Federal State Autonomous Educational Institution of Higher Education
PEOPLES' FRIENDSHIP UNIVERSITY OF RUSSIA NAMED AFTER PATRICE LUMUMBA
RUDN University

Academy of Engineering
educational division (faculty/institute/academy) as higher education programme developer

COURSE SYLLABUS

Geometric Shaping and Analysis of Shells
course title

Recommended by the Didactic Council for the Education Field of:
08.04.01 Civil Engineering
field of studies / speciality code and title

The course instruction is implemented within the professional education programme of higher education:
Civil Engineering and Built Environment
higher education programme profile/specialisation title

2026

1. COURSE GOAL(s)

The purpose of mastering the discipline "Geometric Shaping and Analysis of Shells" is to obtain knowledge, skills, and abilities for choosing the most effective forms for building structures, as well as understanding and using the relationship between the shape of a structure, its strength and ergonomics in design. In the process of studying the discipline, competencies are formed that ensure the achievement of the planned results of mastering the educational program.

The main objectives of the discipline:

- to form the skill of assessing the shape of a structure and choosing the most effective form in terms of strength, material consumption and ergonomics;
- to prepare a new generation of young designers who will reveal new possibilities of thin-walled structures in connection with the emergence of new materials and software packages for calculation, new forms in the architecture of spatial structures.

Each famous spatial structure is unique and their construction cannot be put on stream. The famous architect and engineer E. Torroja says: "The best construction is that whose reliability is ensured mainly by its form, and not by the strength of its material. The latter is achieved easily, while the former, on the contrary, is achieved with great difficulty. This is the charm of the search and the satisfaction of discovery."

2. REQUIREMENTS FOR LEARNING OUTCOMES

The course Geometric Shaping and Analysis of Shells implementation is aimed at the development of the following competences (competences in part):

Table 2.1. List of competences that students acquire during the course «Geometric Shaping and Analysis of Shells»

Competence code	**Competence descriptor**	**Competence formation indicators** (within this course)
PC-1	Conducting scientific research in the field of construction	PC-1.1 Able to carry out planning, preparation for research; PC-1.2 Able to carry out, control, receive research results; PC-1.3 Able to analyze and process research results; PC-1.4 Knows how to draw up, coordinate, and present the results of completed research
PC-2	Development of project products based on the results of engineering and technical design for urban development activities	PC-2.1 Capable of performing engineering and technical design and developing design products for building structures, grounds and foundations

3. COURSE IN HIGHER EDUCATION PROGRAMME STRUCTURE

The course Geometric Shaping and Analysis of Shells refers to the *elective component* of (B1) block of the higher educational programme curriculum.

Within the higher education programme students also master other disciplines (modules) and / or internships that contribute to the achievement of the expected learning outcomes as results of the course Geometric Shaping and Analysis of Shells.

Table 3.1. The list of the higher education programme components that contribute to the achievement of the expected learning outcomes as the internship results.

Competence code	**Competence descriptor**	**Previous courses / modules, internships**	**Subsequent courses / modules, internships**
PC-1	Conducting scientific research in the field of construction	Problem solving tecniques in Civil Engineering; Building materials:	Independent Research Work; Pre-Graduation Practice

		Special Topics	
PC-2	Development of project products based on the results of engineering and technical design for urban development activities	Digital technologies in construction; Structural Design in Reinforced Concrete: Special Topics; Structural Dynamics; Building materials: Special Topics; Structural Design in Steel: Special Topics; Modelling of Construction Processes	Desin Practice; Technological Practice; Pre-Graduation Practice

4. COURSE WORKLOAD

The total workload of the course Geometric Shaping and Analysis of Shells is 2 credits.

Table 4.1. Academic activities types by periods of the higher education programme

Type of academic activities		**Total academic hours**	**Semester(s)**			
			3			
Contact academic hours		36	36			
including:						
Lectures (LC)		18	18			
Lab works (LW)		0	0			
Seminars (workshops / tutorials) (S)		18	18			
Self-studies academic hours		27	27			
Evaluation and assessment academic hours		9	9			
Course work / project, credits						
Course workload	academic hours	72	72			
	credits	2	2			

5. COURSE CONTENTS

Modules	**Contents (topics)**	**Academic activities types ***
Section 1. Classification of surfaces and principles of shape generation	Global classification of surfaces. Classification of ruled surfaces. Second-order surfaces. Optimization of the geometric shape of surfaces according to given criteria	LC, S
Section 2. Geometric characteristics of surfaces	First and second quadratic forms of surfaces, formulas for definition, physical meaning. Gaussian curvature. Shells in the form of ruled surfaces of positive, zero and negative Gaussian curvature	LC, S

Modules	Contents (topics)	Academic activities types *
Section 3. Fundamentals of shell calculation	Fundamentals of shell calculation. Equilibrium and continuity equations, physical equations. Calculation of shells according to moment and momentless theory.	LC, S
Section 4. Shells of revolution	Spherical shell. Shells in the form of a one-sheet hyperboloid of revolution. Paraboloid and ellipsoid of revolution. Circular torus. Pseudosphere. Catenoid. Fundamentals of calculating shells of revolution	LC, S
Section 5. Helical Shells	Five types of helicoids. Fundamentals and features of calculating helical shells. Selecting the most effective type for structures for different practical issues	LC, S
Section 6. Effective shapes of shells	Methods for improving the efficiency of a structure by selecting a shape at the preliminary design of a structure	LC, S

* - to be filled in only for full -time training: LC - lectures; LW - lab work; S - seminars.

