Федеральное государственное автономное образовательное учреждение высшего образования «Российский университет дружбы народов»

АННОТАЦИИ ДИСЦИПЛИН (МОДУЛЕЙ) ОП ВО

Изучение дисциплин ведется в рамках освоения основной профессиональной образовательной программы высшего образования (ОП ВО)

Civil Engineering and Built Environment /
Строительная инженерия и построенная среда (англ.)

(наименование (профиль/специализация) ОП ВО)

реализуемой по направлению подготовки/специальности:

08.04.01 Строительство

(код и наименование направления подготовки/специальности)

Mastering of the discipline is carried out within the framework of the implementation of the main professional educational program of higher education « Civil Engineering and Built Environment »
major
08.04.01 Civil engineering

Name of disciplines	«Professional Russian (as a Foreign Language)»
Course Workload, credits/academic hours	6/216
DISCIPLINE CONTENT	
Units	**Topics**
Module 1. Basics of academic/scientific writing.	Unit 1. Acquaintance with academic / scientific text. Types, primary and secondary genres of academic texts. Structure of scientific text. Scientific style of speech.
	Unit 1.1. Academic / scientific text (AT): parsing. Elements of the content structure of AT. Syntactic structures of AT. General scientific and special vocabulary AT. Syntactic constructions, specifics of an academic/scientific text.
	Unit 1.2. The target audience of AT, the purpose of the statement. Complex argumentation AT. Foreign words and terms. Syntactic analysis of academic/scientific text. Compilation of a glossary for the article.
Module 2. Preparation of an academic/scientific presentation in English.	Unit 2. Features of preparing slides for a scientific presentation. General recommendations. Text and data slides. Requirements for the preparation of the AP.
	Unit 2.1. Academic/scientific presentation in English. Discussions. The structure of an academic/scientific presentation.
Module 3. Academic/scientific presentation in English.	Unit 3. Stylistic devices of academic presentation (AP) - repetitions, parallel constructions, complex grammatical and syntactic constructions.

Name of disciplines	«Problem solving tecniques in Civil Engineering»
Course Workload, credits/academic hours	3/108
DISCIPLINE CONTENT	
Units	**Units**
Introduction	Science as a continuously evolving system of knowledge of objective laws of nature, society and thinking. The goal of science. Scientific research. Purposes of scientific research. The theoretical studies. Applied research. Technical and techno-logical development. The purpose of development. Scientific and technical information. The scientific direction. The scientific problem. The wording of the problem and making hypotheses. Scientific theme.
Experimental studies	The basics of methodology of experimental studies. Natural experiments. Artificial experiments. The computational experiments. Laboratory experiment. Full-scale experiment. Research (search) experi-ment. The goals and objectives of experimental re-search. Experiment planning. The planning matrix. Regression analysis. factorial experiment.

Name of disciplines	«Problem solving tecniques in Civil Engineering»
Course Workload, credits/academic hours	3/108
DISCIPLINE CONTENT	
Units	**Units**
Development of technical and technological solutions scientific and technical problems	Copyright. Patent law. The invention. Useful model. An industrial design. Application for intellectual property object. Methods of preparing the patent ap-plication. A patent search Selection of unique. Criticism of peers. Selection of the prototype. Criticism of the prototype. Drawing description.

Name of disciplines	«Mathematical methods of experimental data processing»
Course Workload, credits/academic hours	3/108
DISCIPLINE CONTENT	
Units	**Units**
Sample characteristics as random variables. Methods for presenting the results of experiments.	Discrete and continuous random variables. Selective characteristics. The laws of distribution of random variables. Computer simulation of a random variable with a given distribution law: normal and log-normal distribution, Poisson distribution, equal probability distribution.
Methods of dropping measurement errors.	Rule "3 Sigma." Criterion for Chouvenet. Criteria of Romanovsky, Irvin, Dickson, variational scale.
Methods for testing statistical hypotheses. Parametric and nonparametric criteria.	The concept of a parametric criterion. Power criterion. Confidence. Errors of the first and second kind. The use of computer technology for the elimination of erroneous values.
Fundamentals of optimization. Construction of mathematical models.	The concept of the objective function, the limitations of the area of decision-making. The Bran-don method. Estimation of adequacy of the con-structed models.
Methods of decision-making in conditions of uncertainty and multicriteria.	Criteria for Wald, Laplace, Hurwitz, Se-Vidge, mixed criteria.
Ranking factors. Processing of survey results.	Ranking methods. Calculation of the coefficient of concord.
Methods of cluster analysis. Ways to form clusters.	Calculation of the characteristics of clusters - centers, dispersion, radius.

