

# POLITECHNIKA KRAKOWSKA IM. TADEUSZA KOŚCIUSZKI

## KARTA PRZEDMIOTU

obowiązuje studentów rozpoczynających studia w roku akademickim 2021/2022

Wydział Inżynierii Lądowej

Kierunek studiów: Budownictwo

Profil: Ogólnoakademicki

Forma studiów: stacjonarne

Kod kierunku: BUD

Stopień studiów: I

Specjalności: Bez specjalności - studia w języku angielskim

### 1 INFORMACJE O PRZEDMIOCIE

|                                         |                         |
|-----------------------------------------|-------------------------|
| NAZWA PRZEDMIOTU                        | Wytrzymałość materiałów |
| NAZWA PRZEDMIOTU<br>W JĘZYKU ANGIELSKIM | Strength of Materials   |
| KOD PRZEDMIOTU                          | WIL BUD oIS C25 21/22   |
| KATEGORIA PRZEDMIOTU                    | Przedmioty kierunkowe   |
| LICZBA PUNKTÓW ECTS                     | 10.00                   |
| SEMESTRY                                | 3 4                     |

### 2 RODZAJ ZAJĘĆ, LICZBA GODZIN W PLANIE STUDIÓW

| SEMESTR | WYKŁAD | ĆWICZENIA<br>AUDYTORYJNE | LABORATORIA | LABORATORIA<br>KOMPUTERO-<br>WE | PROJEKTY | SEMINARIUM |
|---------|--------|--------------------------|-------------|---------------------------------|----------|------------|
| 3       | 30     | 0                        | 0           | 0                               | 30       | 0          |
| 4       | 30     | 15                       | 15          | 0                               | 0        | 0          |

### 3 CELE PRZEDMIOTU

**Cel 1** To familiarize the students with basic notions, definitions and theorems of the statics of plane bar statically determinate structures.

- Cel 2** To familiarize the students with fundamentals of mechanics of continua and boundary problems as theoretical basis to analyze simple and complex cases of strength of materials in order to learn design rules for cross-sections in limit states of bearing capacity and usability.
- Cel 3** To familiarize the students with working of beam elements in nonlinear range to establish material reserves in the case of the work in the elastic-plastic range.
- Cel 4** To familiarize the students with the stability problem of straight bars (without imperfections) along with the simple analyses of effective design of such bars.
- Cel 5** To draw students' attention to the importance of understanding of theoretical and experimental results and the ability to interpret them in order to avoid the error of uncritical confidence in standards and numerical results preparing them for performing scientific work

## 4 WYMAGANIA WSTĘPNE W ZAKRESIE WIEDZY, UMIEJĘTNOŚCI I INNYCH KOMPETENCJI

- 1 Credit for 1st year of mathematics and 1st semester of theoretical mechanics

## 5 EFEKTY KSZTAŁCENIA

- EK1 Wiedza** Student has ordered and theoretically founded knowledge in the scope of statics of bar structures statically determined.
- EK2 Umiejętności** Student can draw the cross-section forces diagrams for beams, arches, trusses and combined structures.
- EK3 Wiedza** Student has knowledge of simple and composed cases of building elements and uses it to design structural elements in the limit states of strength and usability.
- EK4 Umiejętności** Student can identify the working case and design cross-section in simple stress state as well as in complex stress state.
- EK5 Wiedza** Student has the basic knowledge of non-elastic behavior of simple beam elements and analyses limit bearing capacity in elastic and plastic range.
- EK6 Wiedza** Student has sufficient knowledge of the stability problem of straight bars, its importance in design and can analyze simple engineering cases.
- EK7 Wiedza** Student has basic knowledge of recent trends in the subject matter of the strength of materials.
- EK8 Kompetencje społeczne** Student can formulate tasks and independently or in group work on them.

## 6 TREŚCI PROGRAMOWE

| PROJEKTY  |                                                                             |                  |
|-----------|-----------------------------------------------------------------------------|------------------|
| LP        | TEMATYKA ZAJĘĆ<br>OPIS SZCZEGÓŁOWY BLOKÓW TEMATYCZNYCH                      | LICZBA<br>GODZIN |
| <b>P1</b> | Classification of structures, loadings and constraints. Geometric rigidity. | 2                |
| <b>P2</b> | Determination of constraints reactions.                                     | 2                |
| <b>P3</b> | Determination of cross-section forces in simple beams.                      | 2                |
| <b>P4</b> | Determination of cross-section forces in not single span beams.             | 2                |

