## **PEOPLES' FRIENDSHIP UNIVERSITY OF RUSSIA** NAMED AFTER PATRICE LUMUMBA **RUDN University**

**Engineering Academy** 

(educational division (faculty/institute/academy) as programme developer)

**Department of Construction Technology and Structural Materials** 

(department realizing the PhD program)

## **COURSE SYLLABUS**

## **Advanced Structural Mechanic**

(course title)

Scientific specialty:

**2.1.9. Structural mechanics** 

(scientific speciality code and title)

The course instruction is implemented within the PhD programmes:

**Structural mechanics** 

(PhD program title)

## 1. DISCIPLINE (MODULE) GOAL

The objective of mastering the discipline «Advanced Structural Mechanic» is to gain knowledge, skills, and experience in the field of calculation of structures and structures that characterize the stages of competence formation and ensure the achievement of the planned results of the development of the educational program and also preparation for the candidate's examinations and obtaining knowledge, skills and experience in the field of construction.

## 2. REQUIREMENTS FOR LEARNING OUTCOMES

Mastering the discipline "Structural Mechanics" is aimed at preparing for passing candidate exams, as well as mastering the following competencies:

- knowledge of the methodology of theoretical and experimental research in the field of construction;

- mastery of the culture of scientific research in the field of construction, including the use of the latest information and communication technologies;

- mastery of methods for developing scientific and methodological foundations for research, improvement, theoretical, experimental and feasibility studies for the use of various technical solutions and technologies in construction;

- knowledge of linear and nonlinear mechanics of structures and structures, physical and mathematical models, analytical and numerical methods for their calculation, including calculation of structures and structures for reliability under extreme operating conditions.

## 3. WORKLOAD OF THE DISCIPLINE AND TYPES OF ACTIVITIES

The overall workload of the discipline «Advanced Structural Mechanic» is 3 credit units (108 academic hours).

Types of activities		Total	Semesters	
		ac. hrs.	3	
Classroom activities (total), including:		60	60	
в том числе:				
Lectures (LC)		30	30	
Laboratory activities (LA)		_	—	
Practical lessons/Seminars (PC)		30	30	
Independent work		48	48	
Intermediate certification (test with assessment/exam)		_	—	
Overall workload	ac. hrs.	108	108	
	credits	3	3	

Name of the discipline section	<b>Contents of the section (topic)</b>	Type of study work
Section 1. Finite	Topic 1.1. Linear theory of spatial trusses and	LC, PC
element analysis of	properties of rod elements. Linear theory of	
structures	spatial frames and properties of frame elements.	
	Topic 1.2. Linear theory of plates and properties	
	of finite elements of plates. Linear theory of	
	folded plates and finite element properties of	
	folded plates.	
	Topic 1.3. Systems of linear equations: structure,	
	solution, accuracy. Accuracy control using	
	adaptive methods.	
	Topic 1.4. Database, algorithms and interfaces	
	for finite element applications on computers.	

## 4. DISCIPLINE CONTENTS

	Examples of practical application of the method	
	In construction.	
Section 2. Structural	Topic 2.1. Linear and nonlinear equations of	LC, PC
dynamics	motion for load-bearing systems. Spatial and	
	temporal discretization of dynamic boundary	
	value problems. Methods for solving linear and	
	nonlinear problems.	
	Topic 2.2. Modal analysis by finite element	
	method. Time history analysis using finite	
	element method.	
	Topic 2.3. Constructed structures with wind and	
	wave excitation. Objects under construction	
	subject to transport loads and ground vibrations.	
	Structures susceptible to earthquakes. Computer	
	models for dynamic analysis.	
Section 3. Structural	Topic 3.1. Structural stability concepts:	LC, PC
stability	singularity, instability, imperfection, load	
	disturbance. Linear and nonlinear formulations	
	of stability problems.	
	Topic 3.2. Second-order stress analysis of plane	
	frames. Second-order stability analysis of plane	
	frames.	
	Topic 3.3. First-order theory of cosmic reference	
	systems with uniform and inhomogeneous	
	torsion. Second-order stress analysis of space	
	frames. Second-order stability analysis of spatial	
	frames (torsional-flexural deformation).	
	Topic 3.4. Theory of bifurcations and	
	continuation of the load path. Buckling of thin	
	plates. Introduction to deflection of arches and	
	shells. Computer implementation and testing of	
	all methods.	
Section 4. Nonlinear	Topic 4.1. Geometrically nonlinear theory of	LC, PC
structural analysis	elasticity. Theory of plasticity, fracture and	
	destruction, nonlinear constituent laws.	
	Topic 4.2. Geometrically nonlinear theory of	
	spatial trusses: formulation, finite elements.	
	Nonlinear load-displacement behavior, limit	
	points (through, bifurcation). Incremental-	
	iterative methods for solving nonlinear quasi-	
	static problems.	
	Topic 4.3. Geometrically nonlinear frame theory:	
	formulation, finite elements, nonlinear. Load-	
	displacement behavior, limit points (end-to-end,	
	bifurcation).	
	Topic 4.4. Physically nonlinear behavior of	
	trusses and frames, only tension elements.	
	Computer models and interfaces for nonlinear	
	analysis of trusses and frames. Examples of	
	practical applications in structural engineering.	

