Federal State Autonomous Educational Institution of Higher Education
PEOPLES' FRIENDSHIP UNIVERSITY OF RUSSIA NAMED AFTER PATRICE LUMUMBA
RUDN University

Academy of Engineering

educational division - faculty/institute/academy

COURSE DESCRIPTION

Civil Engineering and Built Environment/
08.04.01 Civil Engineering

field of studies / speciality code and title

Course Title	Professional Russian (as a Foreign Language)
Course Workload	6 credits / 216 academic hours
Course contents	
Course Module Title	**Brief Description of the Module Content**
Section 1. The Russian language as a means of mastering a profession.	Topic 1.1. Prestigious and in-demand professions of the engineering and technical sphere (profile). Topic 1.2. Professional portrait of a specialist. Qualities, properties, abilities. Topic 1.3. Acquaintance with texts from professional journals and websites, texts- information of recruitment agencies. Topic 1.4. Making an autobiography and resume. Language means of self-presentation. Topic 1.5. Role lesson: job interview.
Section 2. Formation of a professional thesaurus of an engineering specialist	Topic 2.1. General scientific and highly specialized vocabulary. Term formation. Topic 2.2. Principles of semantics of terminological vocabulary in the specialty. Analysis of word-formation models of professional vocabulary. Topic 2.3 The formation and use of verbal nouns. Topic 2.4. Expression of interrelation and interaction of phenomena, processes, events Prepositions characteristic of scientific and professional speech. Topic 2.5. The use of words-organizers of professional speech, phraseological and stable phrases. Topic 2.6. Quest game "Professional vocabulary".
Section 3. Reading professionally-oriented texts	Topic 3.1. Reading authentic texts on professional topics using various strategies (learning, viewing, informative). Topic 3.2. Structural and semantic analysis of texts in the specialty: selection of keywords, informative center; basic and additional information. Topic 3.3. Reading texts, drawing up different types of plans: nominative, question, thesis. Topic 3.4. The concept of text compression. Formulas for deploying and compressing text material. Topic 3.5. Transformation of texts in the specialty: comprehension, processing of content, presentation of basic information. Preparation of messages for the project on the topic.
Section 4. Professional dialogue: communication strategies, speech tactics and behavior in a business conversation, the structure of a business dialogue	Topic 4.1. Reading and listening to conversations / interviews in the specialty in order to adequately understand professionally relevant information. Topic 4.2. Reading and listening to dialogues / interviews in the specialty in order to form the linguistic apparatus of dialogic speech. Topic 4.3. Communicative means of achieving the goals of professional dialogue: exchange of greetings, introduction to the topic of the dialogue, presentation of your opinion on the topic. Topic 4.4. Communicative means of achieving the goals of professional dialogue: questions to the participant of the dialogue, requesting his opinion. Topic 4.5. Linguistic means of starting a dialogue and its completion, dialogical units of professional dialogue.

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	Topic 4.6. Role-playing game: participation in a dialogue on one of the professional topics.
Section 5. Discussion as a form of professional communication	Topic 5.1 The concept of discussion. Rules of professional discussion. Communicative and semantic blocks characteristic of polylogue discussions. Topic 5.2. Language means of communicative and semantic discussion blocks. Inclusion in the conversation, presentation of one's own point of view, presentation of one's own arguments. Topic 5.3. Linguistic means of communicative and semantic blocks of discussion. Attracting the interlocutor's attention; requesting information about the interlocutor's opinion. Topic 5.4. Linguistic means of communicative and semantic discussion blocks. Clarification of the adequacy of information perception. Topic 5.5. Linguistic means of communicative and semantic discussion blocks. Expression of agreement / disagreement with the interlocutor's opinion, refutation of any particular provision, opinion, bringing counterarguments. Topic 5.6. Linguistic means of communicative and semantic discussion blocks. Linguistic means characteristic of the beginning of the utterance, the allocation of the main idea, for the final part of the utterance. Topic 5.7. Lesson-discussion on an actual professional problem.
Section 6. Preparation of business documents in professional activity. Genres of written business speech	Topic 6.1 Main features and typical language means of an official business text. Functional and structural-linguistic features of documents. Topic 6.2. Document definition. Classification of documents by origin, purpose, registration Topic 6.3. The concept of props. The main details and their design.
Section 7. Speech etiquette in professional activity	Topic 7.1. The content of the concept of "speech etiquette". Basic standards of business etiquette. Topic 7.2. Standards of etiquette of a business person and response tactics when participating in business conversations, negotiations. Topic 7.3. Features of a business telephone conversation, standard speech formulas. Topic 7.4. Role lesson: Talking on the phone on a professional topic.

