# KLAIPEDA STATE UNIVERSITY OF APPLIED SCIENCES

## Faculty of Technologies

**STUDY PROGRAMME:** **CONSTRUCTION**
**STUDY SUBJECT:** **BASIS OF CALCULATION OF CONSTRUCTIONS**
**SUBJECT CODE:** **TF-S-2-023**

| Subject group* | Subject type** | Form of studies | Structure*** | | | | Hours, total | Credits |
|---|---|---|---|---|---|---|---|---|
| | | | T | P | K | S | | |
| SK | P | Full-time (NL) | 40 | 68 | 9 | 123 | 240 | 9 |
| | | Part-time (I) | 16 | 32 | 69 | 123 | | |

*Subject group: BS—general study subjects; SK—subjects of the study field.
**Subject type: P—compulsory subject; A—optional subject (alternative), LP—elective.
***Structure T—theory; P—seminars, placements, laboratory works; K—consulting; S—self-studying.

**PREREQUISITES:** Mathematics; Physics; Applied Mechanics; Building materials; Special and computer graphics; Building structures.

**Annotation**

The subject introduces the key requirements for buildings, the principles and methods of calculating loads that affect buildings and their structures. Knowledge is built about the design features of steel, wood, masonry and reinforced concrete structures, the principles of calculating elements under centric and eccentric tension, compression and flexion. The methods of connecting steel, wooden and reinforced concrete structures and their design features are analysed. Types of steel beams, grates, columns, metal frames, their design schemes, calculation peculiarities and the construction of such structures are introduced. The design and construction features of wooden bearing elements (purlins, decking, bearers, beams, trusses and arches), reliability measures of wooden structures and their fire protection are studied. The causes of cracking of reinforced concrete elements and the methods of calculation of crack width and deformations are analysed. The design schemes and peculiarities of reinforced concrete structures of buildings (such as beams, sheathing, panels, columns, frames, foundations) are introduced. The basics of automated design of building structures are introduced.

**Links between the learning outcomes of the programme and the outcomes of the study subject as well as the study methods and the student performance assessment methods**

| Learning outcomes of the programme | Learning outcomes of the study subject | Study methods | Student performance assessment methods |
|---|---|---|---|
| A.3. Knows the properties and uses of building materials and products, and applies them in building design and construction. | A.3.1. Know the properties of building materials and products, necessary for ensuring the strength and stiffness of the building and its elements. | Interpreting of theoretical material, studying of technical and scientific literature. | Test (1, 2), examination. |
| | A.3.2. Knows and applies the principles of determining the carrying capacity of building structures. | Interpreting of theoretical material, studying of technical and scientific literature. | Test (1, 2), preparation of a course project, preparation of a practical work (2, 4, 6, 8, 9, 10, 11, 12), examination. |
| D.1. Able to prepare the structural part of a project, to choose optimal construction methods, taking into account the construction environment, aesthetic and architectural aspects, economic factors and expected operating conditions. | D.1.1. Able to draw up design schemes of a building and its structures. | Theoretical modelling, problem solving, design, verifiable calculations. | Test (1, 2), preparation of a course project, preparation of a practical work (2, 4, 6, 8, 9, 10, 11, 12). |
| | D.1.2. Able to analyse design data, calculate loads and impacts that affect structures. | Theoretical modelling, problem solving, design, verifiable calculations. | Test (1, 2), preparation of a course project, preparation and defending of a practical work (1, 4, 5, 8, 9, 10, 11, 12), examination. |
| | D.1.3. Able to prepare the part of the project for calculating non-special purpose building structures. | Theoretical modelling, problem solving, design, verifiable calculations, reading and drawing of technical drawings. | Preparation of a course project, preparation of a practical work (2, 4, 6, 8, 9, 10, 11, 12). |
| D.2. Applies international, European and Lithuanian normative construction technical documents and standards in the design and construction process. | D.2.1. Applies international, European and Lithuanian normative construction technical documents in the design of non-special purpose | Theoretical modelling, problem solving, design, studying of technical literature. | Preparation of a course project, preparation of a practical work (1–12), examination. |

