects

Themes of the practical classes:

11. Drawing of shadows on the executed perspectives of graphic works № 3, № 4 and № 5. Defining own and falling shadows.

12. Drawing of shadows on the executed perspectives of graphic works № 6, № 7, № 8 and № 9. Defining own and falling shadows.

As a result of practical classes in the discipline, the student must master the basic techniques of orthogonal drawing, get acquainted with the specifics of architectural graphics, master the basic techniques of architectural drawing.

Tasks are added in workbooks and workshops for practical classes and independent work on the subject “Descriptive Geometry and Architectural Graphics” (for 1st year students majoring in 191 - Architecture and Urban Planning):

1. URL: https://eprints.kname.edu.ua/54665/
2. URL: https://eprints.kname.edu.ua/51694/

In descriptive geometry, drawings are the tool by which direct study of the geometric shapes of the object is carried out and the solution of the spatial problems is carried out. Therefore, the following requirements are imposed on the drawings:

– the drawing should be visual, i.e. he must call forth a spatial representation of the depicted object;

– the drawing must be reversible; he must accurately determine the shape, size and position of the depicted object;

– the drawing should be simple for its graphic execution;

– the image of the object should be easy to read; drawings made by projection are called projections.

3 INDEPENDENT STUDENT WORK

Important in the formation of an active, capable of further development and creative thinking of the personality of the specialist in modern conditions is the independent work of the student, which is organically connected with all other forms of the educational process. These guidelines will help students to master the knowledge of the discipline “Descriptive Geometry and Architectural Graphics” for first-year full-time foreigner students. They are aimed at deepening and expanding the knowledge, skills and abilities of students in this field, is directly based on the basic knowledge of general secondary education.

Descriptive geometry is the branch of geometry, which allows the representation of three-dimensional objects in two dimensions by using a specific set of procedures. The resulting techniques are important for engineering, architecture, design and in art. The theoretical basis for descriptive geometry is provided by planar geometric projections.

Descriptive geometry uses the image-creating technique of imaginary, parallel projectors emanating from an imaginary object and intersecting an imaginary plane of projection at right angles. The cumulative points of intersections create the desired image. Each image view accommodates three dimensions of space. These sequential projections each represent a circuitous, 90° turn in space in order to view the object from a different direction. The result is one of stepping circuitously about an object in 90° turns and viewing the object from each step.

3.1 Themes of graphic tasks for independent work

Independent work in the modern educational process is considered as a form of training organization. Independent work able to provide an independent search for the necessary information, creative perception and comprehension of educational material in the course of classroom activities, various forms of cognitive activity of students in the classroom and in extracurricular activities time. Independent work develops analytical skills, control skills and planning of study time, skills and abilities rational organization of educational work. Thus, independent work is a form of organization educational process, stimulating activity, independence, cognitive interest of students.

The student’s independent educational work is an album of graphic tasks on the topics of lectures and practical classes. Tasks are drawing on an A3 format paper.

Graphic works with the subsequent work of drawing shadows by the method of washing are drawn on an A3 format of watercolor paper.

Drawing tools: rulers, corner rulers, pencils, colored pencils, stationery, ink, liner or rapidograph, watercolor paint, gouache, brushes, paper, watercolor paper.

Module 1 Basics of orthogonal drawing. Specifics of architectural graphics

Content module 1.1 Rectangular projections of elementary geometric shapes.

1. Tasks for independent work to the diagram № 1. Rectangular triangle method (verbal questioning, graphic control).
2. Tasks for independent work to the diagram № 2. Line of intersection of two planes (verbal questioning, graphic control).
3. Tasks for independent work to the diagram № 3. Distance from point to plane (verbal questioning, graphic control).

Content module 1.2 Geometric shaping of surfaces of different shapes.

4. Tasks for independent work to the diagram № 4. Points on surfaces of rotation (verbal questioning, graphic control).
5. Tasks for independent work to the diagram № 5. Methods of drawing the actual cross-sectional size (verbal questioning, graphic control).
6. Tasks for independent work to the diagram № 6. Methods of constructing a line of mutual intersection of surfaces (verbal questioning, graphic control).

Content module 1.3 Construction of shadows on orthogonal drawings and details of architectural objects.

7. Tasks for independent work to the diagram № 7. Determining the breaking points of the shadow. Watercolour design of the task (verbal questioning, graphic control).
8. Tasks for independent work to the diagram № 8. Completion of work. Watercolour design of the task (verbal questioning, graphic control).
9. Tasks for independent work to the diagram № 9. Completion of work. Watercolour design of the task (verbal questioning, graphic control).