Name of disciplines	«Mathematical Modelling»
Course Workload, credits/academic hours	3/108
DISCIPLINE CONTENT	
Units	**Units**
The subject and tasks of the course "mathe- matical modeling of spatial structures"	- Place, purpose and advantage of mathematical modelling in the process of knowledge of ob-jects and natural phenomena. Model, as a tool for the investigation of objects and phenomena and as a tool for managing them. Prerequisites for the successful application of mathematical modelling. Abstract model by R. Kalman. Clas-

Name of disciplines	«Mathematical Modelling»
Course Workload, credits/academic hours	3/108
DISCIPLINE CONTENT	
Units	**Units**
	sification of objects by type of behavior. Analyt-ical and simulation models. Stages of mathemat-ical modelling. Historical experience in the for-mation of mathematical models and solving practical problems by means of mathematics. The task of the trajectory of a ray of light re-flecting from a mirror. The problem of the tra-jectory of a Brachistochrone problem. Models based on the principle of least action and the princi-ple of equilibrium.
Basic fundamental laws in mechanics	Principles of causality. Equations of state. Postu-lates about space and time. The law of conserva-tion. The least action. The principle of Lagrange. Hamilton-Ostrogradsky principle. Stable and unstable equilibrium. Euler equations. Principle d'Alembert.
The concept of a mathematical model	The concept of the model of the object or phe-nomenon. Mathematical model. The requirement for a mathematical model. General technology for solving practical problems using mathemat-ics. The sequence of construction and testing of mathematical models on the examples of the sim-plest problems of mechanics: stretching and compression of the beam. Bending of the beam, loss of stability of the beam. The test of a math-ematical model is an assessment of the state of an object. Models for controlling the parameters of objects and phenomena. The multiplicity of questions about the manifestations of objects and phenomena and the generality of models. Check the adequacy of mathematical models. Simplified models.
Formation of mathematical models	Ideas used as the basis of mathematical models. Reflection of properties and characteristics of objects in a mathematical model. Idealization and abstraction. Mathematical language of the formation of a practical problem. Characteristic concepts for describing objects and phenomena (energy, mass, force, space, time, etc.) and qualitative and quantitative representation in models. Covariance Tasks of analysis and syn-thesis. Determining relationships and empirical dependencies in mathematical models. Dimen-sion of the quantities and formulas expressing the problem. Simplification and refinement of the mathematical model. The dimension of the tasks. Analysis of the impact of simplifications and clarifications.
Types of mathematical models	Structural and functional models. Discrete and continuous, linear and nonlinear models. Simu-lation of partial differential equations. The prob-