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| | buildings. | | |
| D.4. Uses information technology, basic software, applies computer programs to design buildings and prepare estimate documents. | D.4.1. Designs simple structures and draws up structural drawings using the latest information technology. | Theoretical modelling, problem solving, design, verifiable calculations, reading and drawing of technical drawings. | Preparation of a course project, preparation of a practical work (3, 4, 7, 8, 11, 12). |
| E.2. Able to convey information, design ideas and their solutions to specialists and non-specialists. | E.2.1. Able to discuss issues relating to structure calculations and to substantiate his/her claims. | Studying and discussing of technical and scientific literature. | Presentation of a course project, presentation of a practical work (1–12). |
| E.4. Able to independently deepen his/her knowledge, analyse, process information, demonstrate it and apply it to problem solving and decision making. | E.4.1. Able to independently deepen his/her knowledge, to search for information, to process it, to analyse it in the course of preparation of the part of the project for calculating non-special purpose building structures. | Problem solving, design, verifiable calculations, reading and drawing of technical drawings. | Presentation of a course project, preparation of a practical work (1–12). |
| | E.4.2. Self-studying of additional literature. Reasoned justification of decisions made. | Problem solving, design, verifiable calculations, reading and drawing of technical drawings. | Presentation of a course project, preparation of a practical work (1–12). |

**Subject content and scope**

| Topic name and content description | Number of contact hours, full-time | | | Number of contact hours, part-time | | | S | Hours, total |
|---|---|---|---|---|---|---|---|---|
| | T | P | K | T | P | K | | |
| **1. Basics of designing building structures.** | | | | | | | | |
| **1.1. General requirements for building structures.** Requirements for bearing structures. | 1 | - | - | 1 | - | - | 3 | 4 |
| **1.2. Loads affecting buildings and their structures.** Limit states of bearing structures. Calculation of characteristic and design values of materials. **Practical work No. 1** Calculation of loads. Entry of loads to Bentley software. | 1 | 1 | - | 0.5 | 1 | 0.5 | 5 | 7 |
| **2. Metal structures.** | | | | | | | | |
| **2.1. Calculation of elements of steel structures:** Materials of metal structures. Calculation of elements under centric tension and compression. Calculation of flexural metal elements. Calculation of elements under eccentric tension and compression. **Practical work No. 2** Calculation of a steel element under centric tension, compression and flexion by using Bentley software. | 4 | 3 | - | 1 | 2 | 4 | 5 | 12 |
| **2.2. Joints of steel structural elements:** Welded joints. Types of welded joints, their calculation. Bolt joints, their calculation. **Practical work No. 3.** Calculation of a welded butt and lap joint. | 2 | 3 | - | 1 | 2 | 2 | 6 | 11 |
| **2.3. Beams and grates:** Description of a beam. Calculation of continuous beams. Calculation of intermittent beams. Mounting joints. **Practical work No. 4.** Calculation of an ancillary continuous beam. Calculation of a main intermittent beam. | 2 | 3 | - | 1 | 2 | 2 | 5 | 10 |
| **2.4. Columns:** Column types. Calculation of continuous columns. Calculation of intermittent columns. **Practical work No. 5.** Calculation of a continuous column under centric compression. | 1 | 3 | - | 0.5 | 2 | 1.5 | 6 | 10 |
| **2.5. Metal frames and frameworks:** Truss types. Calculation and modelling of trusses by using Bentley | 1 | - | - | 0.5 | - | 0.5 | 5 | 6 |