| PROJEKTY   |                                                                           |                  |
|------------|---------------------------------------------------------------------------|------------------|
| LP         | TEMATYKA ZAJĘĆ<br>OPIS SZCZEGÓŁOWY BLOKÓW TEMATYCZNYCH                    | LICZBA<br>GODZIN |
| <b>P5</b>  | Determination of cross-section forces in continuous beams.                | 2                |
| <b>P6</b>  | Determination of cross-section forces in slanted beams.                   | 2                |
| <b>P7</b>  | Determination of cross-section forces in frames.                          | 2                |
| <b>P8</b>  | Determination of cross-section forces in circular and parabolic arches.   | 2                |
| <b>P9</b>  | Determination of cross-section forces in trusses.                         | 2                |
| <b>P10</b> | Determination of cross-section forces in combined structures.             | 2                |
| <b>P11</b> | Stress state analysis. Static boundary conditions. Shields.               | 2                |
| <b>P12</b> | Strain state analysis. Kinematic boundary conditions.                     | 2                |
| <b>P13</b> | Constitutive equations of elastic continua.                               | 2                |
| <b>P14</b> | Torsion of bars with circular, rectangular and thin-walled cross-section. | 2                |
| <b>P15</b> | Completion and reserve.                                                   | 2                |

| ĆWICZENIA AUDYTORYJNE |                                                                           |                  |
|-----------------------|---------------------------------------------------------------------------|------------------|
| LP                    | TEMATYKA ZAJĘĆ<br>OPIS SZCZEGÓŁOWY BLOKÓW TEMATYCZNYCH                    | LICZBA<br>GODZIN |
| <b>C1</b>             | Geometric characteristics of cross-section.                               | 2                |
| <b>C2</b>             | Torsion of bars with circular, rectangular and thin-walled cross-section. | 2                |
| <b>C3</b>             | Simple and biaxial bending.                                               | 3                |
| <b>C4</b>             | Eccentric tension, cross-section core.                                    | 2                |
| <b>C5</b>             | Transversal bending.                                                      | 2                |
| <b>C6</b>             | Limit analysis of beams in elastic-plastic range.                         | 2                |
| <b>C7</b>             | Analysis of structure in complex stress states.                           | 2                |

| WYKŁAD    |                                                                                                                                |                  |
|-----------|--------------------------------------------------------------------------------------------------------------------------------|------------------|
| LP        | TEMATYKA ZAJĘĆ<br>OPIS SZCZEGÓŁOWY BLOKÓW TEMATYCZNYCH                                                                         | LICZBA<br>GODZIN |
| <b>W1</b> | Introduction to the subject of Strength of Materials (SM). Basic notions and assumptions. Internal and cross-sectional forces. | 4                |

| WYKŁAD     |                                                                                                                                                                                                                                     |                  |
|------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------|
| LP         | TEMATYKA ZAJĘĆ<br>OPIS SZCZEGÓŁOWY BLOKÓW TEMATYCZNYCH                                                                                                                                                                              | LICZBA<br>GODZIN |
| <b>W2</b>  | Cross-section forces in plane bar structures. Static calculations for simple and continuous beams, frames, circular and parabolic arches. Forces in trusses.                                                                        | 10               |
| <b>W3</b>  | Theory of stress state - basic definitions and notions. Stress matrix and its transformation at coordinate set rotation. Principal stresses. Equations of equilibrium (Navier's) in material point. Static boundary conditions.     | 5                |
| <b>W4</b>  | Theory of strains state and displacements of material point. Strain matrix and displacements vector. Geometric equations (Cauchy's). Kinematic boundary conditions.                                                                 | 3                |
| <b>W5</b>  | Constitutive equations for linearly elastic material (Hooke's). Stiffness and compliance matrices. Boundary problem formulation in linear theory of elasticity.                                                                     | 3                |
| <b>W6</b>  | Geometric characteristics of cross-section - static and inertia moments. Matrix of inertia and its transformation due to coordinate set rotation and translation (Steiner's theorems). Principal, central axes and inertia moments. | 2                |
| <b>W7</b>  | Boundary problem formulation for twisted straight bars. Torsion of bars with circular and rectangular cross-section. Approximate analysis of torsion of thin-walled profiles.                                                       | 4                |
| <b>W8</b>  | Analysis of simple and composed cases (tensions, simple bending, biaxial bending, eccentric tension, transversal bending).                                                                                                          | 12               |
| <b>W9</b>  | Determination of beams' deflections using differential equation and Mohr's analogy.                                                                                                                                                 | 4                |
| <b>W10</b> | Analysis of axially compressed struts strength - Euler's problem. Cross-section design. Design of steel members.                                                                                                                    | 5                |
| <b>W11</b> | Non-elastic behavior of elastic-plastic materials. Limit elastic and plastic bearing capacity of the cross-section and the bar structure (kinematic method).                                                                        | 4                |
| <b>W12</b> | Elastic energy of continua and its determination for bar member (Maxwell-Mohr's formula). Effect hypotheses for structure elements (Galileo, Coulomb, Tresca-Guest, Huber-Mises-Hencky and Mohr hypotheses).                        | 4                |