Name of disciplines	«Mathematical Modelling»
Course Workload, credits/academic hours	3/108
DISCIPLINE CONTENT	
Units	**Units**
	lem of the shapes of the searchlight mirror. Linearization. Variational models. Likely models. Other types of models. Hierarchy of mathematical models. Mathematics Mode Closure
Methods for solving problems formulated by mathematical models.	The investigation of the mathematical problem generated by the created mathematical model. Existence, multiplicity and uniqueness of solutions. The choice of mathematical methods for solving the formulated problem. Exact and close solution. Variational tasks. The boundary value problem and the Cauchy problem. Analytical solution. Asymptotic expansions. Ritz method. Bubnov-Galerkin Method. tasks. Euler method. Reduction of the solution to the solution of problems of linear algebra. Finite difference method and finite element method. Systems of linear equations and their solution. The problem of eigenvalues. extremums of functions and functionals. Newton's method for solving nonlinear problems. Research solutions. Selection and control of solu-tion accuracy. Dimensional Verification of models.
The use of computing in mathematical modelling.	The concept of computational experiment. Triad "model-algorithm-program". Numerical simula-tion. A preliminary investigation of mathematical models. Qualitative analysis. Dimensionless analysis of the problem. Approximate solutions. Exact solutions. Algorithm solutions. Programming and problem solving software. Carrying out computer calculations and their analysis. Planning calculations. Processing calculation results. Refinement of computational models.
Mathematical modelling in problems of mechanics of a deformable solid	Representation of a solid body as a continuum. Other simplifying hypotheses and assumptions. Elastic body Plastic body Internal forces, stresses, deformations, displacements. Stress-strain state of a solid. Strain tensor, stress tensor and principal stress. Hooke's law as an equation of state. Static equilibrium equations and equilibrium equations in motion. Compatibility equations of deformations. The expression of the change of energy. The formulation and solution of problems of statics and dynamics of a rigid body. Two-dimensional and one-dimensional problems of the theory of elasticity. Construction of mathematical models and solving problems of mechanics of liquids and gases. Ideal incom-

Name of disciplines	«Mathematical Modelling»
Course Workload, credits/academic hours	3/108
DISCIPLINE CONTENT	
Units	**Units**
	pressible fluid. Viscous fluid. Perfect gas. Setting goals. Euler's equation for the motion of an ideal fluid. Tasks hydrostatics. Perfect fluid movement and viscous fluid movement. Navier-Stokes equation. Waves in liquid and gas.
Problems of finding the optimal solution and their mathematical modelling	Ideas involved in the construction of mathematical models of optimization problems. Variational tasks. The formulation and solution of the Brachistochrone problem. The simplest problems of finding the optimal solution and solving them mathematically. Tasks on the best size of a tincan.Economic tasks in construction. Mathematical programming. Modelling by goal function and constraint inequalities.

Name of disciplines	«Digital technologies in construction»
Course Workload, credits/academic hours	4/144
DISCIPLINE CONTENT	
Units	**Units**
1. BIM Technology	Introduction to BIM process and integrated project de-livery. ND modelling. BIM software systems and guide-lines to choosing different BIM software systems.
2. Basic Modelling	Introduction of modelling environment and tools. Mod-elling approaches to producing plans, 3D models, views and sections of buildings. Modelling of building including basic and vital elements, production of plans, views and 3D models.
3. Advance Concepts	Model customizations, elements and materials. Creation of internal components, external elements, massing and site modelling. Elements visibility, visualization and walkthroughs.
4. Virtual and Augmented Reality	Virtual Reality vs. Augmented Reality. Applications of AR/VR in construction.

Name of disciplines	«Project management»
Course Workload, credits/academic hours	2/72
DISCIPLINE CONTENT	
Units	**Units**
1. Foundations of Project Management	Definition of a project. Nature of construction pro-jects. Project life-cycle. Principles of project management. Project management functions.

Name of disciplines	«Project management»
Course Workload, credits/academic hours	2/72
DISCIPLINE CONTENT	
Units	**Units**
2. Project planning and scheduling	Scheduling process. Work breakdown structures. Scheduling techniques. Critical path method. Resource management. Crashing.
3. Project cost estimating	Planning and design. Project scope management. Elements of cost estimation. Estimating methods, project budgeting. Bidding.
4. Performance measurement	Definition of performance. Performance issues in construction. Factors affecting project success. Industry reports. Performance measurement tools. Key performance indicators.

Name of disciplines	«Life Cycle Economics of Buildings»
Course Workload, credits/academic hours	3/108
DISCIPLINE CONTENT	
Units	**Units**
Introduction	Engineering economy. Decision making process. Costs. Concepts of engineering economics analysis.
Time value of money	Time value of money. Cash flow/time diagram. Single payment. Uniform series payments. Uniform infinite series. Arithmetic gradient uniform series payments.
Economic Evaluation	Economics evaluation. Planning horizon. Life cycle costing. Present worth analysis. Equivalent uniform annual worth analysis. Rate of return method. Benefit/cost ratio method. Payback period.
Applications	Depreciation. Estimating equipment costs (rentals). Sensitivity analysis. Breakeven analysis.