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| software. Construction of truss nodes. Metal frames. Multi-storey metal frameworks. Design schemes. | | | | | | | | |
| **Test No. 1** (topics 2.1, 2.2, 2.3, 2.4, 2.5). | - | 2 | 2 | - | - | 4 | 4 | 8 |
| **3. Wooden structures.** | | | | | | | | |
| **3.1. Calculation of wooden elements:** Design characteristics of materials, their creation in Bentley software. Elements under centric tension and compression. Flexural elements. Elements under eccentric tension and compression. Limit flexibilities. Calculation peculiarities of adhesive elements. Calculation of the limit state of fitness of wooden structure elements.<br>**Practical work No. 6** Calculation of a wooden element under centric tension, compression and flexion by using Bentley software. | 2 | 2 | - | 1 | 2 | 1 | 5 | 9 |
| **3.2.** Types of joints of wooden structure elements: General instructions. Adhesive joints. Joints by halving. Rod joints. Pin joints. Joints with removable nails and screws. Joints with inset metal rods.<br>**Practical work No. 7** Calculation of a rod joint. Calculation of a joint by halving. | 2 | 2 | - | 1 | 2 | 1 | 5 | 9 |
| **3.3. Designing of wooden structures:** Purlins, decking, bearers and beams. Trusses. Arches. Structural reliability measures.<br>**Practical work No. 8** Calculation of roof bearing structures by using Bentley software. | 2 | 2 | - | 1 | 2 | 1 | 4 | 8 |
| **Preparation for examination** | - | - | - | - | - | - | 10 | 10 |
| **4. Reinforced concrete structures.** | | | | | | | | |
| **4.1. Peculiarities of structural calculations:** Limit state of safety. Limit state of fitness. Design values of impacts. Design strength. Creation of characteristic values of reinforced concrete structures and their entering in Bentley software environment. Basics of reinforced concrete theory and design: Material properties. Construction of reinforced concrete elements. Construction of flexural elements. Panels. Beams. Interruption of longitudinal reinforcement. Construction of compressive elements. Construction of tensile elements. Protective concrete layer.<br>**Course project.** Calculation of loads. | 4 | 2 | - | 1 | 1 | 4 | 2 | 8 |
| **4.2. Calculation of flexural strength of elements:** Calculation of a rectangular flexural reinforced concrete element by using Bentley software. Calculation of a "T" shaped flexural reinforced concrete element. Calculation of a Double "T" flexural reinforced concrete element. Calculation of diagonal cross-sectional strength of elements with respect to transverse forces. Diagonal cross-sectional strength of reinforce concrete elements with respect to the bending moment. | 2 | 3 | - | 0.5 | 1 | 3.5 | 3 | 8 |
| **4.3. Calculation of cracking and deformation of reinforced concrete elements:** Causes of cracking. Calculation of the occurrence of cracks in reinforced concrete elements. Calculation of the opening of cracks in reinforced concrete elements. Calculation of the opening of diagonal cracks. Calculation of deformations of elements of reinforced concrete structures. | 1 | 2 | - | 0.5 | 1 | 1.5 | 6 | 9 |
| **4.4. Calculation of compressive and tensile elements:** general guidelines for calculating the strength of the perpendicular section of reinforced concrete elements. Calculation of elements under centric tension. Calculation of elements with rectangular and circular cross-section under eccentric compression. Calculation of bearing pressure.<br>**Practical work No. 9** Calculation of the longitudinal reinforcement of compressed rectangular elements by using Bentley software. Calculation of the longitudinal reinforcement of tensed rectangular elements by using Bentley software. | 2 | 3 | - | 0.5 | 1 | 3.5 | 3 | 8 |

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| **4.5.** Joints of bearing structures. Column joints. Joints of columns and bars. Wall joints. **Basics of designing rational reinforced concrete structures.** Calculation rational flexural reinforced concrete elements. Rational pre-tension of reinforced concrete. Geometric indices of cross-section | 1 | - | - | 0.5 | - | 0.5 | 3 | 4 |
| **4.6. Building sheathings, their calculation.** Features of calculation and reinforcement of a beam monolithic sheathing in Bentley software environment. Peculiarities of calculation and reinforcement of beam-free sheathing Prefabricated panels. Edged and hollow sheathing panels, their reinforcement diagrams. **Reinforced concrete frames and frameworks.** Single-storey frames. Structural diagrams of single-storey frame buildings. Layout of communications. Reinforcement of reinforced concrete columns. Column brackets and their reinforcement. Multi-storey frames. Frameworks of public buildings. Frameworks of industrial buildings. | 2 | - | - | 0.5 | - | 1.5 | 3 | 5 |
| **4.7.** Structures of reinforced concrete buildings, their calculation. Calculation of strip foundations. Reinforcement peculiarities. Construction of separate shallow foundations. Calculation of a double support beam by using Bentley software. Calculation of a multi-support beam Calculation of columns by using Bentley software. | 1 | - | - | 1 | - | - | 1 | 2 |
| **5. Masonry structures.** | | | | | | | | |
| **5.1. Basics of designing masonry structures:** Materials. Design characteristics of masonry. | 2 | - | - | 1 | - | 1 | 2 | 4 |
| **5.2. Calculation of elements of masonry structures according to the requirements for safety limit states:** Elements under centric compression. Elements under eccentric compression. Diagonal compression. Bearing pressure. Flexural elements. Elements under centric tension. Shearing elements. Laminated masonry. Reinforced masonry structures. **Practical work No. 10.** Calculation of non-reinforced masonry under centric compression. | 1 | 2 | - | 0.5 | 1 | 1.5 | 4 | 7 |
| **5.3. Calculation of masonry structures according to the requirements for fitness limit states:** **Practical work No. 11.** Calculation of parameters of masonry under non-centric compression. | 1 | 2 | - | 0.5 | 1 | 1.5 | 3 | 6 |
| **Test No. 2** (topics 5.1, 5.2, 5.3). | - | 2 | 2 | - | - | 4 | 4 | 8 |
| **6. Computer calculations of building structures.** **Practical work No. 12** Automated design of building structures by using Bentley software. | 5 | 14 | 2 | 1 | 4 | 16 | 8 | 29 |
| **Course project** | - | 17 | 3 | - | 7 | 13 | 10 | 30 |
| **Preparation for examination** | - | - | - | - | - | - | 8 | 8 |
| **Total number of hours** | **40** | **68** | **9** | **16** | **32** | **69** | **123** | **240** |

