# CZĘSTOCHOWA UNIVERSITY OF TECHNOLOGY
# FACULTY OF CIVIL ENGINEERING
# CARD OF COURSE DESCRIPTION

| Name of course | | | | | | Course code | Semester |
|---|---|---|---|---|---|---|---|
| **Structural Mechanics II** | | | | | | **WB_BUD_D_I_MB2_05** | **full year** |
| **Type of class** | | | | | | **Level of studies** | **ECTS** |
| **Lecture** | **Classes** | **Laboratory** | **Project** | **Seminar** | **Exam** | BSc programme | |
| **1** | **1** | **-** | **2** | **-** | **E** | full-time studies | **6** |
| **Speciality** | | | | | | **Type of subject** | |
| without division | | | | | | **obligatory** | |
| **Unit:** | | | | ***Department of Building Construction and Engineering*** | | | |
| | | | | ***Room 94*** | | ***Phone / fax: +48 (34) 325 09 04*** | |
| **Teacher** | | | | **Maksym GRZYWIŃSKI, Ph.D.** | | mgrzywin@bud.pcz.czest.pl | |

## I. CARD OF COURSE

| **SUBJECT OBJECTIVES** | |
|---|---|
| **O1** | Acquisition of knowledge on effective solving systems of statically determinate |
| **O2** | The skills of solving systems of statically indeterminate Forces Method |
| **O3** | The skills of solving systems of statically indeterminate Displacement Method |
| **O4** | Ability to build influence lines for statically indeterminate systems |

| **PREREQUISITE & ADDITIONAL REQUIREMENTS** | |
|---|---|
| **R1** | Knowledge of Mechanics and Strength of Materials |
| **R2** | Knowledge of Mathematics in the field of mathematical analysis |
| **R3** | Knowledge of basic concepts in the design of the bar |
| **R4** | Completed course Structural Mechanics I |

| **LEARNING OUTCOMES** | |
|---|---|
| **S1** | Has knowledge of Structural Mechanics II and the ability to use the conceptual apparatus of mechanics in the formulation of practical engineering construction |
| **General skills** | |
| **S2** | He can use literature sources and other materials relating to the engineering problem to be solved. He can make a classification of buildings, construction of supporting structures. |
| **Basic engineering skills** | |
| **S3** | Able to solve statically indeterminate systems by Force Method |
| **S4** | Able to solve statically indeterminate systems by Displacement Method |
| **S5** | Able to draw lines of influence for statically indeterminate systems |
| **Personal and social competences** | |
| **S6** | Able to work independently and in a team. |

| **CONTENTS OF STUDY** | | |
|---|---|---|
| **Type of classes – Lecture** | | **Number of hours** |
| **L01** | The theory of statically indeterminate systems. Degree of indeterminate static systems. Introduction to the Force Method | 2 |
| **L02** | | |
| **L03** | The Force Method for continuous beams. | 1 |
| **L04** | Equation three, four and five moments for continuous beams. | 1 |
| **L05** | The Force Method for trusses. Displacements for statically indeterminate systems. Static load: mechanical and non-mechanical. | 2 |
| **L06** | | |

| | | |
|---|---|---|
| **L07** | The Force Method for plane frame. | 2 |
| **L08** | | |
| **L09** | Displacement Method. Degree of indeterminate kinematic systems (rotations and displacement). | 1 |
| **L10** | The equations of transformation and the canonical equations Displacement Method. | 1 |
| **L11** | Displacement Method - continuous beams, frames. | 2 |
| **L12** | | |
| **L13** | The use of symmetry and antisymmetry structure in solving systems of extra forces. | 1 |
| **L14** | Lines of influence - continuous beams and trusses of extra forces. | 1 |
| **L15** | Repertory before written exam | 1 |
| | **Total:** | **15** |