Name of disciplines	«BIM-Technology in Construction Management»
Course Workload, credits/academic hours	4/144
DISCIPLINE CONTENT	
Units	**Units**
1. BIM Technology	The concept of BIM. Project delivery methods and BIM implementation. Levels of Development (LOD). Applications in construction management.
2. Cloud-BIM for design/construction coordi-nation & clash detection	BIM for buildability scenario forecasting. Interfer-ence management. Clash detection.
3. Construction Planning and 4D Simulation	Construction planning. Elements to model location for scheduling tasks. 4D simulations.
4. Quantity Takeoff and Cost Estimating	Types of estimates. Conceptual estimate. Detailed estimate. Model-based calculation.

Name of disciplines	«Numerical methods for Civil Engineering»
Course Workload, credits/academic hours	4/144
DISCIPLINE CONTENT	
Units	**Units**
Fundamentals of Variational methods for calculating structures	This section discusses analytical and numerical methods for calculating structures based on the Lagrange variational principle: the Ritz-Timoshenko method, the Kantorovich-Vlasov method, and the Bubnov-Galerkin method. The Lagrange principle is proved and the main methods for calculating a rigid deformable body based on the principle of the minimum total energy of deformations are considered.
Fundamentals of the Finite element method (FEM)	This section discusses numerical methods for implementing calculations. The basics of the finite element method for calculating rigid deformable bodies operating in a plane stress state, methods for solving stress-strain problems in calculating the bending of plates and bulk bodies are analyzed.
Variational-difference method for calculating structures	The basics of the Variational-difference method for calculating plates and shells are considered.

Name of disciplines	«Structural Design in Steel »
Course Workload, credits/academic hours	4/144
DISCIPLINE CONTENT	
Units	**Units**
Introduction to steel structures	Introduction: Building codes, Seismic forces, Analysis, and design of complex structures. Loads, philosophy of design, steel and properties,
Members of steel structures	Review of tension members, Review of compression members, Review of flexural members , Review of flexural members, Pure torsion of homogeneous sections; shear stresses due to bending of thin-wall open x-section , Torsional stresses in I-shaped steel sections
Steel structures analysis	Analogy between torsional and plane bending; load and resistance factor design for torsion , Allowable strength design for torsion, torsional buckling , Lateral support of beams; elastic and inelastic lateral torsional buckling of beams,
Steel structures design	,Load and resistance factor design-I shaped beams; allowable strength design – I shaped beams Allowable strength design – I shaped beams, effective lateral unbraced length, Lateral bracing design,

Name of disciplines	«Nanotechnology in Civil Engineering»
Course Workload, credits/academic hours	4/144
DISCIPLINE CONTENT	
Units	**Units**
General approach to composite materials	- Composition of composite materials. Matrix, different types of matrix. Reinforcement of composite materials, types of reinforcement.
Classification of composites	-Classification by the type of reinforcing filler, by the type of matrix, by designation, depending on the type and location of fibers. -Isotropic and anisotropic composite materials. Their advantages and disadvantages.
Fiberglass composites	- Mechanical and physical properties, methods of production. - Application of fiberglass in civil engineering. Spatial structures made of fiberglass.
Methods of strength calculations for structures made of composites.	- Strength criteria for isotropic and anisotropic composite materials. Mieses–Hill criterion, - Zakharov–Malmeister criterion. Goldenblat– Kopnov criterion. Their graphical interpretation and range of application. The modified strength criterion.
Nanotechnologies for production of advanced composite materials	-Types of nano-particles. Carbon nanoparticles: fullerenes, nano-tubes, astralens and the other ones, -Concrete modified with nanoparticles. Influence of nano-modification on physical and mechanical properties of concrete.