**Evaluation system for subject learning outcomes**

| **Subject learning outcome evaluation criteria** |
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| Understanding and application of the basic concepts of the study subject. |
| Calculation of load distribution in building structures. |
| Compilation and selection of design schemes. |
| Selection of geometrical parameters of building structures and their elements. |
| Application of national and European standards for structural design. |
| Cognitive and analytical skills and abilities demonstrated in course design. |
| Application of computer design applications. |
| Design skills and abilities demonstrated in course design. |
| Ability to justify selected solutions. |
| Self-studying of additional literature |

| **Assessment procedure** |
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| A ten-point criterion scale and cumulative assessment are applied. |

$$\mathbf{IKV} = \sum_{i=1}^{n} X_i \times k_i,$$

where:
n—number of intermediate assignments,
Xi—assessment of intermediate assignments and the examination,
Xi—weighted coefficients of intermediate assignments and the examination.

$$\mathbf{IKV} = 0.7X_1 + 0.3X_2$$

**Semester I**
$\mathbf{X_1}$—average of 1 test (0.2), 8 practical works (0.8).
$\mathbf{X_2}$—examination score.
**Semester II**
$\mathbf{X_1}$—average of 1 test (0.2), 4 practical works (0.3) and a course project (0.5).
$\mathbf{X_2}$—examination score.

**Recommended literature and other sources of information**

| Key literature and sources of information | | | |
|---|---|---|---|
| **No.** | **Literature and sources of information** | **Number of copies** | |
| | | **At the library of the Faculty of Technologies** | **At other libraries of the city** |
| 1. | JANICKAS A. (2000). *Gelžbetonio konstrukcijos*. Technologija, Kaunas. | 2 | - |
| 2. | MARČIUKAITIS G. et al. (2007). *Gelžbetoninių konstrukcijų apskaičiavimas pagal euronormas*. Technika, Vilnius. | 18 | - |
| 3. | MARČIUKAITIS G., VALIVONIS J. (2001). *Pastatų konstrukcijų projektavimo pagrindai*. Technika, Vilnius. | 14 | - |
| 4. | PARASONIS J. (2009). *Statinių konstrukcijų projektavimo pagrindai*. Technika, Vilnius. | 15 | - |

| Additional literature and sources of information | |
|---|---|
| **No.** | **Literature and sources of information** |
| 1. | RAŽAITIS V. (2004). *Pastatų konstravimo pagrindai: vadovėlis aukštųjų mokyklų studentams*. Publishing house of Vilnius Academy of Arts, Vilnius. |
| 2. | VALENTINAVIČIUS A., Valiūnas B. (2000). *Medinės konstrukcijos*. Enciklopedija, Vilnius. |
| 3. | ЕВСТИФЕЕВ В. Г. (2005). *Железобетонные конструкции (расчет и конструирование)*. АСВ, Москва. |
| 4. | STR 2.05.04:2003. Impacts and loads. http://www.am.lt/VI/index.php#a/12476\ |
| 5. | STR 2.05.05:2005. Designing of concrete and reinforced concrete structures. http://www.am.lt/VI/index.php#a/12476\ |
| 6. | STR 2.05.07:2005. Designing of wooden structures. http://www.am.lt/VI/index.php#a/12476\ |
| 7. | STR 2.05.08:2005. Designing of steel structures. Key provisions. http://www.am.lt/VI/index.php#a/12476\ |
| 8. | STR 2.05.09:2005. Designing of masonry structures. http://www.am.lt/VI/index.php#a/12476\ |
| 9. | Jerome J. Connor, Susan Faraji (2013). *Fundamentals of Structural Engineering* 2nd edition. |

**Subject description drawn up by:**

| Lecturer | | Vilma Vaičekauskienė |
|---|---|---|
| (*position*) | *(signature)* | *(degree, name, surname)* |