| **Type of classes – Classes** | | **Number of hours** |
|---|---|---|
| **C01** | Determination of the degree of static indeterminate systems, to discuss ways of solving systems of statically indeterminate. | 1 |
| **C02** | Solving beams and frames statically indeterminate using the Force Method of canonical equations, calculation of load displacement unit and the external loads to the core systems. The use of symmetry in the structure calculations. | 3 |
| **C03** | | |
| **C04** | | |
| **C05** | Solve statically indeterminate 2D trusses using the Force Method. Calculation of displacement structures statically indeterminate induced mechanical force and non-mechanical (non-uniform temperature rise at the extreme fiber bars, inaccurate assembly, inelastic subsidence supports). | 3 |
| **C06** | | |
| **C07** | | |
| **C08** | Solving multi-span beams on supports fixed and resilient by force - the equation of three, four and five moments. | 2 |
| **C09** | | |
| **C10** | Displacement Method. Determination of the degree of kinematic indeterminate systems. Solving continuous beams and 2D frames of statically indeterminate external loads and non-mechanical factors. | 3 |
| **C11** | | |
| **C12** | | |
| **C13** | Drawing influence lines for statically indeterminate beams using the equation of three moments. | 1 |
| **C14** | Repertory before finish test | 1 |
| **C15** | **Finish test** | 1 |
| | **Total:** | **15** |

| **Type of classes – Project** | | **Number of hours** |
|---|---|---|
| **P01** | Application guidelines for the exercise of the **project #1** statically indeterminate **truss**. Discussion of the Force Method for trusses. Adoption of the basic system, saving the canonical system of equations. | 2 |
| **P02** | Determination of forces in truss bars. Calculation of displacements for the basic system | 2 |
| **P03** | The solution of the canonical equations. The calculation of the forces in the bars of the real. Execution control calculations by checking the compatibility of deformations. | 2 |
| **P04** | Defense of the exercise project #1. Application guidelines for the exercise **project #2** - statically indeterminate **continuous beam** | 2 |
| **P05** | Discussion of the three methods of moments. Adoption of the basic system. Writing equations and calculating overtime bending moments. Plotting the internal forces of the beam statically indeterminate. | 4 |
| **P06** | | |
| **P07** | Solution statically indeterminate beams of exercise project #2 using the Method of Displacements. Determination of the degree of kinematic indeterminate, the adoption of the basic system, the calculation of the | 4 |

| | | |
|---|---|---|
| **P08** | actual displacement of the system. Calculation of the actual bending moments in principle of superposition. Comparison of the results with the method of the three moments. | |
| **P09** | Defense of the exercise project #2. Application guidelines for the exercise **project #3** - statically indeterminate **frame**. Displacement Method for sliding frames. Determination of the degree of kinematic indeterminate frame, the adoption of the basic system | 4 |
| **P10** | | |
| **P11** | Determination of the actual movements of the canonical system of equations Displacement Method. The calculation of bending moments in principle of superposition. Comparison of the results with the Method of Forces. | 4 |
| **P12** | | |
| **P13** | Calculation of displacements for the basic frame. The solution of the canonical equations. | 2 |
| **P14** | Plotting the internal forces statically indeterminate frame using the principle of superposition. Design validation calculations | 2 |
| **P15** | Defense of the exercise project #3. | 2 |
| | **Total:** | **30** |

| **TEACHING TOOLS** | |
|---|---|
| **1.** | Lectures with audiovisual aids. |
| **2.** | Exercises using audiovisual means and the blackboard and chalk. |
| **3.** | Author's teaching aids |
| **4.** | Literature. |

| **METHODS OF ASSESSMENT ( F – FORMATIVE, P – SUMMARY)** | |
|---|---|
| **F1** | Assessment to prepare for classes. Checking presence. |
| **F2** | Staging elements of the projects carried out independently by the student in accordance with the approved schedule |
| **F3** | Evaluation of activity during the course |
| **P1** | Rating colloquia of credits |
| **P2** | Evaluation of the implementation of projects |
| **P3** | Evaluation of practical knowledge in the field of design |
| **P4** | Rating final exam in writing. |