6. CLASSROOM EQUIPMENT AND TECHNOLOGY SUPPORT REQUIREMENTS

Table 6.1. Classroom equipment and technology support requirements

Type of academic activities	Classroom equipment	Specialized educational / laboratory equipment, software and materials for course study (if necessary)
Lectures	An auditorium for conducting lectures, equipped with a set of specialized furniture; a blackboard (screen) and technical means for multi-media presentations.	
Seminars	A classroom for conducting seminars, group and individual consultations, current and midterm assessment; equipped with a set of specialised furniture and technical means for multimedia presentations.	
Computer Labs	A classroom for conducting classes, group and individual consultations, current and mid-term assessment, equipped with personal computers (in the amount of 14 pcs), a board (screen) and technical means of multimedia presentations.	
Self-studies	A classroom for independent work of students (can be used for seminars and consultations), equipped with a set of specialised furniture and computers with access to the electronic information and educational environment	

7. RESOURCES RECOMMENDED FOR INTERNSHIP

Main readings:

1. Krivoshapko, S.N., Ivanov, V.N. Encyclopedia of analytical surfaces [Electronic resource] 2025. C. xxx+752~pp. ISBN 9783319117720 URL: https://search.ebscohost.com/login.aspx?direct=true&db=msn&AN=MR3309742&site=eds-live

Additional readings:

1. Robinson, Horatio N. Conic sections and analytical geometry: theoretically and practically illustrated / by Horatio N. Robinson [Electronic resource] 2019. 280 c. URL: http://dlib.rsl.ru/rsl01004000000/rsl01004493000/rsl01004493106/rsl01004493106.pdf

2. Alexander I. Bobenko. Advances in Discrete Differential Geometry [Electronic resource] 2023. 1 c. ISBN 9783662504468

URL: http://www.oapen.org/download/?type=document&docid=100185

3. Nicholson P. Vol. 1: The principles of architecture: Containing the fundamental rules of the art, in geometry, arithmetic, and mensuration: With the application of these rules to practice: In 3 vol [Electronic resource]. - London: Bohn, 1841.

URL:
http://dlib.rsl.ru/rsl01004000000/rsl01004430000/rsl01004430454/rsl01004430454.pdf

4. Krivoshapko S. Forming of velaroidal surfaces on ring plan with two families of sinusoids [Electronic resource]: Abstracts / S. Krivoshapko, S. Shambina // 16th Scientific - Professional Colloquium on Geometry and Graphics. - 2022. - P. 19. – Electronic text data.

5. Wentworth G., Smith D. E. Solid geometry / by George Wentworth and David Eugene Smith [Electronic resource] 463 c.

URL:
http://dlib.rsl.ru/rsl01004000000/rsl01004457000/rsl01004457534/rsl01004457534.pdf

6. Krivoshapko S. Classification of cyclic surfaces and geometrical research of canal surfaces [Electronic resource] / S. Krivoshapko, Bock Hyeng C. A. // International Journal of Research and Reviews in Applied Sciences. - 2022. - Vol. 12. – Iss. 3. - P. 360-374. - Electronic text data.

7. Krivoshapko S. Geometrical research of rare types of cyclic surfaces [Electronic resource] / S. Krivoshapko, Bock Hyeng C. A. // International Journal of Research and Reviews in Applied Sciences. - 2022. - Vol. 12. – Iss. 3. - P. 346-359. - Electronic text data.

8. Krivoshapko S. Two methods of analysis of thin elastic open helicoidal shells [Electronic re-source] / S. Krivoshapko, G. GbaguidiAisse // International Journal of Research and Reviews in Applied Sciences. - 2022. - Vol. 12. – Iss. 3. - P. 382-390. - Electronic text data.

Resources of the Internet information and telecommunications network»:

Internet sources:

1. Electronic libraries (EL) of RUDN University and other institutions, to which university students have access on the basis of concluded agreements:

- RUDN Electronic Library System (RUDN ELS) http://lib.rudn.ru/MegaPro/Web
- EL "University Library Online" http://www.biblioclub.ru
- EL "Yurayt" http://www.biblio-online.ru
- EL "Student Consultant" www.studentlibrary.ru
- EL "Lan" http://e.lanbook.com/
- EL "Trinity Bridge"

2. Databases and search engines:

- electronic foundation of legal and normative-technical documentation http://docs.cntd.ru/
- Yandex search engine https:// www .yandex.ru/
- Google search engine https://www.google.ru/
- Scopus abstract database http://www.elsevierscience.ru/products/scopus/

The training toolkit and guidelines for a student:

1. Collection of lectures on the course Geometric Shaping and Analysis of Shells.

* The training toolkit and guidelines for the course are placed on the internship page in the university telecommunication training and information system under the set procedure..

8. ASSESSMENT TOOLKIT AND GRADING SYSTEM* FOR EVALUATION OF STUDENTS' COMPETENCES LEVEL AS INTERNSHIP RESULTS

The assessment toolkit and the grading system* to evaluate the level of competences (competences in part) formation as the course Geometric Shaping and Analysis of Shells results are specified in the Appendix to the internship syllabus.

* The assessment toolkit and the grading system are formed on the basis of the requirements of the relevant local normative act of RUDN University (regulations / order).

DEVELOPERS:

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position in the education department	*signature*	*Last name and first name*

HEAD OF EDUCATIONAL DEPARTMENT:

Head of the Department		*Yazyev Serdar Batyrovich*
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