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

Academy of Engineering

ANNOTATION OF THE EDUCATIONAL DISCIPLINE

Educational program
08.04.01 Civil Engineering

Civil Engineering and Built Environment ,
Mechanics of materials and engineering structures,

Built environment of smart city

Name of the discipline	**Applications of Finite Element Method for Civil Engineering problems**
Scope of discipline	**3 credits (108 h.)**
Discipline summary	
The name of the sections (topics) of the discipline	**A summary of the sections (topics) of the discipline:**
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: Differentiation 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 integration: Gauss integration in quadrilaterals; Gauss integration in triangles.
Finite Element Networks	- Decomposition of a slab. Element shape. Displacement interpolation. Strain interpolation. - 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 solution 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. - Quadrilateral element with 8 nodes. Linear strain triangular element.

Developer:

Assistant at the Department of Civil engineering T. H. Gebre

Director at the Department of Civil engineering M.I. Rynkovskaya

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

Academy of Engineering

ANNOTATION OF THE EDUCATIONAL DISCIPLINE

Educational program
08.04.01 Civil Engineering

Civil Engineering and Built Environment ,
Mechanics of materials and engineering structures,

Built environment of smart city

Name of the discipline	**Applications of Finite Element Method for Civil Engineering problems**

Name of the discipline	**Fundamentals of Finite Element Method**
Scope of discipline	**3 credits (108 h.)**
Discipline summary	
The name of the sections (topics) of the discipline	**A summary of the sections (topics) of the discipline:**
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: Differentiation 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 integration: Gauss integration in quadrilaterals; Gauss integration in triangles.
Finite Element Networks	- Decomposition of a slab. Element shape. Displacement interpolation. Strain interpolation. - 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 solution 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. - Quadrilateral element with 8 nodes. Linear strain triangular element.

Developer:

Ass. Professor at the Department of Civil engineering  T.H. Gebre

Director at the Department of Civil engineering  M.I. Rynkovskaya

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

Academy of Engineering

ANNOTATION OF THE EDUCATIONAL DISCIPLINE

Educational program
08.04.01 Civil Engineering

Civil Engineering and Built Environment ,
Mechanics of materials and engineering structures,

Built environment of smart city

Name of the discipline	**Geometric Shaping and Analysis of Shells**
Scope of discipline	**3 credits (108 h.)**
Discipline summary	
The name of the sections (topics) of the discipline	**A summary of the sections (topics) of the discipline:**
Classification and forms of spatial structures	- Planar designs. Classification and forms of spatial structures. Signs of static shaping. Kinematic 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 structures. Tent structures. Structural concept. Production, transportation and construction of spatial 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 variable 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.
Shells in the form of analytically indefinable surfaces	- Overview of the constructed structures Constructive forms of wildlife and their influence on the development of fundamentally new spatial structures.
Spatial Composite Structures	- Smooth mating of two surfaces. Transformable structures.
Geometrical Shaping of Shells (experimental part)	- Manufacturing models that demonstrate the methods of generating the middle surfaces of the shells.

Developer:

Ass. Professor at the Department of Civil engineering T.H. Gebre

Director at the Department of Civil engineering M.I. Rynkovskaya

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

Academy of Engineering

ANNOTATION OF THE EDUCATIONAL DISCIPLINE

Educational program
08.04.01 Civil Engineering

Civil Engineering and Built Environment ,
Mechanics of materials and engineering structures,

Built environment of smart city

Name of the discipline	***Linear theory of elasticity***
Scope of discipline	**3 (108h)**
Discipline summary	
The name of the sections (topics) of the discipline	**A summary of the sections (topics) of the discipline:**
Equilibrium equations.	The main hypotheses of the theory of elasticity. Equilibrium equations in the rectangular coordinate system. Equilibrium equations in the polar coordinate system. Boundary conditions.
Theory of solving problems of elasticity theory in displacements and stresses.	Deformation theory. Equations of continuity of deformation. The relationship between stresses and deformations. Solution of basic differential equations.
The plane problem of theory of elasticity.	Deformation theory. Equations of continuity of deformation. The relationship between stresses and deformations. Solution of basic differential equations.
Solution of problems of theory of elasticity.	Solution of problems in rectangular coordinate system. Solution of problems in the polar coordinate system.
The theory of bending of plates.	Derivation of the Sophie Germain equations for a thin plate. Calculation of rectangular plates. Calculation of round plates.