**STUDENT'S WORKLOAD**

| **L.p.** | **Activity** | **Averaged workload** | |
|---|---|---|---|
| | | **hours** | **[ECTS]** |
| 1. | **Classes – lecture.** | **15** | 2 |
| 2. | Contact hours of teacher - related lectures. | 5 | |
| 3. | Read the indicated literature. | 5 | |
| 4. | Preparing for the exam. | 5 | |
| 5. | **Classes – practice.** | **15** | 2 |
| 6. | Contact hours of teacher - related practice. | 5 | |
| 7. | Preparing for finish test. | 5 | |
| 8. | **Classes – project.** | **30** | 2 |
| 9. | Contact hours of teacher - related project. | 5 | |
| 10. | Execution of projects. | 10 | |
| | **Total:** | **100** | **6** |

| **BASIC AND SUPLEMENTARY LITERATURE** | |
|---|---|
| **1.** | Carpinteri A.: *Structural Mechanics. A Unified Approach*, Taylor & Francis 1997 |
| **2.** | Darkov A., Kuznetsov V.: *Structural Mechanics*, Mir Publisher Moscov 1969 |
| **3.** | Durka F., Morgan W., Wiliams D.T.: *Structural Mechanics*, Pearson Education Limited 2003 |
| **4.** | Hulse R., Cain J.A.: *Structural Mechanics*, Palgrave Macmillan, 2000 |
| **5.** | Smith P.S.: *Introduction to Structural Mechanics*, Palgrave Macmillan, 2001 |

| MATRIX OF LEARNING OUTCOME CARRYING OUT | | | | | |
|---|---|---|---|---|---|
| **Learning outcome for the course** | **Reference to the effect defined for the field of study** | **Objectives of the course** | **Contents of study** | **Teaching tools** | **Methods of assessment** |
| **S1** | K_W05, K_W06 | O1÷O4 | L02÷L07, L12, C02÷C06, C08, C09, P01÷P09 | 1, 2, 3, 4 | F1÷F3, P1÷P4 |
| **S2** | K_U01, K_U02 K_U22 | O1÷O4 | C01÷C06, C08÷C13, P01÷P15 | 1, 2, 3, 4 | F1÷F3, P1÷P4 |
| **S3** | K_U09 | O1, O2 | C02÷C06, C08, C09, P01÷P09 | 1, 2, 3, 4 | F1÷F3, P1÷P4 |
| **S4** | K_U09 | O1, O3 | C10÷C12, P10÷P14 | 1, 2, 3, 4 | F1÷F3, P1÷P4 |
| **S5** | K_U09 | O1, O4 | C13 | 1, 2, 3, 4 | F1÷F3, P1÷P4 |
| **S6** | K_K01, K_K02 | O1÷O4 | C01÷C15, P01÷P15 | 4 | F1÷F3, P1÷P4 |