| LABORATORIA |                                                                                                                                           |                  |
|-------------|-------------------------------------------------------------------------------------------------------------------------------------------|------------------|
| LP          | TEMATYKA ZAJĘĆ<br>OPIS SZCZEGÓŁOWY BLOKÓW TEMATYCZNYCH                                                                                    | LICZBA<br>GODZIN |
| <b>L1</b>   | Importance of experiments in Strength of Materials.                                                                                       | 2                |
| <b>L2</b>   | Introduction to the strain gauges: mechanical and electric.                                                                               | 2                |
| <b>L3</b>   | Quasi-static tensile strength test of metal samples. Elastic and non-elastic behaviour of material during tension. Mechanisms of failure. | 4                |

| LABORATORIA |                                                                                                                                                   |                  |
|-------------|---------------------------------------------------------------------------------------------------------------------------------------------------|------------------|
| LP          | TEMATYKA ZAJĘĆ<br>OPIS SZCZEGÓŁOWY BLOKÓW TEMATYCZNYCH                                                                                            | LICZBA<br>GODZIN |
| <b>L4</b>   | Verification of the equations of linear theory of elasticity through determination of elastic modulus from elongation and deflection measurement. | 2                |
| <b>L5</b>   | Photoelastic analysis of structures. Photoelastic and strain gauges analysis of the stress in beams and shields.                                  | 3                |
| <b>L6</b>   | Stress state analysis in curved bars and its verification by strain gauges experiments.                                                           | 2                |

## 7 NARZĘDZIA DYDAKTYCZNE

**N1** Lectures

**N2** Exercises

**N3** Laboratories

**N4** Design classes

**N5** Office hours

## 8 OBCIĄŻENIE PRACĄ STUDENTA

| FORMA AKTYWNOŚCI                                                                                 | ŚREDNIA LICZBA GODZIN<br>NA ZREALIZOWANIE<br>AKTYWNOŚCI |
|--------------------------------------------------------------------------------------------------|---------------------------------------------------------|
| <b>Godziny kontaktowe z nauczycielem akademickim, w tym:</b>                                     |                                                         |
| Godziny wynikające z planu studiów                                                               | 120                                                     |
| Konsultacje przedmiotowe                                                                         | 15                                                      |
| Egzaminy i zaliczenia w sesji                                                                    | 5                                                       |
| <b>Godziny bez udziału nauczyciela akademickiego wynikające z nakładu pracy studenta, w tym:</b> |                                                         |
| Przygotowanie się do zajęć, w tym studiowanie zalecanej literatury                               | 60                                                      |
| Opracowanie wyników                                                                              | 10                                                      |
| Przygotowanie raportu, projektu, prezentacji, dyskusji                                           | 80                                                      |
| <b>SUMARYCZNA LICZBA GODZIN DLA PRZEDMIOTU WYNIKAJĄCA Z<br/>CAŁEGO NAKŁADU PRACY STUDENTA</b>    | <b>290</b>                                              |
| SUMARYCZNA LICZBA PUNKTÓW ECTS DLA PRZEDMIOTU                                                    | 10.00                                                   |

## 9 SPOSOBY OCENY

### OCENA FORMUJĄCA

**F1** Test

**F2** Individual project

**F3** Laboratory exercise report

**F4** Final test

### OCENA PODSUMOWUJĄCA

**P1** Weighted average of forming grades

### WARUNKI ZALICZENIA PRZEDMIOTU

**W1** Active participation in lectures and classes - presence will be verified and taken into consideration

**W2** Design projects approved on time

**W3** Positive grade from the design tests

**W4** Positive grade from the final test

### OCENA AKTYWNOŚCI BEZ UDZIAŁU NAUCZYCIELA

**B1** Projekt indywidualny

### KRYTERIA OCENY

| EFEKT KSZTAŁCENIA 1 |                                                                                                                                             |
|---------------------|---------------------------------------------------------------------------------------------------------------------------------------------|
| NA OCENĘ 3.0        | Correct answer of 80% of exam questions on given topic.                                                                                     |
| EFEKT KSZTAŁCENIA 2 |                                                                                                                                             |
| NA OCENĘ 3.0        | Fulfillment of 80% of projects on given topic. Minimum 55% of possible points of written tests and correct answer of 80% of exam questions. |
| NA OCENĘ 4.5        | .                                                                                                                                           |
| EFEKT KSZTAŁCENIA 3 |                                                                                                                                             |
| NA OCENĘ 3.0        | Correct answer of 80% of exam questions on given topic.                                                                                     |
| EFEKT KSZTAŁCENIA 4 |                                                                                                                                             |
| NA OCENĘ 3.0        | Fulfillment of projects on given topic. Minimum 55% of possible points of written tests and correct answer of 80% of exam questions.        |
| EFEKT KSZTAŁCENIA 5 |                                                                                                                                             |
| NA OCENĘ 3.0        | Student can identify non-elastic behavior of simple beam element.                                                                           |
| EFEKT KSZTAŁCENIA 6 |                                                                                                                                             |