Name of disciplines	«Structural Design in Reinforced Concrete: Special Topics»
Course Workload, credits/academic hours	5/180
DISCIPLINE CONTENT	
Units	**Units**
Introduction to steel structures	Introduction: Building codes, Seismic forces, Analysis, and design of complex structures. Loads, philosophy of design, steel and properties,
Beam-Column Design	Interaction equations. Effects of moment gradient loading. Design resistance of beam-column members Methods of Analysis for Required, Strength, The Moment Amplification Method, Braced versus Unbraced Frames, Members in Braced Frames, Members in Unbraced Frames, Design of Beam–Columns, Trusses with Top-Chord Loads Between, Joints
Plate girders	Introduction, General Considerations, AISC Requirements for Proportions of Plate, Girders ; Flexural Strength, Shear Strength Bearing Stiffeners, Design
Connection: Welding and bolting and design codes and analysis of steel using computer software	, Concept of welding process. Type of welded connections and failure mode. Design of welded connections, Type of bolted connections and failure mode. Design of bolted connections. Discussion of different design codes and analysis of steel structural system by using computer software

Name of disciplines	«Structural Stability / Устойчивость сооружений»
Course Workload, credits/academic hours	5/180
DISCIPLINE CONTENT	
Units	**Units**
Concepts of structural stability	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 in stability for shallow and steel trusses
Second order plane frame analysis	Topic 2.1 Members of a frame: Governing equa tions for a member and their solution.
	Topic 2.2. Member stiffness matrix: Exact stiffness coefficients; Limit expressions for the stiffness co efficient
	Topic 2.3. Member load vector: Exact load coefficients; Limit expressions for the load coefficients

Name of disciplines	«Structural Stability / Устойчивость сооружений»
Course Workload, credits/academic hours	5/180
DISCIPLINE CONTENT	
Units	**Units**
	Topic 2.4. Algorithms for second order plane frame analysis. Limitations of second order analysis
Single columns and column groups	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 sta bility in frames.

Name of disciplines	«Structural Design in Reinforced Concrete»
Course Workload, credits/academic hours	5/180
DISCIPLINE CONTENT	
Units	**Units**
Basic concepts of the design of reinforced concrete structures	Historical background. Concrete and reinforced concrete. Advantages of reinforced concrete as a structural material.Design Codes. SI Units and shaded areas. Admixtures. Calculation accuracy. Introduction to Loads. Dead loads. Live loads. Environmental loads. Selection of Design loads. Calculation accuracy.
Flexural and strength analysis of beams according ACI code	- Ultimate or nominal flexural moments. Cracking moment. Elastic stresses—Concrete cracked. - Design methods. Advantages of Strength Design. Elastic Stresses—Concrete Cracked. Structural Safety. - Strength reduction or φ Factors. Minimum Percentage of Steel. Balanced steel percentage.
Analysis and Design of Beams (Single and Double Reinf; T-Beams; Continuous Beams)	- Analysis of T-beams.Design of T-beams. Design of T-beams for negative moments. L-shaped beams. Load factors. Design of rectangular beams. Miscellaneous beam considerations. Determining steel area when beam dimensions are predetermined.
Serviceability limit states of the structures (Deflection of Beams)	Importance of deflections. Control of deflections. Calculation of deflections. Continuous-beam deflections. Types of cracks. Control of flexural cracks. ACI Code Provisions concerning cracks. Miscellaneouss cracks.
Shear and Torsion Design	Shear Stresses in Concrete Beams. Shear Strength of Concrete. Shear Strength of Members Subjected to Axial Forces.

Name of disciplines	«Structural Design in Reinforced Concrete»
Course Workload, credits/academic hours	5/180
DISCIPLINE CONTENT	
Units	**Units**
	Torsional reinforcing. Torsional moments that have to be considered in design. Torsional moment strength. Torsional stresses. Design of torsional reinforcing. Additional ACI Requirements.
Bond, Development Lengths, and Splices.	Development lengths for welded wire fabric in tension. Development lengths for compression bars. Critical sections for development length. Effect of combined shear and moment on development lengths. Effect of shape of moment Diagram on development lengths
Columns. **Design of short columns subject to axial load and bending. Slender columns.**	Types of columns. Axial load capacity of columns. Code requirements for cast-in-place Columns. Failure of tied and spiral columns. Design of axially loaded columns. Design formulas. Comments on economical column design. Axial load and bending. The Plastic centroid. Slenderness effects. Slender columns in nonsway and sway frames. ACI Code treatments of slenderness Effects. Magnification of column moments in nonsway and sway frames.
Footings	Design of wall footings. Plain concrete footings. Rectangular isolated footings. Combined footings. Actual soil pressures. Allowable soil pressures. Design of square isolated footings. Footings subjected to axial loads and moments. Load transfer from columns to footings. Footings supporting round or regular polygon-shaped columns.