Developer:

Associate Professor of the Department of Civil Engineering M. I. Rynkovskaya

Director at the Department of Civil engineering

M.I. Rynkovskaya

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

Academy of Engineering

ANNOTATION OF THE EDUCATIONAL DISCIPLINE

Educational program
08.04.01 Civil Engineering

Theory and Design of Buildings and Structures/

Name of the discipline	Mathematical Modelling
Scope of discipline	**3 (108h)**
Discipline summary	
The name of the sections (topics) of the discipline	**A summary of the sections (topics) of the discipline:**
The subject and tasks of the course "mathematical modeling of spatial structures"	- Place, purpose and advantage of mathematical modelling in the process of knowledge of objects 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. Classification of objects by type of behavior. Analytical and simulation models. Stages of mathematical modelling. Historical experience in the formation of mathematical models and solving practical problems by means of mathematics. The task of the trajectory of a ray of light reflecting from a mirror. The problem of the trajectory of a Brachistochrone problem. Models based on the principle of least action and the principle of equilibrium.
Basic fundamental laws in mechanics	Principles of causality. Equations of state. Postulates about space and time. The law of conservation. 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 phenomenon. Mathematical model. The requirement for a mathematical model. General technology for solving practical problems using mathematics. The sequence of construction and testing of mathematical models on the examples of the simplest problems of mechanics: stretching and compression of the beam. Bending of the beam, loss of stability of the beam. The test of a mathematical 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 synthesis. Determining relationships and empirical dependencies in mathematical models. Dimension 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. Simulation of partial differential equations. The problem 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 solution accuracy. Dimensional Verification of models.
The use of computing in mathematical modelling.	The concept of computational experiment. Triad "model-algorithm-program". Numerical simulation. 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 incompressible 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.

Developer:

Ass. Professor at the Department of Civil engineering  E. M. Tupikova

Director at the Department of Civil engineering  M.I. Rynkovskaya

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

Engineering Academy

ANNOTATION OF THE EDUCATIONAL DISCIPLINE

Educational program
08.04.01 Civil Engineering

Civil Engineering and Built Environment ,
Mechanics of materials and engineering structures,
Built environment of smart city

The name of the discipline	Mathematical methods of experimental data processing
The scope of the discipline	*4 CREDITS, ECTS (144 hours).*
The summary of the discipline	*Title of the sections (topics) of the discipline* *The summary of the sections (topics) of the discipline:*
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 Brandon method. Estimation of adequacy of the constructed 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.

Developer:

Assistant at the Department of Civil engineering  T. H. Gebre

Director at the Department of Civil engineering  M.I. Ryn-kovskaya

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

Academy of Engineering

ANNOTATION OF THE EDUCATIONAL DISCIPLINE

Educational program
08.04.01 Civil Engineering

Civil Engineering and Built Environment,
Mechanics of materials and engineering structures,
Built environment of smart city

Name of the discipline	Modelling of construction processes
Scope of discipline	**3 (108h)**
Discipline summary	
The name of the sections (topics) of the discipline	**A summary of the sections (topics) of the discipline:**
Main points of modelling of construction processes	1.1. Main stages of buildings construction 1.2. Main points of design of various construction processes.
Modelling of underground construction processes	2.1. Underground construction process by slurry wall method 2.2. Underground construction process by top-down method 2.3. Construction of various types of foundations
Modelling of cast-in-situ construction processes	3.1. Various types of formwork systems and fields of their applications 3.2. Technology of concrete works 3.3. Concrete curing in various climatic conditions
Modelling of construction of high-rise buildings	4.1. Construction of skyscrapers 4.2. Construction of tower buildings 4.3. Construction of high-rise buildings by method of floor lift

Developer:

Associate Professor at the Department of Civil engineering  M.I. Rynkovskaya

Director at the Department of Civil engineering  M.I. Rynkovskaya

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

Academy of Engineering

ANNOTATION OF THE EDUCATIONAL DISCIPLINE

Educational program
08.04.01 Civil Engineering

Civil Engineering and Built Environment,
Mechanics of materials and engineering structures,
Built environment of smart city

