



## COURSE DESCRIPTION CARD - SYLLABUS

Course name

Structural mechanics [S1BZ1E>MB2]

### Course

Field of study

Sustainable Building Engineering

Year/Semester

2/4

Area of study (specialization)

–

Profile of study

general academic

Level of study

first-cycle

Course offered in

English

Form of study

full-time

Requirements

compulsory

### Number of hours

Lecture

15

Laboratory classes

0

Other

0

Tutorials

15

Projects/seminars

15

### Number of credit points

3,00

### Coordinators

prof. dr hab. inż. Przemysław Litewka  
przemyslaw.litewka@put.poznan.pl

### Lecturers

### Prerequisites

Student has the basic knowledge in: mathematics, foundations of mechanics, strength of materials in the scope from the current course, as well as the structural mechanics from the 3rd semester Student can use the possessed knowledge and gain new abilities from accessible literature. Student can apply the known theory to solve practical problems Student is aware of necessity to expand knowledge so that he can find the justification for its application to practical problems. Student understands the necessity of constant education.

### Course objective

Solution of frames using the classical version of stiffness method and beams - in the classical and matrix versions. Calculation of critical loading for elastic frames. Fundamental knowledge in structural dynamics, computation of natural frequencies and dynamic coefficients.

### Course-related learning outcomes

Knowledge:

1. Student knows the relations between displacements and loading in statics, stability and dynamics of straight beams

2. Student knows the methods to build computational models for structures with concentrated masses
3. Student knows the influence of the large axial forces on plane bar structures.

**Skills:**

1. Student can find the distributions of internal forces and compute displacements due to external loading, temperature change and imposed displacements in plane bar structures.
2. Student can formulate equilibrium conditions for plane frames according to second order theory and can compute the critical loading.
3. Student can compute natural frequencies and amplitudes of harmonically forced vibrations for bar structures with concentrated masses

**Social competences:**

1. Student can work individually and in a team
2. Student has the responsibility for the correctness of the obtained solutions and can give their interpretation
3. Student has the consciousness for necessity of continuous expansion of knowledge.

### Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:

1. The examination is written. In the case of failed first attempt there is the right for second attempt. The dates for first and second attempts will be given in the beginning of the semester. Examination comprises three to four questions with equal weight. Solution to more than 50% of the questions is required to pass the examination.
2. The positive final mark for example classes is given after positive passing of both tests T1 and T2 scheduled during the semester. The final mark is the weighted mean of positive marks for the tests (T1 – weight 3.0, T2 – weight 2.0). In the case of a negative mark (2.0) for any of the tests – the first attempt mark is 2.0. An absence in any of the tests results in the absent mark in the first attempt. The second attempt test will take place during the examination session – the date will be given in January. The student has to retake the test(s) which were not passed during the semester. Every test comprises three questions with unequal weights (3, 1 and 1 points) – the answers for each question are assessed as null, half or full points. The positive mark is obtained for the total percentage of points higher than 50%, i.e. higher than 2.5.
3. Exercise classes (projects) – solution and submission of two individual exercises (projects)  
The exercises must be submitted at the latest on the deadline specified at the beginning of the semester. Delayed submissions are not accepted.

In the case of no submission of any exercise the student is not classified.

The mark for the particular exercise is given depending on the level of its correctness:

mark 5.0 – 95–100%

mark 4.5 – 90–94%

mark 4.0 – 85–89%

mark 3.5 – 80–84%

mark 3.0 – 75–79%

mark 2.0 – 0–74% (negative)

The final mark for the exercise classes is equal to the weighted mean (E1 – weight 3.0, E2 – weight 2.0) if both marks are positive.

In the case of at least one negative mark 2.0 the final mark in the first attempt is 2.0. In such a case the student will get the repetition exercise(s) which has (have) to be submitted during the examination session.

The final mark in the second attempt is equal to the weighted mean (E1 – weight 3.0, E2 – weight 2.0) if both marks are not negative. The mark(s) for the repetition exercise(s) replace(s) the mark(s) for the first date exercise(s). In the case of at least one negative mark the final mark in the second attempt is 2.0.

Systematic work and reporting the progress during the exercise classes is obligatory. The lack of regular consulting will cause the negative mark and/or no-classification case. The presence in the exercise class is granted for the consultation, not just attending the class.

### Programme content

**Lecture**

Slope-deflection formulae for straight beams (2h)

Kinematically indeterminate systems - stiffness method (2h)

Matrix version of stiffness method for beams (2h)

Dynamics of systems with concentrated masses. System with 1 degree of freedom. Free and forced vibrations - undamped and damped (2h)

Dynamics of systems with distributed mass - undamped vibrations (2h)

Influence of large axial forces on bending of beams. Initial stability of frames. Examples (4h)

Tutorials

Stiffness method - non-sway and sway frames - external loading and imposed displacements (6h)

Matrix version of stiffness method for beams (2h)

Free and harmonic forced vibrations of frames with concentrated masses (4h)

Exercises (projects)

1. Classical and matrix stiffness method

2. Dynamics of bar structures with concentrated masses - free and harmonically forced undamped vibrations

## Course topics

Derivation of slope-deflection formulae

Plane frame kinematically indeterminate - stiffness method

Computation of internal forces in plane frames using the stiffness method - action of forces and support displacements

Structural dynamics - free and forced vibrations with and without damping - illustration of main phenomena for the system with one dynamic degree of freedom

Dynamics of plane beams and frames with discrete mass model - undamped vibrations

Dynamics of beams with distributed mass - natural frequencies, slope-deflection formulae

Second order theory - influence of large axial forces, critical loading, slope-deflection formulae - analysis of stability loss for beams and plane frames.

## Teaching methods

Lecture - monographic lecture, tutorials, exercises - exercise and project method

## Bibliography

Basic

1. Electronic textbook <http://www.ikb.poznan.pl/przemyslaw.litewka/str-me-w.html>

2. M. Guminiak, J. Rakowski, Zbiór zadań z mechaniki budowli, Wydawnictwo PWSZ, Piła 2008

3. M. Guminiak, J. Rakowski, Mechanika budowli. Zbiór zadań z elementami ujęcia komputerowego, Wydawnictwo PWSZ, Piła 2011

4. Z. Cywiński, Mechanika budowli w zadaniach (t.I+II), PWN, Warszawa 1976

5. J. Rakowski, Mechanika budowli, Zadania cz.1, Wydawnictwo PP, Poznań 2007

Additional

1. Internet textbook, Mechanika budowli, [www.ikb.put.poznan.pl/node/49](http://www.ikb.put.poznan.pl/node/49)

2. W. Nowacki, Mechanika budowli, PWN, Warszawa 1974

3. Z. Dyląg i in., Mechanika budowli (t.I+II), PWN, Warszawa 1989

## Breakdown of average student's workload

	Hours	ECTS
Total workload	120	4,00
Classes requiring direct contact with the teacher	50	2,00
Student's own work (literature studies, preparation for laboratory classes/ tutorials, preparation for tests/exam, project preparation)	70	2,00