

**THE WORKING PROGRAM OF THE DISCIPLINE**

**Name of the discipline** Structural stability

**Program focus (focus (profile), specialization)**

08.04.01 Civil Engineering

**Orientation of the program (profile):**

**Design and Theory of Buildings and structures,**

**Mechanics of materials and engineering structures,**

**Built environment of smart city**

## 1. Goals and objectives of the discipline:

The purpose and objectives of the discipline The purpose of mastering the discipline "Structural Stability" is to gain knowledge, skills, skills and experience in the field of design of building structures that characterize the stages of competence formation and ensure the achievement of the planned results of the development of the educational program.

Various structures and structures designed and constructed by an engineer must necessarily have strength, that is, the ability to resist destruction under the action of external loads applied to them, rigidity, that is, the ability to resist deformations, and stability – the ability of a structure to maintain one form of balance. The solution of these three tasks is the main content of the discipline.

The main objectives of the discipline "Structural Stability" are:

- study of the concept of free vibrations of building structures;
- consideration of the types of dynamic impact of loads on building structures structures;
- familiarity with the requirements for building structures to ensure stability;
- study of ways to solve problems in the calculation of building structures for stability and dynamic impacts..

## 2. Place of discipline in the structure of EPVO:

The discipline "Structural Stability" refers to the variable part of Block 1 of the curriculum. Its study is based on the material of previous disciplines, and it is also the basis for the study of subsequent disciplines of the curriculum, the list of which is presented in table 1.

### Previous and subsequent disciplines aimed at developing competencies

Table # 1

#### Previous and subsequent disciplines aimed at developing competencies

n/π	a Code and name of the competence	Previous disciplines	Subsequent disciplines (groups of disciplines)
General professional competencies			
	OPC -2, PC -1, PC -2, PC -11, PC -11	Theoretical of Structural Analysis, Structural Dynamics, Basic Course(s) in Structural steel design	Design of Structural Stability of frame elements and design of building structures

## 3. 3. Requirements for the results of mastering the discipline:

*The discipline of "Structural Stability" is aimed at the formation of students ' competence following:*

it is able to solve the problems of professional activity on the basis of the use of theoretical and practical foundations, the mathematical apparatus of fundamental sciences. (GPC-1)

Conducting applied research in the field of engineering and technical design for urban planning activities (PC-1)

Development of project products based on the results of engineering and technical design for urban planning activities (PC-2)

-Preparation of the section of project documentation for metal structures of buildings and structures (PC-11)

Study of the object of urban planning activity to obtain information about the state and predicted properties of the foundation, foundation structures and underground structures (PC-12)

*The result of training in the discipline is knowledge, skills, and (or) the experience of activities that characterize the stages of competence formation and ensure the achievement of the planned results of the development of the educational program, presented in table 2*

.As a result of studying the discipline, the student must:

**Know:**

- in the field of methods of mathematical analysis.
- know the state standards and be able to use them.
- basic methods of calculation and design of building structures.
- know the main theoretical provisions of the discipline:
- requirements for products and quality of information and theoretical support of the calculation base.
- knowledge of specialized software and computing systems.

**Be able to:**

- use modern information technologies.
- be able to use the appropriate computer developments.
- use modern software and computing systems for the calculation of building structures.
- use information technology to solve specific tasks.
  
- use information technology to solve specific tasks;
- use information technology in professional activities

**.Own:**

- application of theoretical knowledge in practice.
- search for the necessary information.
- use of the latest automated projecting systems.
- use of information support in the calculation of structures and structures.
- organization of high-quality calculation of structures and structures.
- search for new software and computing systems to solve the tasks.

**4. Scope of discipline and types of educational work**

The total workload of the discipline is 4 credit units.

