**TRAINING COMPLEX OF DISCIPLINE**

**Mechanics of structural elements**

Occupation 050603 - Mechanics

(Code name)

Study mode \_\_ full-time education\_\_

**Module №1. Introduction and basic concepts**

Lecture #1

Mechanical construction elements as a base engineering methods and calculation methods of structural elements for strength, rigidity and stability in terms of durability and economy. Objectives and course content. Goals and objectives of the mechanics of structural elements are: to provide simple and practical methods and techniques for the calculation of structural elements on the strength, stiffness and resistance to a wide range of engineering applications. The place and role of the course in the mechanical cycle of disciplines, the relationship with the theory of elasticity and plasticity. Brief historical information. The basic *concepts.* Movements and deformations.

Lecture #2

The main hypotheses and design scheme. Internal forces in the section of the rod and the method of sections. Voltage. The principle of the initial size .External and internal forces. Elasticity and plasticity. Friability and hardness. Types of solids. Statically indeterminate system. Material testing. Determination efforts tensile-compression rods in the form of direct reactions of connections.

**Module № 2. axial tension-compression rods. Torsion and shear.**

Lecture #3.

Determination of longitudinal forces, stresses and strains in the transverse cross-sections straight bars. The principle of superposition and Hooke's law.Stress and strain state in tension-compression straight bars. Formation mechanism of deformation. Effect of temperature and time factor on the mechanical characteristics of the material.

Lecture #4

Law of Pairs of shear stresses. Mechanical characteristics of the materials. Safety factor. General principles for design of structural elements and the strength condition. Determination of longitudinal forces, stresses and strains in the transverse cross-sections straight bars. (Statically indeterminate system.) Potential energy of the longitudinal strain.

Lecture #5

Pure shear. Hooke's law. The shear modulus. Shear strain. Relative angular displacement. The specific potential energy in shear. Torsion of circular rods. Building diagrams torques. Geometric characteristics of the cross-sections. Static moments of the cross-sections. Axial cross-sectional moments. The mechanism of deformation of the rod with a circular cross-section. The hypothesis of plane sections.

Lecture #6

Determination of stresses and displacements in torsion of round bars. Bernoulli's principle - the hypothesis of plane sections. Polar moment of inertia of the cross section of the rod in torsion. Torsional stiffness of the shaft. The formula for determining the angle of rotation of the cross section of the rod in torsion. The formula for determining the shear stresses occurring in the particles cross-section of the rod in torsion. The formula for determining the maximum shear stresses generated in the particles of the cross section of the rod in torsion. Polar moment of resistance of the cross section of the rod in torsion. The strain energy of the rod in torsion.

**Module number 3. Bending beams.**

Lecture #7

The concept of bending strain. Flat bend. Definitions. Clean and lateral bending. Internal force factors in bending. Construction of the diagrams of bending moments and shear forces generated in the cross sections of the beam in bending. Construction of the bending moment and shear forces. Rule for determining the magnitude of the shear forces. Typically the choice of sign of the transverse forces. Rule for determining the magnitude of the bending moments. Typically the choice of sign of bending moments. Differential relationship between the bending moments, shear force and the intensity of the external load.

Lecture #8

Determination of normal stress in pure bending. The proof of the immutability of the cross section of a beam in pure bending. Formation mechanism of deformation of the beam in pure bending. Determining the position of the neutral layer and the neutral line. The mobile system axes. The concept of direct and oblique views of the bend. The dependence of the beam curvature of the bending moment. Flexural stiffness of the beam. The formula for the normal stresses that occur in the particles of the cross-section of the beam in pure bending. The formula for determining the maximum normal stresses occurring in the particles of the cross section of the beam in pure bending. Section modulus of the cross section of the beam in bending. The strain energy of the beam in pure bending.

Lecture #9

Determination of normal and tangential stresses in transverse bending. Approximation formula for the normal stresses arising in the particles of the cross section of the beam in transverse bending. The hypothesis of plane sections. Using the law of pairing shear stresses to determine the shear stresses arising from the cross-section of the beam particles with transverse bending. Zhuravskoye formula for determining the shear stresses arising from the cross-section of the beam particles with transverse bending. The formula for determining the maximum shear stresses generated in the particles of the cross section of the beam in transverse bending.

Module number 4. Movements in core systems with arbitrary loading.

Lecture #10

The potential energy of the rod at an arbitrary loading. The potential energy of the rod element as the sum of independent work of each of the six internal force factors. Definition of dimensionless coefficients characterizing the geometric shape of the cross section of the rod. Particular cases of the application of the formula to determine the potential energy of the rod at an arbitrary loading. Application of the principle of virtual displacements to the deformable systems. General theorems of solid mechanics. Castigliano theorem. The theorem of reciprocity of work and the reciprocity theorem movements. Examples.

Lecture #11

Determination of displacements in the core systems with arbitrary loading. Disadvantages determine the displacements in the core systems with arbitrary loading using Castigliano's theorem. Way to overcome these shortcomings. Integral movement Maxwell-Mohr. The method of application of the fictitious force. Determination of internal force factors of unit strength. Method Vereshchagin. Conditions of applicability of the method Two Vereshchagin. Paths approximate application of the method Vereshchagin. Determining the displacements and strains using the reciprocity theorem works and movements. Examples.

Module number 5. Disclosure of statically indeterminate beam systems by force.

Lecture #12

Communication imposed on the rod system. The concept of core systems in Vila farm and frame. Planar and spatial systems. Degree of redundancy. Necessary and additional number of connections. Internal and external communication rod systems. Defining Relationships in closed circuits. Reciprocal links. The principle of the application of unknown internal force factors. The idea of the force method. The choice of the basic system of the force method. Constructing diagrams internal force factors in the frames.

Lecture #13

The equations for determining the unknown internal force factors. Canonical equations of the force method. Using the principle of the independence forces and Hooke's law. The formula for determining the coefficients of the canonical equations of the force method. Application method Vereshchagin. Examples. The concept of the method of moving.

**Module number 6. Stability of compressed *rods.***

Lecture #14

The concept of sustainability. Formulation of the problems of the stability of elastic systems. Euler problem. The differential equation of the elastic line of the compressed core. A formula to determine the critical force. The concept of the Euler force. Higher forms of equilibrium. Types of boundary conditions when considering the stability of the compressed core. The method of specular reflection. The dependence of the critical force of the rod fixing conditions. Factor driving the length of the rod. Derivation of the formula coefficient of reduction of stem length for a special occasion.

Lectures #15

Energy method for determining critical loads. Search the conditions under which the equilibrium system saves energy minimum (the system remains stable). Approximate determination of critical loads. Energy balance. On the limits of applicability of Euler's formula. Figure test material. Variable modulus. Reducing the current modulus. The formula for the critical voltage through the flexibility of the rod. Ratio method to reduce allowable stress. Final conclusions.