|                     |                                                                                                         |
|---------------------|---------------------------------------------------------------------------------------------------------|
| NA OCENĘ 3.0        | Student can identify the stability problem of straight bars and know the basic formulas used in design. |
| EFEKT KSZTAŁCENIA 7 |                                                                                                         |
| NA OCENĘ 3.0        | Student has known at least one topic related to modern strength of materials.                           |
| EFEKT KSZTAŁCENIA 8 |                                                                                                         |
| NA OCENĘ 3.0        | Student fulfil home assignments and performed laboratory experiment in group.                           |

## 10 MACIERZ REALIZACJI PRZEDMIOTU

| EFEKT KSZTAŁCENIA | ODNIESIENIE DANEGO EFEKTU DO SZCZEGÓŁOWYCH EFEKTÓW ZDEFINIOWANYCH DLA PROGRAMU | CELE PRZEDMIOTU            | TREŚCI PROGRAMOWE                                              | NARZĘDZIA DYDAKTYCZNE | SPOSOBY OCENY  |
|-------------------|--------------------------------------------------------------------------------|----------------------------|----------------------------------------------------------------|-----------------------|----------------|
| EK1               | K_W04 K_W05                                                                    | Cel 1                      | p1 p2 p3 p4 p5<br>p6 p7 p8 p9 p10<br>w1 w2                     | N1 N2 N4 N5           | F1 F2 F4 P1    |
| EK2               | K_W04 K_W05<br>K_U04                                                           | Cel 1                      | p1 p2 p3 p4 p5<br>p6 p7 p8 p9 p10<br>w2                        | N1 N2 N4 N5           | F1 F2 F4 P1    |
| EK3               | K_W04 K_W05                                                                    | Cel 2                      | p14 c1 c2 c3 c4<br>c5 w6 w7 w8 w9                              | N1 N2 N4 N5           | F1 F4 P1       |
| EK4               | K_W04 K_W05<br>K_U07 K_U08<br>K_U09                                            | Cel 2 Cel 3<br>Cel 4 Cel 5 | p14 c1 c2 c3 c4<br>c5 w4 w5 w6 w7<br>w8 w9 l3 l4               | N1 N2 N3 N4 N5        | F1 F2 F3 F4 P1 |
| EK5               | K_W04 K_W05<br>K_U11                                                           | Cel 2 Cel 3<br>Cel 5       | c1 c2 c3 c4 c5 c6<br>c7 w5 w6 w7 w8<br>w9 w10 w11 w12<br>l1 l3 | N1 N2 N3 N4 N5        | F3 F4 P1       |
| EK6               | K_W04 K_W05<br>K_U11                                                           | Cel 1 Cel 4                | w9 w10                                                         | N1 N2 N4 N5           | F1 F2 F4 P1    |
| EK7               | K_W04                                                                          | Cel 5                      | w12 l5                                                         | N1 N2 N3 N5           | F1 F3 F4 P1    |
| EK8               | K_K01                                                                          | Cel 5                      | l1 l2 l3 l4 l5 l6                                              | N2 N3                 | F2 F3          |

## 11 WYKAZ LITERATURY

### LITERATURA PODSTAWOWA

[1] | da Silva V. D. — *Mechanics and Strength of Materials*, Berlin, Heidelberg, 2006, Springer

### LITERATURA UZUPEŁNIAJĄCA

[1] | Gere J. M., Timoshenko S. P. — *Mechanics of Materials*, Boston, 1997, PWS

[2] | Gross D., Hauger W. et al. — *Engineering Mechanics*, Heidelberg, 2011, Springer

## 12 INFORMACJE O NAUCZYCIELACH AKADEMICKICH

### OSOBA ODPOWIEDZIALNA ZA KARTĘ

dr inż. Krzysztof Nowak (kontakt: [krzysztof.nowak@pk.edu.pl](mailto:krzysztof.nowak@pk.edu.pl))

### OSOBY PROWADZĄCE PRZEDMIOT

1 dr inż. Krzysztof Nowak (kontakt: [krzysztof.nowak@pk.edu.pl](mailto:krzysztof.nowak@pk.edu.pl))

## 13 ZATWIERDZENIE KARTY PRZEDMIOTU DO REALIZACJI

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(miejscowość, data)

(odpowiedzialny za przedmiot)

(dziekan)

PRZYJMUJĘ DO REALIZACJI (data i podpisy osób prowadzących przedmiot)

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