Type of educational work	Total hours	Semesters			
		3			
<b>Classroom Practice in Obtaining Professional Skills and Professional Experience (Research Practice). lessons (total)</b>	32	32			
Including:	-	-	-	-	-
<i>Lectures</i>	16	16			
<i>Practical lessons (PL)</i>	16	16			
<i>Seminars (S)</i>	-	-			
<i>Laboratory work (LW)</i>	-	-			
<b>Independent work (total)</b>	40	ЭКЗАМЕН			
Total labor intensity	108	108			
hour	3	3			
cred-its					

**5. Content of the discipline**

**5.1. Contents of discipline sections**

No	The name of the discipline section	Section content (topics)
1.	<b>Concepts of structural stability</b>	Topic 1.1. Definition of stability. Instability without large displacements. Order and linearity of structural theories; First order theory of an axially loaded bar
		Topic 1.2. Second order theory for Euler columns; Behaviour of geometrically imperfect columns; Behaviour of columns with load perturbation
		Topic 1.3. Instability with large displacements: Nonlinear mathematical model of a 2-bar truss; Solutions of governing equations; Types of instability for shallow and steel trusses
2.	<b>Second order plane frame analysis</b>	Topic 2.1 Members of a frame: Governing equations for a member and their solution.
		Topic 2.2. Member stiffness matrix: Exact stiffness coefficients; Limit expressions for the stiffness coefficient
		Topic 2.3. Member load vector: Exact load coefficients; Limit expressions for the load coefficients
		Topic 2.4. Algorithms for second order plane frame analysis. Limitations of second order analysis
3.	<b>Single columns and column groups</b>	Topic 3.1. Single columns: Boundary conditions for single columns. Elastically supported single columns.
		Topic 3.2. Effective length and slenderness of columns. Linked Columns
		Topic 3.3. Columns in frames: Translation and rotation restraints at nodes; Single column with girder restraint and side-sway. Columns in portal frames
		Topic 3.4. Columns in multi-storey buildings. General method for the analysis of column stability in frames.

## 5.2. Sections of disciplines and types of classes

No	Discipline section No.	Lectures	Practice	Lab. works	Seminars	Independent work of students	Total hour
1.	<b>Concepts of structural stability</b>	2	2	0	0	8	12
2.	<b>Second order plane frame analysis</b>	5	5	0	0	21	31
3.	<b>Single columns and column groups</b>	6	6	0	0	34	46
	<b>Examination</b>	0	0	0	0	36	36

## 6. Laboratory workshop

No laboratory workshop provided.

## 7. Practical exercises (seminars)

No.	Discipline section No.	Subjects of practical classes (seminars)	Labor capacity (hour.)
1.	<b>Introduction to Nonlinear Behavior of Structures</b>	Definition of stability. Instability without large displacements. Order and linearity of structural theories; First order theory of an axially loaded bar Second order theory for Euler columns; Behaviour of geometrically imperfect columns; Behaviour of columns with load perturbation. Instability with large displacements: Nonlinear mathematical model of a 2-bar truss; Solutions of governing equations; Types of instability for shallow and steel trusses	
2.	<b>Fundamentals of nonlinear theory of elasticity</b>	Members of a frame: Governing equations for a member and their solution, Member stiffness matrix: Exact stiffness coefficients; Limit expressions for the stiffness coefficient Member load vector: Exact load coefficients; Limit expressions for the load coefficients Algorithms for second order plane frame analysis. Limitations of second order analysis	
3.	<b>Nonlinear analysis of plane trusses and frames.</b>	Single columns: Boundary conditions for single columns. Elastically supported single columns. Effective length and slenderness of columns. Linked Columns Columns in frames: Translation and rotation restraints at nodes; Single column with girder restraint and side-sway. Columns in portal frames. Columns in multi-storey buildings. General method for the analysis of column stability in frames.	

## 8. Material and technical support of the discipline:

*(describes the material and technical bases necessary for the implementation of the educational process in the discipline (module)).*

<b>Audience with a list of material and technical support</b>	<b>Location</b>
<b>Lecture hall No. 408</b> Equipment and furniture: - technical means: - projection screen; - Epson EH-TW 3200 multimedia projector; - a set of specialized furniture: tables, benches, chairs, blackboard.	city of Moscow, Ordzhonikidze str., 3
<b>Training room for seminars, practical classes, current control and intermediate certification No. 418</b> Equipment and furniture: - training models; - screen; - NEC Z projector; - set of specialized furniture: tables, benches, chairs, blackboard.	city of Moscow, Ordzhonikidze str., 3