Name of disciplines	«Building materials: Special Topics»
Course Workload, credits/academic hours	5/180
DISCIPLINE CONTENT	
Units	**Units**
Section #1. BASIC PROPERTIES OF BUILDING MATERIALS	1. Properties, structure and composition of building materials 2. Physical properties and structural char-acteristics 3. Mechanical properties.
Section #2. THERMAL INSULATION MATE-RIALS 1 part	1. Purpose and classification of thermal insu-lation materials 2. Technical properties of heat-insulating ma-terials
Section No.3. THERMAL INSULATION MATERIALS 2 part	1. Inorganic heat-insulating materials and products. 2. Organic thermal insulation materials and products.
Section #4. THERMAL INSULATION MATERIALS Part 3	1. Organic thermal insulation materials and products. 2. Heat-insulating plastics
Section #5.	1. General provisions

Name of disciplines	«Building materials: Special Topics»
Course Workload, credits/academic hours	5/180
DISCIPLINE CONTENT	
Units	**Units**
MATERIALS FOR ROOFING	2. Rolled and mastic roofs Roofs made of sheet and piece materials
Section #6. PAINT AND VARNISH MATERIALS Part 1	1. Nomenclature and characteristics 2. Binders for paints 3. Pigments
Section #7. PAINT AND VARNISH MATERIALS	1. Pigments 2. Fillers 3. Diluents and solvents 4. Types of paint compositions
Section #8. ACOUSTIC MATERIALS	1. General information 2. Sound-absorbing materials

Name of disciplines	«Structural Design in Steel: Special Topics»
Course Workload, credits/academic hours	4/144
DISCIPLINE CONTENT	
Units	**Units**
Introduction to steel structures	Introduction: Building codes, Seismic forces, Analysis, and design of complex structures. Loads, philosophy of design, steel and properties,
Members of steel structures	Review of tension members, Review of compression members, Review of flexural members , Review of flexural members, Pure torsion of homogeneous sections; shear stresses due to bending of thin-wall open x-section , Torsional stresses in I-shaped steel sections
Steel structures analysis	Analogy between torsional and plane bending; load and resistance factor design for torsion , Allowable strength design for torsion, torsional buckling , Lateral support of beams; elastic and inelastic lateral torsional buckling of beams,
Steel structures design	,Load and resistance factor design-I shaped beams; allowable strength design – I shaped beams Allowable strength design – I shaped beams, effective lateral unbraced length, Lateral bracing design,

Name of disciplines	«Modelling of Construction Processes»
Course Workload, credits/academic hours	4/144
DISCIPLINE CONTENT	
Units	**Units**
BIM Technology	The concept of BIM. Project delivery methods and BIM implementation. Levels of Development (LOD). Applications in construction management.

Name of disciplines	«Modelling of Construction Processes»
Course Workload, credits/academic hours	4/144
DISCIPLINE CONTENT	
Units	**Units**
Cloud-BIM for design/construction coordination & clash detection	BIM for buildability scenario forecasting. Interference management. Clash detection.
Construction Planning and 4D Simulation	Construction planning. Elements to model location for scheduling tasks. 4D simulations.
Quantity Takeoff and Cost Estimating	Types of estimates. Conceptual estimate. Detailed estimate. Model-based calculation.