Room Type	Room Equipment	Specialized educational / laboratory equipment, software and materials for mastering the discipline
Class for	Room for seminar-type classes, equipped with	Not necessary
Seminars, Lectures	a set of specialized furniture, board (screen) and technical / multimedia gadgets	
Self-Work Class	Room for self-working (can be used for lecture and seminars activities), equipped with a set of specialized furniture, board (screen) and technical / multimedia gadgets and computers with an access to EIPES	Not necessary
Computer class	Computer class for conducting classes, group and individual consultations, ongoing monitoring and intermediate certification, equipped with personal computers (9 pcs.), a whiteboard (screen) and technical means for multimedia presentations.	RUDN University software: Plaxis 2D Suit (Network license). Plaxis Professional (version 8) + Plaxis Dynamics Modul + PlaxFlow (version 1) - Education Registration number 90- 07-019-00261-3 MS-office corporate, Registration code: 86626883 Parent program: 86493330 Status: Active

#### 5. EQUIPMENT REQUIREMENTS AND TECHNOLOGY SUPPORT

## **6. METHODOLOGICAL SUPPORT AND LEARNING MATERIALS** *Main readings:*

1. Krivoshapko S.N. Structural mechanics: lectures, seminars, calculation and graphic works [Electronic resource]: Textbook for universities / S.N. Krivoshapko. - 2nd ed. reworked and additional ; Electronic text data. - M.: Yurayt, 2011. - 391 p. - System requirements: Windows XP and higher. - ISBN 978-5-9916-1375-0: 229.00. Access mode: http://lib.rudn.ru/MegaPro/UserEntry?Action=Rudn\_FindDoc&id=359565&idb=0

2. Shambina S.L. Structural mechanics [Text/electronic resource]: Lecture notes. / S.L. Shambina. - Electronic text data. - M.: Publishing house RUDN, 2015. - 48 p. : ill. - ISBN 978-5-209-06779-5: 42.15. Access mode:

http://lib.rudn.ru/MegaPro/UserEntry?Action=Rudn\_FindDoc&id=447028&idb=0

3. Tukhfatullin, B. A. Numerical methods for calculating building structures. Finite element method: textbook. manual for academic undergraduates / B. A. Tukhfatullin. — 2nd ed., rev. and additional - Moscow: Yurayt Publishing House, 2019. - 157 p. — (Series: Bachelor. Academic course). — ISBN 978-5-534-08899-1. — Access mode: HYPERLINK https://biblio-online.ru/bcode/442338

## Additional readings:

1. Петров, В.В. Нелинейная инкрементальная строительная механика/ В.В. Петров. -Москва: Инфра-Инженерия, 2014. - 480 с. - ISBN 978-5-9729-0076-3; То же [Электронный ресурс]. - URL: http://biblioclub.ru/index.php?page=book&id=234783 2. Голушко, С.К. Прямые и обратные задачи механики упругих композитных пластин и оболочек вращения / С.К. Голушко, Ю.В. Немировский. - Москва : Физматлит, 2008. - 429 с. - ISBN 978-5-9221-0948-2 ; То же [Электронный ресурс]. - URL: http://biblioclub.ru/index.php?page=book&id=68839

3. Димитриенко, Ю.И. Нелинейная механика сплошной среды: учебное пособие / Ю.И. Димитриенко. - Москва : Физматлит, 2009. - 624 с. - ISBN 978-5-9221-1110-2 ; То же [Электронный ресурс]. - URL: http://biblioclub.ru/index.php?

Радин, В.П. Метод конечных элементов в динамических задачах сопротивления материалов / 4. В.П. Радин, Ю.Н. Самогин, В.П. Чирков. - Москва: Физматлит, 2013. - 314 с. : схем., табл. - Библиогр. в кн. - ISBN 978-5-9221-1485-1 ; То же [Электронный ресурс]. - URL: http://biblioclub.ru/index.php?page=book&id=275558

## Internet sourses:

ELS RUDN University and third party EBS, to which university students have accessbased signed contracts:

- RUDN Electronic Library System, http://lib.rudn.ru/MegaPro/Web;
- ELS University Library Online, http://www.biblioclub.ru;
- EBS Urayt, http://www.biblio-online.ru;
- ELS Student Consultant, http://www.studentlibrary.ru;
- EBS Lan, http://e.lanbook.com;
- EBS Trinity Bridge http://www.trmost.ru Databases and search engines:
- Electronic fund of legal and normative-technical documentation, http://docs.cntd.ru;
- Yandex search system https:// www .yandex.ru ;
- Google search system https://www.google.com ;
- Reference database Scopus , http://www.elsevierscience.ru/products/scopus

*Educational and methodological materials for students' self-work studying the discipline / module:* 

A course of lectures on the discipline «Advanced Structural Mechanic».

# 7. ASSESSMENT TOOLKIT AND GRADING SYSTEM FOR EVALUATION OF PHD STUDENTS' COMPETENCES LEVEL AS COURSE RESULTS

Assessment toolkit and a grading system to evaluate the level of competences (competences in part) formation as the course results are specified in the Appendix to the course syllabus.

## **DEVELOPERS:**

Professor

A.P. Svintsov

## HEAD OF THE DEPARTMENT

Director of the department

S.B. Yazyev