Course Title	Problem solving tecniques in Civil Engineering
Course Workload	3 credits / 108 academic hours
Course contents	
Course Module Title	**Brief Description of the Module Content**
Section 1. Theoretical research	Science as a continuously developing system of knowledge of the objective laws of nature, society and thinking. The purpose of science. Scientific research. Objectives of scientific research. Fundamentals of the methodology of scientific research. Theoretical research. Applied research. Technical and technological development. The purpose of the development. Scientific and technical information. Scientific direction. A scientific problem. Formulation of the problem and hypothesis. Scientific topic.
Section 2. Planning experiments and observations	Fundamentals of experimental research methodology. Goals and objectives of experimental research. Experiment planning. The planning matrix. Random balance method. The planning matrix. Random balance method. Construction of interpolation models. Optimization of processes (planning of extreme experiments). Regression analysis. Factorial experiment.
Section 3. Experimental studies	Natural experiments. Artificial experiments. Computational experiments. Laboratory experiment. A full-scale experiment. Research (search) experiment. Confirming experiment. Design of the methodology and selection of equipment. Preparation of samples and elements. Development of a variable control plan. Conducting an experiment. Processing and interpretation of the results. Preparation of a scientific report.
Section 4. Processing and analysis of research results	Comparison of the results of theoretical and experimental studies. Comparison criteria. Criteria for the adequacy of theoretical dependencies to experimental ones. Mathematical processing of experimental data. Analysis of the results of experimental studies. Preparation of research results for publication and scientific periodicals. Scientific and technical report. Report.

Course Title	Mathematical methods of experimental data processing
Course Workload	3 credits / 108 academic hours
Course contents	
Course Module Title	**Brief Description of the Module Content**
Section 1. Sample characteristics as random variables are ways to represent the results of experiments.	Topic 1.1 Discrete and continuous random variables. Selective characteristics. Laws of random variable distribution. Topic 1.2 Computer simulation of a random variable with a given distribution law: normal and logo - normal distribution, Poisson distribution, distribution of equal probability.
Section 2. Methods for screening out measurement misses	Topic 2.1 The "3-sigma" rule. The Chauvenet criterion. Criteria of Romanovsky, Irwin, Dixon, variation-al scope
Section 3. The concept of a parametric criterion. The power of the criterion. Confidence probability	Topic 3.1 The concept of parametric criteria. The power of the criterion. Confidence probability Topic 3.2 Errors of the first and second kind. The use of computer technologies for the elimination of erroneous values.
Section 4. Fundamentals of optimization. Construction of mathematical models.	Topic 4.1 The concept of the objective function, the limitations of the decision-making domain. Topic 4.2 The Brandon method
Section 5. Methods of decision-making under conditions of uncertainty and multicriteria	Topic 5.1 Criteria of Wald, Laplace, Hurwitz, Savage, mixed criteria.
Section 6. Ranking of factors. Processing of survey results	Topic 6.1 Ranking methods. Calculation of the concordance coefficient
Section 7. Methods of cluster analysis	Topic 7.1 Ways of forming clusters. Calculation of the characteristics of cluster centers, dispersion

Course Title	Numerical methods for Civil Engineering
Course Workload	4 credits / 144 academic hours
Course contents	
Course Module Title	**Brief Description of the Module Content**
Section 1. Fundamentals of variational methods for calculating structures	Topic 1.1 Solving problems of bending beams by Variational methods. Topic 1.2 Fundamentals of the Variational methods. Topic 1.3 Lagrange's variational principle. Topic 1.4 Direct variational methods for solving problems in the theory of elasticity. Topic 1.5 Solution of plate bending problems by Variational methods.
Section 2. Fundamentals of the Finite element method (FEM)	Topic 2.1 Functions of the shape and stiffness matrix of the final element. Topic 2.2 Structural stiffness matrix based on FEM. Calculation of the SSS of the construction. Topic 2.3 Calculation of the plate by the Finite element method.
Section 3. Variational-difference method for calculating structures	Topic 3.1 Introduction to the Variational-difference method for calculating structures. Topic 3.2 Example of calculating a plate using the Variational-difference method.

