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

Nanotechnology in Civil Engineering
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

2024

1. COURSE GOAL(s)

The goal of the course Nanotechnology in Civil Engineering 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.

2. REQUIREMENTS FOR LEARNING OUTCOMES

The course Nanotechnology in Civil Engineering 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 «Nanotechnology in Civil Engineering»

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 Nanotechnology in Civil Engineering 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 Nanotechnology in Civil Engineering.

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		Sustainability in Civil Engineering; Geometric Shaping and Analysis of Shells; Independent Research Work (obtaining basic skills of research work); Independent Research Work; Pre-Graduation Practice
PC-2	Development of project products based on the results of engineering and technical design for urban development		Life Cycle Economics of Buildings; Structural Design in Reinforced Concrete: Special Topics;

	activities		Structural Dynamics; Structural Design in Steel: Special Topics; Modelling of Construction Processes; Applications of Finite Element Method for Civil Engineering problems; Sustainability in Civil Engineering; Optimization Methods in Civil Engineering; Structural Stability; Geometric Shaping and Analysis of Shells; Engineering Systems of Buildings; Desin Practice; Technological Practice; Pre-Graduation Practice

4. COURSE WORKLOAD

The total workload of the course Nanotechnology in Civil Engineering is 4 credits.

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

Type of academic activities		**Total academic hours**	**Semester(s)**			
			1			
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		81	81			
Evaluation and assessment academic hours		27	27			
Course work / project, credits						
Course workload	academic hours	144	144			
	credits	4	4			

5. COURSE CONTENTS

Modules	**Contents (topics)**	**Academic activities types ***
Section 1. General approach to composite materials	Topic 1.1 Composition of composite materials. Matrix, different types of matrix. Reinforcement of composite materials, types of reinforcement	LC, S

Modules	Contents (topics)	Academic activities types *
Section 2. Classification of composites	Topic 2.1 Classification by the type of reinforcing filler, by the type of matrix, by designation, depending on the type and location of fibers Topic 2.2 Isotropic and anisotropic composite materials. Their advantages and disadvantages	LC, S
Section 3. Fiberglass composites	Topic 3.1 Mechanical and physical properties, methods of production. Topic 3.2 Application of fiberglass in civil engineering. Spatial structures made of fiberglass.	LC, S
Section 4. Methods of strength calculations for structures made of composites	Topic 4.1 Strength criteria for isotropic and anisotropic composite materials. Mieses–Hill criterion, Topic 4.2 Zakharov–Malmeister criterion. Golenblat– Kopnov criterion. Their graphical interpretation and range of application. The modified strength criterion.	LC, S
Section 5. Nanotechnologies for production of advanced composite materials	Topic 5.1 Types of nano-particles. Carbon nanoparticles: fullerenes, nano-tubes, astralens and the other ones. Topic 5.2 Concrete modified with nanoparticles. Influence of nano-modification on physical and mechanical properties of concrete.	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	Not required.	
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. Bafekrpour E. Advanced Composite Materials: Properties and Applications [Электронный ресурс] 2023. ISBN 9783110574432 URL: https://doi.org/10.1515/9783110574432

Additional readings:

1. Maurizio Dapor, Simone Taioli, Nicola M. Pugno. New Frontiers in Multiscale Modelling of Advanced Materials 2016. 1 c. ISBN 9782889197552 URL: http://journal.frontiersin.org/researchtopic/3121/new-frontiers-inmultiscale-modelling-of-advanced-materials
2. Kasperkiewicz J. Micro An Intermediate Step to Nano Level Analysis in Concrete Like Composites // Nanotechnology in Construction. 2004. ISBN 978-0-85404-623-2 DOI: http://dx.doi.org/10.1039/9781847551528-00063
3. Computational and Experimental Mechanics of Advanced Materials : Contributed volume. - : Springer Vi-enna, 2009. - (CISM International Centre for Mechanical Sciences ; 514). - ISBN 978-3-211-99685-0. http://lib.rudn.ru/MegaPro/UserEntry?Action=Rudn_FindDoc&id=326990&idb=0
4. G.M.L. Gladwell. Lecture Notes on Composite Materials: Contributed volume / G.M.L. Gladwell, B. Rene, S. Tomasz. - : Springer Netherlands, 2009. - (Solid Mechanics and Its Applications ; 154). - ISBN 978-1-4020-8772-1. http://lib.rudn.ru/MegaPro/UserEntry?Action=Rudn_FindDoc&id=327148&idb=0

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 Nanotechnology in Civil Engineering.

* 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 Nanotechnology in Civil Engineering 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, educational department	signature	name and surname
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HEAD OF EDUCATIONAL DEPARTMENT:

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