Name of the discipline	**Geometric Shaping and Analysis of Shells**
Scope of discipline	**3 ЗЕ (108 час.)**
Discipline summary	
The name of the sections (topics) of the discipline	**A summary of the sections (topics) of the discipline:**
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, depend-ingon the type and location of fibers. Isotropic and anisotropic composite materials. Their advantages and disadvantages.
Fiberglass composites	Mechanical and physical properties, methods ofproduction. Application of fiberglass in civil engineering. Spatial structures made of fiber-glass.
Methods of strength calculations for struc-tures 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 ad-vancedcomposite materials	Types of nano-particles. Carbon nanoparticles: fullerenes, nano-tubes, astralens and the other ones. Concrete modified with nanoparticles. In-fluence of nano-modification on physical and mechanical properties of concrete.

Developer:
Ass. Professor at the Department of Civil engineering  S. L. Shambina

Program Manager
Ass. Professor at the Department of Civil engineering  M.I. Rynkovskaya

Director at the Department of Civil engineering  M.I. Rynkovskaya

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

Academy of Engineering

ANNOTATION OF THE EDUCATIONAL DISCIPLINE

Educational program
08.04.01 Civil Engineering

Civil Engineering and Built Environment , Mechanics of materials and engineering structures, Built environment of smart city

Name of the discipline	**Problem solving techniques in Civil Engineering**
Scope of discipline	**3 credits (108 h.)**
Discipline summary	
The name of the sections (topics) of the discipline	**A summary of the sections (topics) of the discipline:**
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 technological 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) experiment. The goals and objectives of experimental research. Experiment planning. The planning matrix. Regression analysis. factorial experiment.
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 application. A patent search Selection of unique. Criticism of peers. Selection of the prototype. Criticism of the prototype. Drawing description.
Processing and analysis of research results	Comparison of results of theoretical and experimental studies. The matching criteria. Criteria of adequacy of theoretical and experimental dependencies. Mathematical processing of experimental data. Analysis of experimental results. Preparation of research results for publication and scientific periodicals. Scientific report. Abstract. Dissertation.

Associate Professor of the Department of Civil Engineering M. I. Rynkovskaya

Director of the Construction Department M. I. Rynkovskaya

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

Academy of Engineering

ANNOTATION OF THE EDUCATIONAL DISCIPLINE

Educational program
08.04.01 Civil Engineering

Civil Engineering and Built Environment , Mechanics of materials and engineering structures, Built environment of smart city

Name of the discipline	**Structural Design in Steel**
Scope of discipline	**3 credits (108 h.)**
Discipline summary	
The name of the sections (topics) of the discipline	**A summary of the sections (topics) of the discipline:**
Calculation of the transverse frame of the steel framework of a multistory building	Determination of the loads and impacts acting on the transverse frame of the steel framework of a multistory building. The overall calculation of the transverse frame of the steel framework of a multistory building based ona flat FE model. Analysis of the calculation results.The overall calculation of the transverse frame of the steel framework of a multistory building based on the spatial model of the FE model.
Calculation of metal truss	- Total FE calculation of metal truss. Analysis of the calculation results. Selection of cross-sections and checking the strength of the elements of the metal truss. Investigation of the stress-strain state of metal truss's joints

Developer:

Associate Professor of the Department of Civil Engineering M. I. Rynkovskaya

Program Manager

Associate Professor of the Department of Civil Engineering M. I. Rynkovskaya

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

Academy of Engineering

ANNOTATION OF THE EDUCATIONAL DISCIPLINE

Educational program
08.04.01 Civil Engineering

Civil Engineering and Built Environment ,
Mechanics of materials and engineering structures,

Built environment of smart city

Name of the discipline	**Geometric Shaping and Analysis of Shells**
Scope of discipline	**3 credits (108 h.)**
Discipline summary	
The name of the sections (topics) of the discipline	**A summary of the sections (topics) of the discipline:**
Classification and forms of spatial structures	- Planar designs. Classification and forms of spatial structures. Signs of static shaping. Kinematic 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 structures. Tent structures. Structural concept. Production, transportation and construction of spatial 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 variable 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.
Shells in the form of analytically indefinable surfaces	- Overview of the constructed structures Constructive forms of wildlife and their influence on the development of fundamentally new spatial structures.
Spatial Composite Structures	- Smooth mating of two surfaces. Transformable structures.
Geometrical Shaping of Shells (experimental part)	- Manufacturing models that demonstrate the methods of generating the middle surfaces of the shells.