Course Title	Mathematical Modelling
Course Workload	3 credits / 108 academic hours
Course contents	
Course Module Title	**Brief Description of the Module Content**
Section 1. The subject and tasks of the course "mathematical modeling of spatial structures"	Topic 1.1 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. Topic 1.2 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 refractive Brachistochrone problem. Models based on the principle of least action and the principle of equilibrium.
Section 2. Basic fundamental laws in mechanics	Topic 2.1 Principles of causality. Equations of state. Postulates about space and time. The law of conservation. Topic 2.2 The least action. The principle of Lagrange. Hamilton-Ostrogradsky principle. Topic 2.3 Stable and unstable equilibrium. Euler equations. Principle d'Alembert.
Section 3. The concept of a mathematical model	Topic 3.1 The concept of the model of the object or phenomenon. Mathematical model. The requirement for a mathematical model. Topic 3.2 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. Topic 3.3 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.
Section 4. Formation of mathematical models	Topic 4.1 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. Topic 4.2 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.
Section 5. Types of mathematical models	Topic 5.1 Structural and functional models. Discrete and continuous, linear and nonlinear models.

Course Title	Mathematical Modelling
Course Workload	3 credits / 108 academic hours
Course contents	
Course Module Title	**Brief Description of the Module Content**
	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
Section 6. Methods for solving problems formulated by mathematical models	Topic 6.1 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. Topic 6.2 The boundary value problem and the Cauchy problem. Analytical solution. Asymptotic expansions. Ritz method. Bubnov-Galerkin Method. Discretization of tasks. Euler method. Reduction of the solution to the solution of problems of linear algebra. Finite difference method and finite element method. Topic 6.3 Systems of linear equations and their solution. The problem of eigenvalues. Search for extremums of functions and functionals. Newton's method for solving nonlinear problems. Research solutions. Selection and control of solution accuracy. Dimensional control. Verification of models.
Section 7. The use of computing in mathematical modelling	Topic 7.1 The concept of computational experiment. Triad "model-algorithm-program". Numerical simulation. A preliminary investigation of mathematical models. Qualitative analysis. Dimensionless analysis of the problem. Topic 7.2 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.
Section 8. Mathematical modelling in problems of mechanics of a deformable solid	Topic 8.1 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. Topic 8.2 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. Topic 8.3 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.
Section 9.	Topic 9.1 Ideas involved in the construction of mathematical models of optimization problems.

Course Title	Mathematical Modelling
Course Workload	3 credits / 108 academic hours
Course contents	
Course Module Title	**Brief Description of the Module Content**
Problems of finding the optimal solution and their mathematical modelling	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 tin can. Economical tasks in construction. Mathematical programming. Modelling by goal function and constraint inequalities

Course Title	Digital technologies in construction
Course Workload	4 credits / 144 academic hours
Course contents	
Course Module Title	**Brief Description of the Module Content**
Section 1. BIM Technology	Introduction to BIM process and integrated project delivery. ND modelling. BIM software systems and guidelines to choosing different BIM software systems
Section 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.
Section 3. Advance Concepts	Model customizations, elements and materials. Creation of internal components, external elements, massing and site modelling. Elements visibility, visualization and walkthroughs
Section 4. Virtual and Augmented Reality	Virtual Reality vs. Augmented Reality. Applications of AR/VR in construction

Course Title	Geoinformation Systems and Applications
Course Workload	3 credits / 108 academic hours
Course contents	
Course Module Title	**Brief Description of the Module Content**
Fundamental concepts of geoinformatics	Topic 1.1 Geographic information system: overview, software and data, spatial and attribute data, vector and raster data, layers, networks and web components. Topic 1.2 Open and Commercial GIS. Topic 1.3 Thematic GIS applications.
Geoinformation systems and spatial data	Topic 2.1 Data sources for GIS. Data entry problems. Topic 2.2 Remote sensing as a data source. Topic 2.3 Geographic reference and cartographic projections in GIS.
Thematic mapping, surfaces and digital Relief Model (DEM)	Topic 3.1 Compilation of thematic maps, types of digital terrain models, algorithms for working with DEM. Creating 3D terrain models. Topic 3.2 Integrated use of remote sensing data and geoinformation technologies in industry management
Analytical functions of GIS	Topic 4.1 Typical requests. Overlay. Topic 4.2 Spatial queries in GIS
Design of the project style	Topic 5.1 Creating a map layout

Course Title	Project management
Course Workload	2 credits / 72 academic hours
Course contents	
Course Module Title	**Brief Description of the Module Content**
Section 1. Foundations of Project Management	Definition of a project. Nature of construction projects. Project life-cycle. Principles of project management. Project management functions.
Section 2. Project planning and scheduling	Scheduling process. Work breakdown structures. Scheduling techniques. Critical path method. Resource management. Crashing.
Section 3. Project cost estimating	Planning and design. Project scope management. Elements of cost estimation. Estimating methods, project budgeting. Bidding.
Section 4. Performance measurement	Definition of performance. Performance issues in construction. Factors affecting project success. Industry reports. Performance measurement tools. key performance indicators.