<p><b>Educational and methodical office for independent, research work of students and course design</b> No. 417 (Laboratory of engineering equipment of buildings and Structures )</p> <ul style="list-style-type: none"> <li>- a set of specialized furniture;</li> <li>- chalkboard, markerboard ;</li> <li>- ASUS computers-5 pcs., ASER monitors-5 pcs.;</li> <li>- Microlab System Subwoofer-1 pc.;</li> <li>- проекторEPSON EB X11 projector</li> </ul>	<p>. Moscow, Ordzhonikidze str., 3</p>
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### 9. Informational support of the discipline

(A list of information technologies used in the implementation of the educational process in the discipline (module), including a list of software and information reference systems (if necessary))

a) Software: PowerPoint

b) databases, information and reference systems and search engines:

1. RUDN University Online Library.
2. Guidelines for completing homework.
3. Tasks for completing homework on the personal page of the teaching staff in electronic form.
4. A point-rating system for evaluating students ' knowledge, displayed on the teacher's personal page.

### 10. Educational and methodological support of the discipline:

Main literature:

1. Trahair N.S., Bradford M.A., Nethercot D.A., Gardner L. (2008). The Behaviour and Design of Steel Structure to EC3. Fourth edition. Published by Taylor & Francis, New York, 490.  
<https://civteam.files.wordpress.com/2013/03/the-behaviour-and-design-of-steel-structuresto-ec3-2008.pdf>

Additional literature:

1. Guddat J., Jongen H.TH. Structural stability in nonlinear optimization :  
<http://dx.doi.org/10.1080/02331938708843275>
2. Second order structural theory for the stability analysis of columns/  
Российский университет дружбы народов. / Vera V Galishnikova [и др.]. // Structural Mechanics of Engineering Constructions and Buildings. 2018. №14.3. С. 192-197. ISSN 1815-5235 DOI: 10.22363/1815-5235-2018-14-3-192-197  
<https://cyberleninka.ru/article/n/second-order-structural-theory-for-the-stability-analysis-ofcolumns>
3. Chen W.F., Sohal I. Plastic Design and Second-Order Analysis of Steel Frames./ Springer-Verlag New York, 1995. – 509 p

### 11. Methodological guidelines for students on mastering the discipline (module)

Organization of classes on the discipline "" Stability of structures / " Stability of structures " is carried out according to the following types of academic work: lectures, practical classes.

The implementation of the competence approach in the framework of the preparation direction of 08.04.01 Civil Engineering / Construction provides for a combination in the educational process of contact work with a teacher and extracurricular independent work of students to fully form and develop its professional skills.

Lectures are conducted in the stream audience, including using a multimedia projector in the form of an educational presentation. The main points of lecture classes are outlined by students, individual topics (parts of themes and sections) are proposed for independent study with the obligatory compilation of the abstract (verified by the teacher in the process of current control).

The purpose of practical classes is to receive knowledge with students and develop practical skills of work in the design of building structures. To achieve these goals, both traditional forms of operation are used - solving problems, work with technological equipment / specialized software when performing laboratory work with specialized software when performing a course project, etc.

Independent work covers the study of the learning individuals of the theoretical course. Independent work is carried out in an individual format based on educational and methodological materials of the discipline (applications 2-4). The level of material development on independently studied courses is checked when conducting current control and certification tests (credit) on discipline. Methodological recommendations with student are posted in the TUIS RUDN.

## **12. Fund of assessment funds for conducting intermediate certification of students in the discipline (module)**

Materials for assessing the level of development of educational material of the discipline " Stability of structures" (estimated materials), including a list of competencies, indicating the stages of their formation, description of the indicators and criteria of assessment of competencies at different stages of their formation, the description of the scales of assessment, typical assignments, or other materials needed for the assessment of knowledge, skills and (or) experience activities that characterize the stages of formation of competences in the process of development of educational programs, instructional materials, procedures evaluation of knowledge, skills and (or) experience activities that characterize the stages of formation of competences, fully developed and available to students on the page of discipline in TUIS RUDN.

### **Developer:**

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