Name of disciplines	«Applications of Finite Element Method for Civil Engineering problems»
Course Workload, credits/academic hours	3/108
DISCIPLINE CONTENT	
Units	**Units**
Plane Stress and Plane Strain Theory	- Plane stress and plan strain approximations. Coordinate systems. Displacement of material points. State of strain. State of stress. Stress equilibrium at a point. Constitutive equations. Boundary conditions. Differential form of the governing equations. Weighted residual method. Integral form of the governing equations ,|
Finite Element Tools	-Finite element concept. Description of finite element shape. Quadrilateral elements. Triangular elements. Interpolation of variables in finite elements. - Differentiation of functions in finite elements: Dif-ferentiation of shape functions. Differentiation of behavioral variables -Integration of functions in finite elements: Integration over quadrilateral elements: Integration over triangular elements. - Numerical integration One-dimensional Gauss in-tegration: Gauss integration in quadrilaterals: Gauss integration in triangles.
Finite Element Networks	- Decomposition of a slab. Element shape. Displacement interpolation. Strain mterpolation. - Element and system stiffness matrices. Element and system body load vectors. Boundary conditions: Shape of the boundary; System boundary load vector: Boundary conditions at nodes. - Algebraic governing equations. Assembly and solu-tion of the algebraic system equations. Assembly of the system equations. - Structure of the system matrix. Solution of linear equations with profile and status. Accuracy and convergence of the finite element method. Stress computation.
Finite Element Types	- Rectangular element with 4 nodes. Constant strain triangular element.

Name of disciplines	«Applications of Finite Element Method for Civil Engineering problems»
Course Workload, credits/academic hours	3/108
DISCIPLINE CONTENT	
Units	**Units**
	- Quadrilateral element with 8 nodes. Linear strain triangular element.

Name of disciplines	«Sustainability in Civil Engineering»
Course Workload, credits/academic hours	3/108
DISCIPLINE CONTENT	
Units	**Units**
Conceptual development of a typology of sustainable buildings	• Introduction to the basic terminology of sustainable buildings. Principles of formation of sustainable architecture. Energy efficient (passive, active) and smart buildings. • Factors of influence on the process of viability and "sustainable" development of buildings and structures. • The concept of "life cycle of the building". Organizational structure of buildings. • Main trends in the development of modern urban planning. Above-ground and underground types of "green buildings". adaptive architecture. Eco-certification of "green" construction objects in Russia and abroad.
Architectural and space-planning solution for energy-efficient buildings.	• Typology of energy efficient buildings. Overview of the first projects of energy efficient buildings. Definition of the basic principle of energy efficient buildings. • Typology of buildings according to the method of extracting energy from natural factors (solar buildings, wind-powered, hydropower-active and buried dwellings). "Active" and "passive" houses. • Accounting for regional specifics in the design of energy efficient buildings. Stages of designing an energy-efficient building. Factors taken into account when designing, reconstructing and evaluating energy-efficient buildings (climate of the area and orientation of buildings, solar radiation and insolation, aeration and wind regime, type of landscape of the building site, main patterns of microclimate formation in various conditions of the underlying surface). Gardening and improvement.. Types of space-planning solutions for energy-efficient buildings. Determination of rational features of space-planning solutions for energy-efficient houses in the Russian

Name of disciplines	«Sustainability in Civil Engineering»
Course Workload, credits/academic hours	3/108
DISCIPLINE CONTENT	
Units	**Units**
	Federation and abroad. Foreign experience in the design and construction of bioclimatic energy efficient architecture.

Name of disciplines	«Optimization Methods in Civil Engineering»
Course Workload, credits/academic hours	2/72
DISCIPLINE CONTENT	
Units	**Units**
Introduction to optimization	Methods of Operations Research. Historical development.
Statement of optimization problem	Constrained and unconstrained optimization problems. Design Vector. Design Constraints constraint surface. Objective Function. Objective Function Surfaces.
Classification of optimization problems	Classification Based on the Existence of Constraints. Classification Based on the Nature of the Design Variables. Classification Based on the Physical Structure of the Problem. Classification Based on the Nature of the Equations Involved.
Classical optimization techniques	Single-variable optimization. Theorem of necessary and sufficient condition.
Multivariable optimization with no constraints	The necessary and sufficient conditions for the minimum or maximum of an unconstrained function of several variables