Course Title	Life Cycle Economics of Buildings
Course Workload	3 credits / 108 academic hours
Course contents	
Course Module Title	**Brief Description of the Module Content**
Section 1. Introduction	Engineering economy. Decision making process. Costs. Concepts of engineering economics analysis.
Section 2. 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
Section 3. 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.
Section 4. Applications	Depreciation. Estimating equipment costs (rentals). Sensitivity analysis. Breakeven analysis

Course Title	BIM-Technology in Construction Management
Course Workload	3 credits / 108 academic hours
Course contents	
Course Module Title	**Brief Description of the Module Content**
Section 1. Basic concepts	BIM concept. Project implementation methods and BIM implementation. Levels of Development (LOD).
Section 2. Cloud-BIM for design/construction coordination and collision detection	Systems and a systematic approach in the management of a construction enterprise. Synergetic of the system. Efficiency of synergetic management of a construction enterprise.
Section 3. Construction planning and 4D modeling	Construction planning. Location Modeling Elements for Task Planning. Modeling 4D.
Section 4. Calculation of the scope of work and cost estimates 5D	Types of estimates. Conceptual estimate. detailed cost estimate. Calculation based on 5D models.

Course Title	Structural Design in Steel
Course Workload	4 credits / 144 academic hours
Course contents	
Course Module Title	**Brief Description of the Module Content**
Section 1. Introduction to steel structures	Introduction: Building codes, Seismic forces, Analysis, and design of complex structures. Loads, philosophy of design, steel and properties
Section 2. Members of steel struc-tures	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
Section 3. 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
Section 4. 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

Course Title	Nanotechnology in Civil Engineering
Course Workload	4 credits / 144 academic hours
Course contents	
Course Module Title	**Brief Description of the Module Content**
Section 1. General approach to composite materials	Topic 1.1 Composition of composite materials. Matrix, different types of matrix. Reinforcement of composite materials, types of reinforcement
Section 2. Classification of composites	Topic 2.1 Classification by the type of reinforcing filler, by the type of matrix, by designation, depending on the type and location of fibers Topic 2.2 Isotropic and anisotropic composite materials. Their advantages and disadvantages
Section 3. Fiberglass composites	Topic 3.1 Mechanical and physical properties, methods of production. Topic 3.2 Application of fiberglass in civil engineering. Spatial structures made of fiberglass.
Section 4. Methods of strength calculations for structures made of composites	Topic 4.1 Strength criteria for isotropic and anisotropic composite materials. Mieses–Hill criterion, Topic 4.2 Zakharov–Malmeister criterion. Golenblat– Kopnov criterion. Their graphical interpretation and range of application. The modified strength criterion.
Section 5. Nanotechnologies for production of advanced composite materials	Topic 5.1 Types of nano-particles. Carbon nanoparticles: fullerenes, nano-tubes, astralens and the other ones. Topic 5.2 Concrete modified with nanoparticles. Influence of nano-modification on physical and mechanical properties of concrete.

