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**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

1. COURSE GOAL(s)

The goal of the course Geometric Shaping and Analysis of Shells is to gain knowledge and skills to show the relationship between the shape of the structure, its strength and ergonomics, which characterizes the stages of competence formation and ensures the achievement of the planned results of the development of the educational program.

The main objective of the course "Geometric Shaping and Analysis of Shells" / "Geometric Shaping and Analysis of Shells" is to train a new generation of young architects and civil engineers who will discover new possibilities of thin-walled structures in connection with the emergence of new materials and software systems for calculation, new forms in the architecture of spatial structures. Each famous spatial structure is unique and their construction can not be made mass. The famous architect and engineer E. Torroja said: "The best structure is the one whose reliability is mainly due to its shape, and not due to the strength of its material. The latter is achieved simply, while the former, on the contrary, with great difficulty. This is the beauty 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 techniques in Civil Engineering; Nanotechnology in Civil Engineering; Building materials: Special Topics	Independent Research Work; Pre-Graduation Practice

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 Steel; Nanotechnology in Civil Engineering; Structural Design in Reinforced Concrete: Special Topics; Structural Dynamics; Structural Design in Reinforced Concrete; Building materials: Special Topics; Structural Design in Steel: Special Topics; Modelling of Construction Processes	Desin Practice; Technological Practice; Pre-Graduation Practice
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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			
<i>Contact academic hours</i>	36	36			
including:					
Lectures (LC)	18	18			
Lab works (LW)	0	0			
Seminars (workshops / tutorials) (S)	18	18			
<i>Self-studies academic hours</i>	27	27			
<i>Evaluation and assessment academic hours</i>	9	9			
<i>Course work / project, credits</i>					
Course workload	academic hours	72	72		
	credits	2	2		

5. COURSE CONTENTS

Modules	Contents (topics)	Academic activities types *
Section 1. Classification and forms of spatial structures	Topic 1.1 Planar designs. Classification and forms of spatial structures. Signs of static shaping. Kinematic surfaces	LC, S
Section 2. On the design and construction of spatial	Topic 2.1 Structures working "on the span", rigid shells, regular systems, suspended roofs, transforming systems, air-supporting and air-	LC, S

Modules	Contents (topics)	Academic activities types *
structures	suspended structures. Topic 2.2 Tent structures. Structural concept. Production, transportation and construction of spatial systems	
Section 3. Shells of revolution	Topic 3.1 Spherical shell. Shells in the form of a single-cavity hyperboloid of revolution. Paraboloid and ellipsoid of revolution. Circular torus. Topic 3.2 Pseudosphere. Catenoid. Globoid. A drop. The mating surfaces of coaxial cylinder and cone.	LC, S
Section 4. Ruled shells of zero Gaussian curvature	Topic 4.1 Conical, cylindrical and torso shells. Build torso developments. Replacement of cylinders, cones and torse surfaces folds. Sur-faces of the equal slope	LC, S
Section 5. Ruled shells of negative Gaussian curvature	Topic 5.1 Hyperbolic paraboloid. Conoids. Cylindroids. 5 types of ruled helicoids. Ruled rotary and spiroid surfaces. Catalan Surfaces	LC, S
Section 6. Cyclic surfaces	Topic 6.1 Channel surfaces. Normal cyclic surfaces. Cyclic surfaces with a parallelism plane. Cyclic surfaces with circles in the planes of the bunch	LC, S
Section 7. Kinematic surfaces	Topic 7.1 Direct transfer surfaces. Rotative and spiroid surfaces	LC, S
Section 8. Umbrella surfaces and umbrella type surfaces	Topic 8.1 Wavy type and wavy surfaces. Corrugated surfaces. Corrugated products. Umbrella domes on the cone. Reinforced concrete, metal, tent umbrella shells	LC, S
Section 9. Minimal surfaces	Topic 9.1 Minimal surfaces strung on a rigid support contour. Dome structures made of plastic	LC, S
Section 10. Helicoidal and helical shape shells. Shells in the form of spiral and spiral shape surfaces	Topic 10.1 Ordinary screw surfaces. Screw surface variable pitch. Cyclic surface in the cylinder. Helical surfaces with generatrix in the planes of the bunch	LC, S
Section 11. Membrane and cable coatings	Topic 11.1 Examples of built structures with membrane and suspended roofs	LC, S
Section 12. Shells in the form of analytically indefinable surfaces	Topic 12.1 Overview of the constructed structures. Constructive forms of wildlife and their influence on the development of fundamentally new spatial structures	LC, S
Section 13. Spatial composite structures	Topic 12.1 Smooth mating of two surfaces. Transformable structures	LC, S
Section 14. Geometrical shaping of shells	Topic 13.1 Manufacturing models that demonstrate the methods of generating the middle surfaces of the shells	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.	Software: MathCAD
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] 2015. 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 resource] / 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/](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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Structural Materials

position, educational department

signature

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name and surname

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