Module 2 Axonometric. Perspective

Content module 2.1 Axonometric. Shadows in axonometric.

10. Tasks for independent work to graphic work № 1. Drawings of building details – stairs, niches, cornices (verbal questioning, graphic control).
11. Tasks for independent work to graphic work № 2. Determining the visibility of areas of shapes. Visibility guidance (verbal questioning, graphic control).
12. Tasks for independent work. Design works № 1 and № 2 with the technique of watercolour washing taking into account the density of the paint solution for own and falling shadows (graphic control).

Content module 2.2 Perspective.

13. Tasks for independent work to graphic work № 3. Completion and registration of work (verbal questioning, graphic control).

14. Tasks for independent work to graphic work № 4. Drawing of lines of overall intersection of parts of the object (verbal questioning, graphic control).

15. Tasks for independent work to graphic work № 5. Drawing of parts and lines of overall intersection of parts of the object (verbal questioning, graphic control).

16. Tasks for independent work to graphic work № 6. Drawing of stairs by the method of proportional division of segments (verbal questioning, graphic control).

17. Tasks for independent work to graphic work № 7. Drawing of intermediate circles, envelope of the vase line (verbal questioning, graphic control).

18. Tasks for independent work to graphic work № 8. Drawing of cornice profiles in bisector planes (verbal questioning, graphic control).

19. Tasks for independent work to graphic work № 9. Drawing of details of the room (verbal questioning, graphic control).

Content module 2.3 Drawing shadows in perspective of complex architectural objects.

20. Tasks for independent work. Design works № 3, № 4 and № 5 with watercolour washing technique taking into account the density of the paint solution for own and falling shadows (graphic control).

21. Tasks for independent work. Design works № 6, № 7, № 8 and № 9 with watercolour washing technique taking into account the density of the paint solution for own and falling shadows (graphic control).

RECOMMENDED LITERATURE

1. Короев Ю. И. Начертательная геометрия : учебник / Ю. И. Короев – М. : Кнорус, 2015. – 420 с.
2. Лусь В. Нарисна геометрія, інженерна та машинна графіка : навч. посібник / В. І. Лусь ; Харків. нац. ун-т міськ. госп-ва ім. О. М. Бекетова. – Харків : ХНУМГ ім. О. М. Бекетова, 2019. – 223 с.
3. Нарисна геометрія : підручник для студ. вищ. навч. закл. / В. Є. Михайленко, М. Ф. Євстіфеєв, С. М. Ковальов, О. В. Кащенко, за ред. В. Є. Михайленка. – Київ : Вища школа, 2004. – 304с.
4. Начертательная геометрия и инженерная графика : Учеб.-метод. комплекс / Сост. Артемьева Т. Я., Лубченок В. А., Махова Т. С., Ярмолович С. В.; под общ. ред. С. В. Ярмоловича. – Новополоцк : ПГУ, 2004. – 204 с.
5. Основи архітектурної графіки : навч. посібник / А. О. Радченко, О. Ю.Усачова ; Харків. нац. ун-т. міськ. госп-ва. ім. О. М. Бекетова. – Харків : ХНУМГ ім. О. М. Бекетова, 2018. – 248 с.
6. Практикум з нарисної геометрії. Навчально-методичний посібник (для самостійної роботи студентів) /Авт. : Лусь В. І., Киркач Т. Є., Мандріченко О. Є., Радченко А. О.; за ред. Луся В. І. – Харків : ХНАМГ, 2014. – 118 с.
7. Практикум для практичних занять та самостійної роботи з навчальної дисципліни «Нарисна геометрія та архітектурна графіка». 1-й змістовий модуль «Прямокутні проекції елементарних геометричних фігур» (для студентів 1 курсу зі спеціальності 191 – Архітектура та містобудування) / Харків. нац. ун-т міськ. госп-ва ім. О. М. Бекетова ; уклад. : А. О. Радченко, О. Ю. Усачова. – Харків : ХНУМГ ім. О. М. Бекетова, 2020. – 20 с.
8. Робочий зошит для практичних занять та самостійної роботи з навчальної дисципліни «Нарисна геометрія та основи архітектурної графіки». 2-й змістовий модуль «Тіні в ортогональних проекціях» (для студентів 1 курсу зі спеціальності 191 – Архітектура та містобудування) / Харків. нац. ун-т міськ. госп-ва ім. О. М. Бекетова ; уклад. : А. О. Радченко, О. Ю. Усачова. – Харків : ХНУМГ ім. О. М. Бекетова, 2019. – 20 с.
9. Ching F. Architectural graphics / Francis D.K. Ching. – New Jersey: John Wiley & Sons, 2015. – 275 p.

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