Course Title	Structural Design in Reinforced Concrete: Special Topics
Course Workload	5 credits / 180 academic hours
Course contents	
Course Module Title	**Brief Description of the Module Content**
Section 1. Basic concepts of the design of reinforced concrete structures	Topic 1.1 Historical background. Concrete and reinforced concrete. Advantages of reinforced concrete as a structural material. Topic 1.2 Design Codes. SI Units and shaded areas. Admixtures. Calculation accuracy. Topic 1.3 Introduction to Loads. Dead loads. Live loads. Environmental loads. Selection of Design loads. Calculation accuracy.
Section 2. Flexural and strength analysis of beams according ACI code	Topic 2.1 Ultimate or nominal flexural moments. Cracking moment. Elastic stresses—Concrete cracked. Topic 2.2 Design methods. Advantages of Strength Design. Elastic Stresses—Concrete Cracked. Structural Safety. Topic 2.3 Strength reduction or φ Factors. Minimum Percentage of Steel. Balanced steel percentage
Section 3. Analysis and Design of Beams (Single and Double Reinf; T-Beams; Continuous Beams)	Topic 3.1 Analysis of T-beams. Design of T-beams. Design Topic 3.2 Analysis of T-beams. Design of T-beams. Design of T-beams for negative moments. L-shaped beams. Load factors. Design of rectangular beams. Topic 3.3 Miscellaneous beam considerations. Determining steel area when beam dimensions are predetermined
Section 4. Serviceability limit states of the structures (Deflection of Beams)	Topic 4.1 Importance of deflections. Control of deflections. Calculation of deflections. Continuous-beam deflections. Topic 4.2 Types of cracks. Control of flexural cracks. ACI Code Provisions concerning cracks. Miscellaneouss cracks
Section 5. Shear and Torsion Design	Topic 5.1 Shear Stresses in Concrete Beams. Shear Strength of Concrete. Shear Strength of Members Subjected to Axial Forces. Topic 5.2 Torsional reinforcing. Torsional moments that have to be considered in design. Torsional moment strength. Torsional stresses. Design of torsional reinforcing. Additional ACI Requirements
Section 6. Bond, Development Lengths, and Splices	Topic 6.1 Development lengths for welded wire fabric in tension. Development lengths for compression bars. Critical sections for development length. Topic 6.2 Effect of combined shear and moment on development lengths. Effect of shape of moment Diagram on development lengths
Section 7. Columns. Design of short columns subject to axial load and bending. Slender columns	Topic 7.1 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. Topic 7.2 Slenderness effects. Slender columns in nonsway and sway frames. ACI Code treatments of slenderness Effects. Magnification of column moments in nonsway and sway frames
Section 8. Footings	Topic 8.1 Design of wall footings. Plain concrete footings. Rectangular isolated footings. Combined footings. Actual soil

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Course contents	
Course Module Title	**Brief Description of the Module Content**
	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

Course Title	Structural Dynamics
Course Workload	5 credits / 180 academic hours
Course contents	
Course Module Title	**Brief Description of the Module Content**
Section 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
Section 2. Hit	Dynamic coefficient
Section 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
Section 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.
Section 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.

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Course contents	
Course Module Title	**Brief Description of the Module Content**
Section 1. Basic concepts of the design of reinforced concrete structures	Topic 1.1 Historical background. Concrete and reinforced concrete. Advantages of reinforced concrete as a structural material. Design Codes. SI Units and shaded areas. Admixtures. Calculation accuracy
Section 2. Flexural and strength analysis of beams according ACI code	Topic 2.1 Ultimate or nominal flexural moments. Cracking moment. Elastic stresses -Concrete cracked. Topic 2.2 Design methods. Advantages of Strength Design. Elastic Stresses—Concrete Cracked. Structural Safety. Topic 2.3 Strength reduction or φ Factors. Minimum Percentage of Steel. Balanced steel percentage
Section 3. Analysis and Design of Beams (Single and Double Reinf; T-Beams; Continuous Beams)	Topic 3.1 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
Section 4. Serviceability limit states of the structures (De-flection of Beams)	Topic 4.1 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
Section 5. Shear and Torsion Design	Topic 5.1 Shear Stresses in Concrete Beams. Shear Strength of Concrete. Shear Strength of Members Subjected to Axial Forces. Torsional reinforcing. Torsional moments that have to be considered in design. Torsional moment strength. Torsional stress-es. Design of torsional reinforcing. Additional ACI Requirements
Section 6. Bond, Development Lengths, and Splices	Topic 6.1 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
Section 7. Columns. Design of short columns subject to axial load and bending. Slender columns	Topic 7.1 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. Topic 7.2 Slenderness effects. Slender columns in nonsway and sway frames. ACI Code treatments of slenderness Effects. Magnification of column moments in nonsway and sway frames.
Section 8. Footings	Topic 8.1 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.

Course Title	Building materials: Special Topics
Course Workload	5 credits / 180 academic hours
Course contents	
Course Module Title	**Brief Description of the Module Content**
Section 1. Main 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 thermal insulation materials
Section 3. Thermal insulation materials Part 2	1. Inorganic heat-insulating materials and products. 2. Organic thermal insulation materials and products.
Section 4. Thermal insulation materials 3part	1. Organic thermal insulation materials and products. 2. Heat-insulating plastics
Section 5. Roofing materials	1. General Provisions 2. Roll and mastic roofs 3. Roofs from sheet and piece materials
Section 6. Painting materials 1 part	1. Nomenclature and characteristics 2. Binders for paints 3. Pigments
Section 7. Paints and varnishes	1. Pigments 2. Fillers 3. Thinners and solvents 4. Varieties of painting compositions
Section 8. Acoustic materials	1. General information 2. Sound-absorbing materials Soundproof1. General information 2. Sound-absorbing materials Soundproof

