Federal State Autonomous Educational Institution of Higher Education
"Peoples' Friendship University of Russia"

Academy of Engineering

Recommended by ISSC

THE WORKING PROGRAM OF THE DISCIPLINE

Name of the discipline Structural dynamics

Recommended for educational field: 08.04.01 Civil Engineering

Specialization (profile): Civil Engineering and Built Environment , Mechanics of materials and engineering structures, Built environment of smart city

1. Goals and objectives of the discipline: The purpose of mastering the discipline «Structural dynamics" is to prepare the future specialist to solve problems and teach him to determine the dynamic characteristics of construction and engineering structures.
Loads that change rapidly in time cause the cross-sections of the structure to move with accelerations, resulting in inertial forces that need to be taken into account in the calculations, in addition, in some cases, stresses that vary in time can occur at certain points of the structure, which leads to material fatigue, so the purpose of the discipline is to teach calculations for the effect of dynamic loads caused by wind gusts, machines, engines and other mechanisms that cause vibrations of structures.
The dynamic calculation is aimed at providing the necessary structural strength and preventing large deformations. Stresses that are variable in time occur in structural elements under the influence of loads that are variable in magnitude or direction, as well as loads that move relative to the designed element. Numerous experiments confirm that under the action of alternating stresses, the destruction of materials occurs at stresses significantly lower than the dangerous stresses under static loading. Solving this problem is also the goal of the discipline.
The objective of the discipline is to teach students to determine the dynamic effects on structures and take them into account when calculating.

2. Place of discipline in the structure of EP VO:

The discipline "Structural dynamics" 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, a list of which is presented in table 1.

Prior and subsequent disciplines aimed at the formation of competencies

№	Code and name of competence	Preceding disciplines	Subsequent disciplines (groups of disciplines)
General cultural competences			
	GC-2	higher mathematics, physics, theoretical mechanics	computational methods and computer modeling in scientific research
Professional competencies (type of professional activity of a civil engineer)			
	PC-1, PC-2, PC-11; PK-12	material resistance, technical mechanics, construction mechanics	modern methods of vibration protection of rod structures

3. Requirements for the results of mastering the discipline:
GC-2-Able to manage a project at all stages of its life cycle
PC-1-Conducting applied research in the field of engineering design for urban planning activities
PC-2-Development of design products based on the results of engineering design for urban planning activities
PC-11-Preparation of a section of design documentation for metal structures of buildings and structures
PK-12-Study of the object of urban planning activities to obtain information about the state and predicted properties of the foundation, foundation structures and underground structures

As a result of studying the discipline, the student must:
Know:
- key concepts and definitions, assumptions and principles adopted in the course "Structural dynamics", the formula for determining the dynamic coefficient, the basic principle of calculating structures for vibrations;
- methods for calculating the strength of structures taking into account the forces of inertia; methods for calculating the strength of the simplest systems under shock load application; methods for calculating the strength of elastic systems under vibrations; concepts of fatigue failure, endurance limit and methods for calculating the strength under cyclic stresses.

Be able to:
- perform calculations of systems taking into account the forces of inertia; perform calculations of systems under shock loading, calculate the dynamic coefficients of impact; determine the circular frequency of natural vibrations of the system; take into account the phenomenon of resonance; solve the problem of longitudinal vibrations of the rod;

Own:
-information about free and forced vibrations of systems with different degrees of freedom; methods of calculation for shock effects, the method of displacement in problems of harmonic vibrations of rod systems.

4. Scope of discipline and types of educational work

The total workload of the discipline is 3 credit units.