Name of disciplines	«Structural Dynamics»
Course Workload, credits/academic hours	2/72
DISCIPLINE CONTENT	
Units	**Units**
General information on the dynamics of deformed systems	General concepts. Forces of inertia. The D'Alembert principle. The main types of dynamic load. Dynamic tasks, reduced to tasks of static calculation. Calculation of inertial loads
Hit	Dynamic factor
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. Attenuation of vibrations. Elastic free oscillations of systems with several degrees of freedom.
Free oscillations of rod systems as systems with distributed mass	Free oscillations of beams as systems with distributed mass. Longitudinal oscillations of a rod with distributed mass. The method of displacements in problems on harmonic vibrations

Name of disciplines	«Structural Dynamics»
Course Workload, credits/academic hours	2/72
DISCIPLINE CONTENT	
Units	**Units**
	of rod systems. Free vibrations of rod systems with distributed mass. Free oscillations of the Π-shaped frame.
Calculation of fatigue	Voltage variables. Stress cycle. Fatigue. Curve fatigue. Limit of endurance. The main factors affecting the value of the limit of endurance
Free oscillations of plates and shells	Free vibrations of rectangular plates. Oscillations of cylindrical and spherical shells.

Name of disciplines	«Geometric Shaping and Analysis of Shells»
Course Workload, credits/academic hours	2/72
DISCIPLINE CONTENT	
Units	**Units**
Classification and forms of spatial structures	- Planar designs. Classification and forms of spatial structures. Signs of static shaping. Kine- matic surfaces.
On the design and construction of spatial structures	- Structures working "on the span", rigid shells, regular systems, suspended roofs, transforming systems, air-supporting and air-suspended struc- tures. Tent structures. Structural concept. Pro- duction, transportation and construction of spa- tial systems.
Shells of Revolution	- Spherical shell. Shells in the form of a single- cavity hyperboloid of revolution. Paraboloid and ellipsoid of revolution. Circular torus Pseudosphere. Catenoid. Globoid. A drop. The mating surfaces of coaxial cylinder and cone.
Ruled shells of zero Gaussian curvature	- Conical, cylindrical and torse shells. Build torse developments. Replacement of cylinders, cones and torse surfaces folds. Surfaces of the equal slope.
Ruled shells of negative Gaussian curvature	- Hyperbolic paraboloid. Conoids. Cylindroids. 5 types of ruled helicoids. Ruled rotary and spiroid surfaces. Catalan Surfaces.
Cyclic surfaces	- Channel surfaces. Normal cyclic surfaces. Cyclic surfaces with a parallelism plane. Cyclic surfaces with circles in the planes of the bunch.
Kinematic surfaces	- Direct transfer surfaces. Rotative and spiroid surfaces.
Umbrella surfaces and umbrella type surfaces	- Wavy type and wavy surfaces. Corrugated surfaces. Corrugated products. Umbrella domes on the cone. Reinforced concrete, metal, tent umbrella shells.
Minimal surfaces	- Minimal surfaces strung on a rigid support contour. Dome structures made of plastic.
Helicoidal and helical shape shells. Shells in the form of spiral and spiral shape surfaces.	- Ordinary screw surfaces. Screw surface vari- able pitch. Cyclic surface in the cylinder. Helical surfaces with generatrix in the planes of the bunch.
Membrane and cable coatings.	- Examples of built structures with membrane and suspended roofs.

Name of disciplines	«Geometric Shaping and Analysis of Shells»
Course Workload, credits/academic hours	2/72
	DISCIPLINE CONTENT
Units	**Units**
Shells in the form of analytically indefinable surfaces	- Overview of the constructed structures Con- structive forms of wildlife and their influence on the development of fundamentally new spatial structures.
Spatial Composite Structures	- Smooth mating of two surfaces. Transforma- ble structures.
Geometrical Shaping of Shells (experimental part)	- Manufacturing models that demonstrate the methods of generating the middle surfaces of the shells.

РУКОВОДИТЕЛЬ ОП ВО:

Директор департамента строительства		Рынковская М.И.
Должность, БУП	Подпись	Фамилия И.О.