Course Title	Structural Design in Steel: Special Topics
Course Workload	5 credits / 180 academic hours
Course contents	
Course Module Title	**Brief Description of the Module Content**
Section 1. Introduction to steel structures	Introduction: Building codes, Seismic forces, Analysis, and design of complex structures. Loads, philosophy of design, steel and properties
Section 2. 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 Be-tween, Joints
Section 3. Plate girders	Introduction, General Considerations, AISC Requirements for Proportions of Plate, Girders ; Flexural Strength, Shear Strength Bearing Stiffeners, Design
Section 4. 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

Course Title	Modelling of Construction Processes
Course Workload	5 credits / 180 academic hours
Course contents	
Course Module Title	**Brief Description of the Module Content**
Section 1. BIM Technology	The concept of BIM. Project delivery methods and BIM implementation. Levels of Development (LOD). Applications in construction management
Section 2. Cloud-BIM for design/construction coordination & clash detection	BIM for buildability scenario forecasting. Interference management. Clash detection
Section 3. Construction Planning and 4D Simulation	Construction planning. Elements to model location for scheduling tasks. 4D simulations
Section 4. Quantity Takeoff and Cost Estimating	Types of estimates. Conceptual estimate. Detailed estimate. Model-based calculation

Course Title	Applications of Finite Element Method for Civil Engineering problems
Course Workload	3 credits / 108 academic hours
Course contents	
Course Module Title	**Brief Description of the Module Content**
Section 1. Plane Stress and Plane Strain Theory	Topic 1.1 Plane stress and plan strain approximations. Coordinate systems. Displacement of material points. State of strain. State of stress. Stress equilibrium at a point. Topic 1.2 Constitutive equations. Boundary conditions. Differential form of the governing equations. Weighted residual method. Integral form of the governing equations.
Section 2. Introduction to the finite element method	Topic 2.1 Finite element concept. Description of finite element shape. Quadrilateral elements. Triangular elements. Interpolation of variables in finite elements. Topic 2.1 Differentiation of functions in finite elements: Differentiation of shape functions. Differentiation of behavioral variables Topic 2.1 Integration of functions in finite elements: Integration over quadrilateral elements; Integration over triangular elements. Topic 2.1 Numerical integration. One-dimensional Gauss integration: Gauss integration in quadrilaterals; Gauss integration in triangles
Section 3. Potential energy and approximate analysis	This section will enable the student to: a) Develop the expressions for strain energy, work done and potential energy for beam and bar problems b) Understand and apply the concept of minimum potential energy. c) Understand the Rayleigh-Ritz method as an introduction to the finite element method
Section 4. Finite element formulation and application of bar elements	This section will enable the student to: a) Recognize the displacement field and shape functions used in the formulation of a bar finite element. b) Derive the stiffness matrix as well as load vector due to various load conditions acting on a bar element. c) Perform a finite element analysis for a complete bar problem in order to evaluate displacements and stresses along the length of the bar. d) Judge on the accuracy of a specific bar element mesh used to solve a certain bar problem
Section 5. Introduction to theory of elasticity	This section will enable the student to understand the basic equilibrium and kinematic equations, the constitutive relations as well as the potential energy expression for 2-D plane stress and plane strain elasticity problems
Section 6. Shape functions for 2-D problems	This section will enable the student to: a) Recognize various types of elements used to solve 2-D plane problems. b) Recognize the natural coordinate systems, the shape functions used in various 2-D plane elements. c) Evaluate the Jacobian expression for various 2-D plane elements
Section 7.	This section will enable the student to: a) Derive the stiffness matrix as well as the load vector due to various load conditions acting on a CST

Course Title	Applications of Finite Element Method for Civil Engineering problems
Course Workload	3 credits / 108 academic hours
Course contents	
Course Module Title	**Brief Description of the Module Content**
Finite element formulation and application by constant stress triangular (CST) element	element. b) Know how to handle the effect of inclined boundaries. c) Perform finite element analysis of 2-D problems using CST elements.
Section 8. Practical consideration in modelling	This section will enable the student to: a) Recognize some basic considerations when laying out a finite element mesh including element size and grading. b) Know how to number a finite element mesh in order to optimize the computer storage and the running time