Type of educational work	Total hours	Semesters			
		1	2	3	4
Classroom Practice in Obtaining Professional Skills and Professional Experience (Research Practice). **lessons (total)**	90		90		
Including:	-	-	-	-	-
Lectures	36		36		
Practical lessons (PL)	54		54		
Seminars (S)					
Laboratory work (LW)					
Independent work (total)	18		18		
Total labor intensity	108		108		
hour credits	3		3		

5. Content of the discipline

5.1. Contents of discipline sections

№	The name of the discipline section	Section content (topics)
1	**General information about the dynamics of deformable systems**	General concepts. Forces of inertia. The Dalembert principle. The main types of dynamic load. Dynamic tasks that are reduced to static calculation tasks. Calculation for inertial loads
2	**Hit**	Dynamic coefficient
3	**Oscillations of systems with n degrees of freedom.**	Elastic natural oscillations of systems with one degree of freedom. Forced oscillations of systems with one degree of freedom. Resonance. Vibration damping. Elastic free oscillations of systems with several degrees of freedom. Determination of the number of degrees of freedom for flat rod systems. A system with two degrees of freedom.
4	**Free oscillations of rod systems as systems with distributed mass**	Free vibrations of beams as systems with distributed mass. Longitudinal vibrations of a rod with a distributed mass. The solution is in the form of a traveling wave. A standing wave type solution. The method of displacements in problems of harmonic oscillations of rod systems. Free oscillations of rod systems with distributed mass. Free vibrations of the U-shaped frame.

5	**Calculation of fatigue**	Variable stresses. Stress cycle. Fatigue. The fatigue curve. The limit of endurance. The main factors affecting the value of the endurance limit

5.2. Разделы дисциплин и виды занятий

No.	Discipline section No.	Lectures.	Practice	Lab. works	Seminars	Independent work of students	Total hour.
1	**General information about the dynamics of deformable systems**	4	12			8	24
2	**Hit**	4	10				14
3	**Oscillations of systems with n degrees of freedom.**	16	14				30
4	**Free oscillations of rod systems as systems with distributed mass**	8	12			10	30
5	**Calculation of fatigue**	4	6				10

6. Laboratory workshop

No laboratory workshop provided.

7. Practice (Seminars)

No.	Discipline section No.	Subjects of practical classes (seminars)	Labor capacity (hour.)
1	**1**	Dynamic tasks that are reduced to static calculation tasks. Calculation for inertial loads.	12
2	**2**	Hit	10
3	**3**	Dynamic tasks that are reduced to static calculation tasks. Calculation for inertial loads. Elastic natural oscillations of systems with one degree of freedom. Determination of the frequencies and forms of natural vibrations of a beam with two degrees of freedom. Determination of the frequencies and forms of natural vibrations of a frame with two degrees of freedom.	14
4	**4**	Calculation of beams for dynamic load. Permissible operating mode of the engine. The method of displacements in problems of harmonic oscillations of rod systems. Free vibrations of the U-shaped frame.	12
5	**5**	Concepts of fatigue and endurance	6
	Total:		**54**

8. Material and technical support of the discipline::

Auditorium with a list of logistics	Location
Lecture room - Specialized room number 298 - "Modeling of large-span building structures"	Moscow, st. Ordzhonikidze, 3

Equipment and furniture: - a set of specialized furniture; - chalk board; - projection screen; - multimedia projector EPSON EMP-X5.	
Classroom for independent work-Computer class No. 352 A set of specialized furniture; technical means: PolyVision Webster TSL 610 interactive whiteboard, Toshiba TLP XC3000 multimedia projector, Draper Luma 178x178 roll-up wall screen, Pirit Codex 1226 computer - 1 pc., GENIUS SP-i350 sound amplification equipment-1 pc., Xerox 3125-1 pc. printer, Epson 10V Photo scanner-1 pc., HP DesignJet 130+ NR (A1) plotter-1 pc., Pirit Doctrina computers-9 pcs., ViewSonic 22" LCD monitor VA2216w-9 pcs., 19" NEC monitor-1 pc., chalk board.	Moscow, st. Ordzhonikidze, 3