## II. METHODS OF ASSESSMENT – DETAILS

| MARKS | LEARNING OUTCOME |
|---|---|
| | **S1** |
| **2 (F)** | Student does not have a basic knowledge of Structural Mechanics II and did not know how to use the basic conceptual apparatus and a simple construction solves engineering problems with errors. |
| **3 (E)** | Student has a basic knowledge of Structural Mechanics II, and know how to use the basic conceptual apparatus and can solve simple problems of engineering construction |
| **3,5 (D)** | Student has a basic knowledge of Structural Mechanics II, and know how to use the basic conceptual apparatus. In addition, he can perfectly solve simple problems of engineering construction |
| **4 (C)** | Student has a wide knowledge of Structural Mechanics II, know how to use advanced conceptual apparatus and can perfectly solve simple and complex problems selected engineering construction |
| **4,5 (B)** | Student has a wide knowledge of Structural Mechanics II, know how to use advanced conceptual apparatus and is able to solve simple and complex problems of engineering construction |
| **5 (A)** | Student has a wide knowledge of Structural Mechanics II, know how to use advanced conceptual apparatus and perfectly able to solve simple and complex problems of engineering construction |
| | **S2** |
| **2 (F)** | Student can not replace primary literature sources necessary to solve the tasks of Structural Mechanics systems statically determinate |
| **3 (E)** | Student is able to briefly mention primary literature sources and can not fully exploit their |
| **3,5 (D)** | Student is able to briefly mention primary literature sources and attempts to use them properly |
| **4 (C)** | Student knows the primary literature sources and can be used in a range of tasks to be solved |
| **4,5 (B)** | Student knows the basic and additional literature sources and can be used in a range of tasks to be solved, knows how to make a classification of buildings, construction of supporting structures. |
| **5 (A)** | Student can fluently replaced by reference and can fluently use it in terms of tasks to be solved |
| | **S3** |
| **2.0 (F)** | Student understands what the solution to the problem by force but it can not properly begin the task |
| **3.0 (E)** | Student is able to solve a simple example using the Force Method, but the solution contains errors |
| **3,5 (D)** | Student is able to correctly solve a simple example using the Force Method |
| **4.0 (C)** | Student is able to correctly solve a simple example and selected complex systems |
| **4,5 (B)** | Student is able to solve simple and complex example by the Force Method |
| **5.0 (A)** | Student is able to correctly solve simple and complex example by the Force Method |

| S4 | |
|---|---|
| **2.0 (F)** | Student understands what is the solution of the Displacement Method but it can not properly begin the task |
| **3.0 (E)** | Student is able to solve a simple example using the Displacement Method, but the solution contains errors |
| **3,5 (D)** | Student is able to correctly solve a simple example using the Displacement Method |
| **4.0 (C)** | Student is able to correctly solve a simple example and selected complex systems |
| **4,5 (B)** | Student is able to solve simple and complex example by the Displacement Method |
| **5.0 (A)** | Student is able to correctly solve simple and complex example by the Displacement Method |
| **S5** | |
| **2.0 (F)** | Student understands what is drawing influence lines for statically indeterminate systems but can not properly begin the task |
| **3.0 (E)** | Student is able to solve simple task of drawing influence lines for statically indeterminate systems, however, the solution contains errors |
| **3,5 (D)** | Student is able to correctly solve the simple task of drawing influence lines for statically indeterminate systems |
| **4.0 (C)** | Student is able to draw perfectly straight lines for the impact of statically indeterminate systems and complex systems for selected |
| **4,5 (B)** | Student is able to solve simple and complex task of preparing the influence lines for statically indeterminate systems |
| **5.0 (A)** | Student is able to correctly solve simple and complex task of preparing the influence lines for statically indeterminate systems |
| **S6** | |
| **2.0 (F)** | Student is not able to work or individually or in a team |
| **3.0 (E)** | Student can work individually with the help of the teacher, teamwork is conflicting and delayed the work team |
| **3,5 (D)** | Student can work individually with the help of the teacher, teamwork is conflicting, but tries not to delay the work of the team |
| **4.0 (C)** | Student can work individually and in a team, is systematic but not too creative |
| **4,5 (B)** | Student can work individually and in a team, is systematic, trying to be creative and well-organized |
| **5.0 (A)** | Student can work individually and in a team. It can be the most appropriate solution to the problem is creative and well organized, able to mitigate conflicts |

## III. OTHER USEFUL INFORMATIONS ABOUT THE SUBJECT

| | |
|---|---|
| **1.** | Information, where and how students may acquaint with literature, author's teaching aids and others: according to the type of materials: |
| | *According to the type of material – in the classroom, in the teacher's office and university or faculty library* |
| **2.** | Information about the place of classes: |
| | *Show-case in the Faculty of Civil Enginering and faculty www page.* |
| **3.** | Information about time of classes (day and hour): |
| | *Show-case in the Faculty of Civil Engineering and faculty www page.* |
| **4.** | Information about consultations (place and hours): |
| | *The timetable posted on the door of Room 75 at the Faculty of Civil Engineering st. Academic 3 (second floor).* |