Developer:

Ass. Professor at the Department of Civil engineering T.H. Gebre

Director at the Department of Civil engineering M.I. Rynkovskaya

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

Academy of Engineering

ANNOTATION OF THE EDUCATIONAL DISCIPLINE

Educational program
08.04.01 Civil Engineering

Civil Engineering and Built Environment ,

Mechanics of materials and engineering structures,

Built environment of smart city

Name of the discipline	**Structural Design in Reinforced Concrete**
Scope of discipline	**3 credits (108 h.)**
Discipline summary	
The name of the sections (topics) of the discipline	**A summary of the sections (topics) of the discipline:**
The 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. Derivation of beam expressions. Strains in Flexural Members. Balanced sections, tension-Controlled sections, and compression-controlled or brittle sections. 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. One-way slabs.

	Cantilever beams and continuous beams. Analysis of Two-Way slabs with Beams. Design of two-way slabs by the ACI Code. Shear resistance of slabs. Depth limitations and stiffness requirements. Analysis of Two-Way slabs with Beams. Design of two-way slabs by the ACI Code. Shear resistance of slabs. Depth limitations and stiffness requirements.
Design of one-way slabs and Two- ways slabs.	Design of rectangular beam and one-way slabs. Two- ways slabs. Design of rectangular beams. Miscellaneous beam considerations. Determining steel area when beam dimensions are predetermined. One-way slabs. Cantilever beams and continuous beams Design of Doubly Reinforced Beams. Compression steel. Analysis of Two-Way slabs with Beams. Design of two-way slabs by the ACI Code. Shear resistance of slabs. Depth limitations and stiffness requirements. Distribution of Moments in slabs. Design of an interior flat plate. Placing of live loads. Transfer of moments and shears between slabs and columns.
Serviceability limit states of the structures (Deflection of Beams)	Importance of deflections. Control of deflections. Calculation of deflections. Effective moments of Inertia. Long-Term deflections. Simple-Beam deflections. Continuous-beam deflections. Types of cracks. Control of flexural cracks. ACI Code Provisions concerning cracks. Miscellaneous cracks,
Shear and Torsion Design	Introductory Comments on Torsion Shear Stresses in Concrete Beams. Shear Strength of Concrete. Shear Strength of Members Subjected to Axial Forces. Shear cracking of reinforced concrete beam. Behavior of beams with web reinforcement. ACI Code requirements. Design for Shear. Economical Spacing of Stirrups. Shear Friction and Corbels. 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.	Cutting off or bending bars. Bond stresses. Development lengths for tension reinforcing. 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. Cutting off or bending bars. Bar splices in flexural members. Tension splices. Compression splices. Headed and mechanically anchored bars.
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. Use of interaction Diagrams. Design and analysis of eccentrically loaded columns using interaction Diagrams. Shear in Columns. 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.

Developer:

Ass. Professor at the Department of Civil engineering  T.H. Gebre

Director at the Department of Civil engineering  M.I. Rynkovskaya

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

Academy of Engineering

ANNOTATION OF THE EDUCATIONAL DISCIPLINE

Educational program
08.04.01 Civil Engineering

Civil Engineering and Built Environment ,

Mechanics of materials and engineering structures,

Built environment of smart city

Name of the discipline	**Structural Design in Reinforced Concrete: Special Topics**
Scope of discipline	**3 credits (108 h.)**
Discipline summary	
The name of the sections (topics) of the discipline	**A summary of the sections (topics) of the discipline:**
The 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. Derivation of beam expressions. Strains in Flexural Members. Balanced sections, tension-Controlled sections, and compression-controlled or brittle sections. 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. One-way slabs. Cantilever beams and continuous beams. Analysis of Two-Way slabs with Beams. Design of