Course Title	Sustainability in Civil Engineering
Course Workload	3 credits / 108 academic hours
Course contents	
Course Module Title	**Brief Description of the Module Content**
Section 1. Conceptual development of a typology of sustainable buildings	Topic 1.1. Introduction to the basic terminology of sustainable buildings. Principles of formation of sustainable architecture. Energy efficient (passive, active) and smart buildings. Topic 1.2. Methods and technologies for saving different types of energy and resources. Topic 1.3. 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. Topic 1.4. Main trends in the development of modern urban planning. Above-ground and underground types of "green buildings". adaptive architecture. Topic 1.5. Eco-certification of "green" construction objects in Russia and abroad. LEAD, BREAM, DGNB, Green Zoom, Well, Fit Well –international and local certification systems. The main principals and criteria of certification
Section 2. Architectural and space-planning solution for energy-efficient buildings	Topic 2.1. Typology of energy efficient buildings. Overview of the first projects of energy efficient buildings. Definition of the basic principle of energy efficient buildings. Topic 2.2.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. Topic 2.3.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. Topic 2.4.Types of space-planning solutions for energy-efficient buildings. Determination of rational features of space-planning solutions for energy-efficient houses. Experience in the design and construction of energy efficient and passive buildings in Europe and in Russia. Examples of implemented sustainable buildings: townhouses, cottages, apartment buildings, schools, office and administrative buildings, reconstruction of old buildings. Features of designing energy efficient and passive buildings in Asian countries. Examples of the implementation of energy efficient buildings in Asian countries. Design and construction of energy efficient and passive buildings in the USA and Canada.

Course Title	Optimization Methods in Civil Engineering
Course Workload	2 credits / 72 academic hours
Course contents	
Course Module Title	**Brief Description of the Module Content**
Section 1. Introduction to optimization	Topic 1.1 Methods of Operations Research. Historical development
Section 2. Statement of optimization problem	Topic 2.1 Constrained and unconstrained optimization problems. Design Vector. Design Constraints constraint surface. Objective Function. Objective Function Surfaces
Section 3. Classification of optimization problems	Topic 3.1 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
Section 4. Classical optimization techniques	Topic 4.1 Single-variable optimization. Theorem of necessary and sufficient condition
Section 5. Multivariable optimization with no constraints	Topic 5.1 The necessary and sufficient conditions for the minimum or maximum of an unconstrained function of several variables

Course Title	Structural Stability
Course Workload	2 credits / 72 academic hours
Course contents	
Course Module Title	**Brief Description of the Module Content**
Section 1. 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; Behavior of geometrically imperfect columns; Behavior 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
Section 2. Second order plane frame analysis	Topic 2.1 Members of a frame: Governing equations for a member and their solution. Topic 2.2 Member stiffness matrix: Exact stiffness coefficients; Limit expressions for the stiffness co efficient Topic 2.3 Member load vector: Exact load coefficients; Limit expressions for the load coefficients Topic 2.4 Algorithms for second order plane frame analysis. Limitations of second order analysis
Section 3. 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 3.4 Columns in frames: Translation and rotation restraints at nodes; Single column with girder restraint and side-sway. Columns in portal frames Topic 3.4 Columns in multi-storey buildings. General method for the analysis of column stability in frames.