9. Information support of the discipline

a) software

Specialized software for conducting lectures and practical classes, completing coursework and independent work of students:

b) databases, reference and search systems

- electronic fund 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/
- Site of the Ministry of Construction and Housing and Communal Services of the Russian Federation http://www.minstroyrf.ru/
- Electronic library system RUDN - EBS RUDN http://lib.rudn.ru/MegaPro/Web
- EBS "University Library Online" http://www.biblioclub.ru
- EBS Yurayt http://www.biblio-online.ru
- EBS "Student Consultant" www.studentlibrary.ru
- EBS "Doe" http://e.lanbook.com/

10. Educational and methodological support of the discipline:

a) main literature

1. Рынковская М.И. Динамика стержневых систем: программа и задания курсовых, расчетно-графических и домашних работ / М.И. Рынковская. – Москва : РУДН, 2016. – 31 с. : ил.
2. Рынковская М.И. Динамика упругих систем: конспект лекций / М.И. Рынковская. – Москва : РУДН, 2015. – 67 с. : ил.
3. Смирнов А.Ф., Александров А.В. и др. Строительная механика. Динамика и устойчивость. – М.: СИ,1984. – 416 с.
4. Кривошапко С.Н. Строительная механика: теория и практикум: учеб. пособие / С.Н. Кривошапко. – Изд. 2-е. – М.: «Юрайт», 2014. – 392 с.

б) дополнительная литература:

1. Бабаков И.М. Теория колебаний: учеб. пособие / И.М. Бабаков. – 4-е изд., испр. – М.: Дрофа, 2004. – 591, [1]с.: 12ил., 15 табл. – (Классики отечественной науки).

2. Бабанов В.В. Строительная механика: учебник для студ. высш. учебных заведений обучающихся по направлению строительство, В 2 т. Т. 2 / В. В. Бабанов. - М.: Издательский центр "Академия", 2012. – 288 с.
3. Безухов, Н.И. Устойчивость и динамика сооружений в примерах и задачах: учеб. пособие для студ. высш. техн. уч. завед. / Н.И. Безухов, О.В. Лужин, Н.В. Колкунов. – Изд. 2-е, перераб. и доп. – М.: Изд-во литературы по строительству, 1969. – 424 с.
4. Ганджунцев, М. И. Основы динамики и устойчивости стержневых систем : учеб. пособие / М. И. Ганджунцев, А. А. Петраков. – М.: МГСУ, 2012. – 96 с. – ISBN 978-5-7264-0658-9.
5. Копнов, В.А. Сопротивление материалов. Руководство для решения задач и выполнения лабораторных и расчетно-графических работ / В.А. Копнов, С.Н. Кривошапко. – М.: «Высшая школа», 2005. – 352 с.
6. Рекач В.Г. Руководство к решению задач прикладной теории упругости: уч. пособие / В.Г. Рекач. – Изд. 3-е. – М.: Книжный дом «ЛИБРОКОМ», 2010. – 288 с.

11. Methodical instructions for students on mastering the discipline (module)

Methodological guidelines for students on the development of the discipline (module)
Lectures are delivered in classrooms equipped with technical training facilities and video projectors. Lectures should be presented in the form of PowerPoint presentations.
Laboratory work is carried out in a laboratory fully equipped for laboratory work.
Practical classes are held in classrooms equipped with technical training facilities. Practical tasks are analyzed, as well as examples of solving computational and graphical tasks.
Control measures consist of two control works (for 2 ak. one hour each), exam at the end of the semester.
Methodological recommendations for the student are posted in the TUIS.

12. The fund of assessment funds for conducting intermediate certification of students in the discipline (module)

Materials for assessing the level of mastering the educational material of the discipline " Structural dynamics ", including a list of competencies indicating the stages of their formation, a description of indicators and criteria for evaluating competencies at various stages of their formation, a description of the assessment scales, typical control tasks or other materials necessary to assess knowledge, skills, skills and (or) experience of activity, characterizing the stages of the formation of competencies in the process of mastering the educational program, methodological materials that determine the procedures for assessing knowledge, skills, skills and (or) experience of activities that characterize the stages of the formation of competencies are developed in full and are available for students on the discipline page in TUIS RUDN.

The program is compiled in accordance with the requirements of the ES HE in the RUDN.

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