	two-way slabs by the ACI Code. Shear resistance of slabs. Depth limitations and stiffness requirements. Analysis of Two-Way slabs with Beams. Design of two-way slabs by the ACI Code. Shear resistance of slabs. Depth limitations and stiffness requirements.
Design of one-way slabs and Two- ways slabs.	Design of rectangular beam and one-way slabs. Two- ways slabs. Design of rectangular beams. Miscellaneous beam considerations. Determining steel area when beam dimensions are predetermined. One-way slabs. Cantilever beams and continuous beams Design of Doubly Reinforced Beams. Compression steel. Analysis of Two-Way slabs with Beams. Design of two-way slabs by the ACI Code. Shear resistance of slabs. Depth limitations and stiffness requirements. Distribution of Moments in slabs. Design of an interior flat plate. Placing of live loads. Transfer of moments and shears between slabs and columns.
Serviceability limit states of the structures (Deflection of Beams)	Importance of deflections. Control of deflections. Calculation of deflections. Effective moments of Inertia. Long-Term deflections. Simple-Beam deflections. Continuous-beam deflections. Types of cracks. Control of flexural cracks. ACI Code Provisions concerning cracks. Miscellaneous cracks,
Shear and Torsion Design	Introductory Comments on Torsion Shear Stresses in Concrete Beams. Shear Strength of Concrete. Shear Strength of Members Subjected to Axial Forces. Shear cracking of reinforced concrete beam. Behavior of beams with web reinforcement. ACI Code requirements. Design for Shear. Economical Spacing of Stirrups. Shear Friction and Corbels. 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.	Cutting off or bending bars. Bond stresses. Development lengths for tension reinforcing. 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. Cutting off or bending

	bars. Bar splices in flexural members. Tension splices. Compression splices. Headed and mechanically anchored bars.
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. Use of interaction Diagrams. Design and analysis of eccentrically loaded columns using interaction Diagrams. Shear in Columns. 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.

Developer:

Ass. Professor at the Department of Civil engineering T.H. Gebre

Director at the Department of Civil engineering M.I. Rynkovskaya

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

Academy of Engineering

ANNOTATION OF THE EDUCATIONAL DISCIPLINE

Educational program
08.04.01 Civil Engineering
Design and Theory of Buildings and structures,
Mechanics of materials and engineering structures,
Built environment of smart city

Name of the discipline	Structural dynamics
Scope of discipline	3 credit (108h)
Discipline summary	
The name of the sections (topics) of the discipline	**A summary of the sections (topics) of the discipline:**
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 of rod systems. Free vibrations of rod systems with distributed mass. Free oscillations of the П-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.

Developer:

Associate Professor at the Department of Civil engineering  M.I. Rynkovskaya

Director at the Department of Civil engineering  M.I. Rynkovskaya

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

Academy of Engineering

ANNOTATION OF THE EDUCATIONAL DISCIPLINE

Educational program
08.04.01 Civil Engineering

Civil Engineering and Built Environment,

Mechanics of materials and engineering structures,

Built environment of smart city

Name of the discipline	**Structural Stability**
Scope of discipline	**3 credits (108 h.)**
Discipline summary	
The name of the sections (topics) of the discipline	**A summary of the sections (topics) of the discipline:**
1. Concepts of structural stability	Definition of stability. Instability without large dis placements: Order and linearity of structural theo ries; First order theory of an axially loaded bar; Se cond order theory for Euler columns; Behaviour of geometrically imperfect columns; Behaviour of col umns 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 steep trusses.
2. Second order plane frame analysis	Members of a frame: Governing equations for a member and their solution. Member stiffness matrix: Exact stiffness coefficients; Limit expressions for the stiffness coefficients. 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. Single columns and column groups	Single columns: Boundary conditions for single col umns. Elastically supported single columns. Effec tive length and slenderness of columns. Linked Col umns. Columns in frames: Translation and rotation restraints at nodes; Single column with girder re straint and side-sway. Columns in portal frames. Columns in multistorey buildings. General method for the analysis of column stability in frames.