Course Title	Geometric Shaping and Analysis of Shells
Course Workload	2 credits / 72 academic hours
Course contents	
Course Module Title	**Brief Description of the Module Content**
Section 1. Classification and forms of spatial structures	Topic 1.1 Planar designs. Classification and forms of spatial structures. Signs of static shaping. Kinematic surfaces
Section 2. On the design and con-struction of spatial structures	Topic 2.1 Structures working "on the span", rigid shells, regular systems, suspended roofs, transforming systems, air-supporting and air-suspended structures. Topic 2.2 Tent structures. Structural concept. Production, transportation and construction of spatial systems
Section 3. Shells of revolution	Topic 3.1 Spherical shell. Shells in the form of a single-cavity hyperboloid of revolution. Paraboloid and ellipsoid of revolution. Circular torus. Topic 3.2 Pseudosphere. Catenoid. Globoid. A drop. The mating surfaces of coaxial cylinder and cone.
Section 4. Ruled shells of zero Gaussian curvature	Topic 4.1 Conical, cylindrical and torso shells. Build torso developments. Replacement of cylinders, cones and torse surfaces folds. Sur-faces of the equal slope
Section 5. Ruled shells of negative Gaussian curvature	Topic 5.1 Hyperbolic paraboloid. Conoids. Cylindroids. 5 types of ruled helicoids. Ruled rotary and spiroid surfaces. Catalan Surfaces
Section 6. Cyclic surfaces	Topic 6.1 Channel surfaces. Normal cyclic surfaces. Cyclic surfaces with a parallelism plane. Cyclic surfaces with circles in the planes of the bunch
Section 7. Kinematic surfaces	Topic 7.1 Direct transfer surfaces. Rotative and spiroid surfaces
Section 8. Umbrella surfaces and umbrella type surfaces	Topic 8.1 Wavy type and wavy surfaces. Corrugated surfaces. Corrugated products. Umbrella domes on the cone. Reinforced concrete, metal, tent umbrella shells
Section 9. Minimal surfaces	Topic 9.1 Minimal surfaces strung on a rigid support contour. Dome structures made of plastic
Section 10. Helicoidal and helical shape shells. Shells in the form of spiral and spiral shape surfaces	Topic 10.1 Ordinary screw surfaces. Screw surface variable pitch. Cyclic surface in the cylinder. Helical surfaces with generatrix in the planes of the bunch
Section 11. Membrane and cable coatings	Topic 11.1 Examples of built structures with membrane and suspended roofs
Section 12. Shells in the form of analytically indefinable surfaces	Topic 12.1 Overview of the constructed structures. Constructive forms of wildlife and their influence on the development of fundamentally new spatial structures
Section 13. Spatial composite structures	Topic 12.1 Smooth mating of two surfaces. Transformable structures
Section 14. Geometrical shaping of shells	Topic 13.1 Manufacturing models that demonstrate the methods of generating the middle surfaces of the shells

Course Title	Engineering Systems of Buildings
Course Workload	2 credits / 72 academic hours
Course contents	
Course Module Title	**Brief Description of the Module Content**
Section 1. Introduction	Topic 1.1 General characteristics of building engineering systems. Electricity, heating, water supply, drainage, ventilation and air conditioning of buildings as a part of the building and life support of people
Section 2. Building power supply	Topic 2.1 Equipment for power supply. Calculation of power supply of the building. Tracing of electrical wires in the building
Section 3. Building heat supply	Topic 3.1 Design of buildings' heating systems. Heat pipelines and their placement. Routing and installation of heat networks in the building. Specific thermal characteristics of the building for heating, taking into account the construction volume of the heated part of the building, The average calculated internal temperature of the heated rooms and the correction factor for the change of the specific thermal characteristics depending on the local climatic conditions. Selection of the optimum heating system in the building and parameters of heat carriers. Topic 3.2 Calculation of the heating system of the building. Installation of devices of heating systems. Calculation of pipelines of the heating system for the longest and most loaded circulating ring of the system, through which at the present pressure difference in the system, the specified costs of the heat carrier are passed. Calculation of single and two-pipe heating system. Hydraulic mode and thermal stability of water heating systems. Dimensions of openings for heating pipelines in the building. Materials and equipment for installation of devices of heating systems. Installation work on the installation of heating systems
Section 4. Building water supply	Topic 4.1 Classification of water supply systems. Materials and equipment of the water supply system. Schematics of water supply networks of the building. Tracing of water supply networks in the building. Operation of water supply systems and their separate structures. Method of calculation of water supply of the building. Mathematical model of calculation of water pipes of the building. Hydraulic calculation of water networks in the building.
Section 5. Water disposal of the building	Topic 5.1 Water disposal systems and their characteristics. The device and principle of operation of systems of water disposal of the building. The basics of design of systems of water disposal of the building. Calculation of the capacity of water drainage networks of the building
Раздел 6. Building ventilation	Topic 6.1 Design of ventilation systems of the building. Air receiving and venting devices for exhaust and supply ventilation. Intake and exhaust chambers. Determination of the required air exchange in the building. General provisions for the design of the ventilation system. Exhaust and intake ventilation. Dimensions of holes for laying ventilation channels in the building. Materials and equipment for installation of ventilation system devices. Installation work on installation of ventilation systems. Topic 6.2 Calculation of the building ventilation system. Determination of the required area of cross sections of the main branch sections. Determination of pressure loss in the ventilation

Course Title	Engineering Systems of Buildings
Course Workload	2 credits / 72 academic hours
Course contents	
Course Module Title	**Brief Description of the Module Content**
	network. Determination of the design gravity pressure. Determination of the coefficient of resistance on friction
Section 7. Air conditioning	Topic 7.1 Air conditioning of buildings. Air-conditioning devices. Routing and installation of air-conditioning networks. Dimensions of openings for laying air-conditioning channels in the building. Materials and equipment for the installation of air-conditioning devices. Installation work on the installation of air-conditioning systems