Developer:

Assistant at the Department of Civil engineering T.H, Gebre

Director of the Department of civil engineering M. I. Rynkovskaya

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

Academy of Engineering

Department of Civil Engineering

ANNOTATION OF THE EDUCATIONAL DISCIPLINE

Educational program
08.04.01 Civil Engineering

Civil Engineering and Built Environment,

Mechanics of materials and engineering structures,

Built environment of smart city

Name of the discipline	***Project management***
The scope of the discipline	**5 credits (180 h.)**
Summary of the discipline	
The name of the sections (topics) of the discipline	**Summary of the sections (topics) of the discipline:**
1. Foundations of Project Management	Definition of a project. Nature of construction projects. Project life-cycle. Principles of project management. Project management functions.
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.

Developer:

Ass. Professor
Department of Civil engineering _____ (signature) Elsheikh A.M (surname, initials)

Director
Department of Civil engineering _____ (signature) Rynkovskaya M.I. (surname, initials)

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

Academy of Engineering

Department of Civil Engineering

ANNOTATION OF THE EDUCATIONAL DISCIPLINE

Educational program
08.04.01 Civil Engineering

Name of the discipline	***Digital technologies in construction***
The scope of the discipline	**4 credits (144 h.)**
Summary of the discipline	
The name of the sections (topics) of the discipline	**Summary of the sections (topics) of the discipline:**
1. BIM Technology	Introduction to BIM process and integrated project delivery. ND modelling. BIM software systems and guidelines to choosing different BIM software systems.
2. Basic Modelling	Introduction of modelling environment and tools. Modelling 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.

Developer:

Ass. Professor
Department of Civil engineering _____ (signature) Elsheikh A.M (surname, initials)

Director
Department of Civil engineering _____ (signature) Rynkovskaya M.I. (surname, initials)

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

Academy of Engineering

Department of Civil Engineering

ANNOTATION OF THE EDUCATIONAL DISCIPLINE

Educational program
08.04.01 Civil Engineering

Name of the discipline	***BIM-Technology in Construction Management***
The scope of the discipline	**4 credits (144 h.)**
Summary of the discipline	
The name of the sections (topics) of the discipline	**Summary of the sections (topics) of the discipline:**
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 coordination & clash detection	BIM for buildability scenario forecasting. Interference 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.

Developer:

Ass. Professor
Department of Civil engineering _____ Elsheikh A.M
signature surname, initials

Director
Department of Civil engineering _____ Rynkovskaya M.I.
signature surname, initials

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

Academy of Engineering

ANNOTATION OF THE EDUCATIONAL DISCIPLINE

Educational program
08.04.01 Civil Engineering

Civil Engineering and Built Environment,
Mechanics of materials and engineering structures,
Built environment of smart city

Name of the discipline	**Optimization methods in Civil Engineering**
Scope of discipline	**3 ЗЕ (108 час.)**
Discipline summary	
The name of the sections (topics) of the discipline	**A summary of the sections (topics) of the discipline:**
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

Developer:

Ass. Professor at the Department of Civil engineering  M.I. Rynkovskaya

Director at the Department of Civil engineering  M.I. Rynkovskaya

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

Academy of Engineering

ANNOTATION OF THE EDUCATIONAL DISCIPLINE

Educational program
08.04.01 Civil Engineering

Civil Engineering and Built Environment ,

Mechanics of materials and engineering structures,

Built environment of smart city

Name of the discipline	**Building materials (special topic)**
Scope of discipline	**3 credits (108 h.)**
Discipline summary	
The name of the sections (topics) of the discipline	**A summary of the sections (topics) of the discipline:**
Section #1. **BASIC PROPERTIES OF BUILDING MATERIALS**	1. Properties, structure and composition of building materials 2. Physical properties and structural characteristics 3. Mechanical properties.
Section #2. THERMAL INSULATION MATERIALS 1 part	1. Purpose and classification of thermal insulation materials 2. Technical properties of heat-insulating materials
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. MATERIALS FOR ROOFING	1. General provisions 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

Developer:

Ass. Professor at the Department of Civil engineering T.H. Gebre

Director at the Department of Civil engineering M.I. Rynkovskaya