Politechnika Krakowska im. Tadeusza Kościuszki

Karta przedmiotu

obowiązuje studentów rozpoczynających studia w roku akademickim 2024/2025

Wydział Inżynierii Lądowej

Kierunek studiów: Budownictwo

Profil: Ogólnoakademicki

Forma sudiów: stacjonarne

Kod kierunku: BUD

Stopień studiów: I

Specjalności: Bez specjalności - studia w języku angielskim

1 Informacje o przedmiocie

Nazwa przedmiotu	Mechanika teoretyczna
Nazwa przedmiotu w języku angielskim	Theoretical Mechanics
Kod przedmiotu	WIL BUD oIS B12 24/25
Kategoria przedmiotu	Przedmioty podstawowe
Liczba punktów ECTS	9.00
Semestry	2 3

2 Rodzaj zajęć, liczba godzin w planie studiów

Semestr	Wykład	Ćwiczenia audytoryjne	Laboratoria	Laboratoria komputerowe	Projekty	Seminarium
2	30	30	0	0	0	0
3	30	30	0	0	0	0

3 Cele przedmiotu

Cel 1 Introduce the basic concepts describing forces existing in engineering. Acquaint of the students with the idea of reduction of systems of forces.

Cel 2 Familiarize the students with the problems of kinematics of a particle and a rigid body to the extent enabling the formulation and analysis of motion of the simple mechanical systems.

Cel 3 Familiarize the students with the concepts of statisc. The acqusition of the skills of identification and formation of the statically determinate structures, and determining reactions at supports for statically determinate structures.

Cel 4 Acquaint the students with the quantities characterizing the mass distribution of the rigid bodies and systems of material points.

Cel 5 Familiarize the students with dynamics of a particle under smooth and non-smooth constraints, and dynamics of the system of particles and rigid bodies.

Cel 6 Acquaint the student with the selected problems of the analytical mechanics to the extent enabling the formulation of the differential equations of motion of the simple material system, and analysing their stability of equilibrium.

4 Wymagania wstępne w zakresie wiedzy, umiejętności i innych kompetencji

1 The first semester of the mathematics course must be copmleted.

5 Efekty kształcenia

EK1 Wiedza A student understands and explains the basic concepts of the theory of the equivalence of the systems of forces.

EK2 Umiejętności For an arbitrary force system (planar and spatial) a student can determine the equivalent couple-force system at a given point , and the simplest equivalent force system.

EK3 Wiedza A student defines the basic kinematic quantities occuring in the motion of a particle and a rigid body and describes relations between them.

EK4 Umiejętności A student can analyse statical determinacy and stability of the structures, and determine the reactions at supports and the forces in truss members for statically determinate structures.

EK5 Umiejętności A student is able to analyse the tensor of inertia of the system of particels and rigid bodies.

EK6 Wiedza A student describes the basic quantities of dynamics of a particle and a rigid system, and describes the friction phenomenon in civil engineering.

EK7 Umiejętności A student can analyse free, dumped and forced vibrations of the simple construction elements modelled as systems with the single degree of freedom.

EK8 Wiedza A student is capable of forming the differential equations of motion of material systems by means of the methods of analytical mechanics.

6 Treści programowe

Projekty		
Lp	Tematyka zajęć Opis szczegółowy bloków tematycznych	Liczba godzin
P1	Reduction of the spatial force system.	4
P2	Reduction of the planar and parallel force system.	4

Projekty		
Lp	Tematyka zajęć Opis szczegółowy bloków tematycznych	Liczba godzin
P3	Kinematics of a particle, acceleration decomposition. Circural motion.	2
P4	Kinematics of a rigid body: distribution of velocities in planar motion, centers of instantenous rotation.	2
P5	Reactions at supports for simple beams and frames.	2
P6	Reactions at supports and forces in truss members for compound structures, by means of the equations of equilibrium and the principle of virtual work.	5
P7	Dynamics of a particle. Determination of motion of a particle by means of the different dynamic methods.	3
P8	The tensor of inertia for solids and planar figures. Statical moments, moments and products of inertia for the cross-section composite areas. Principal and principal centroidal moments and axes of inertia.	5
P9	Determination of motion and the stable equilibrium position of the systems by means of analytical mechanics.	3

Wykład		
Lp	Tematyka zajęć Opis szczegółowy bloków tematycznych	Liczba godzin
W1	Introduction to mechanics: fundamental concepts, division, mechanics and engineering	1
W2	Forces and force systems: moment of a force about a point, moment of the force about a line, a system of forces, moment transport theorem and corollaries, a couple- definition and properties, equivalent systems of forces, elementary transformations of the force system, reduction of the force system to a force-couple system at a chosen point, the simplest equivalent force system (zero force system, resultant force, couple, wrench), the central axis of the system, special force systems : planar force system, concurrent force system, parallel force system, distributed load - reduction.	9
W3	The discription of motion in terms of position vector, and in terms of path coordinates, velocity and acceleration vectors, tangential and centripetal acceleration, circular motion- angular velocity and acceleration compound motion of a particle, inertial and non-inertial reference frames, composition of velocity and acceleration in compound motion.	4
W4	Kinematics of a rigid body, distribution of velocities in a rigid body, methods of description of motion, special cases of motion : translation, rotation about a fixed point, rotation about a fixed axis, planar motion, center of instantenous rotation in planar motion.	4

Wykład		
Lp	Tematyka zajęć Opis szczegółowy bloków tematycznych	Liczba godzin
W5	Equilibrium of forces and objects in equilibrium constraints - definition and classification, examples of constrained motion, virtual displacement, the principle of virtual work, derivation of the equations of equilibrium.	6
W6	Statics: supports, reactions at supports, idealized structures static determinacy and stability of the structure, determining reactions at supports and forces in the truss members for statically determinate structure by means of equations of equilibrium and the principle of virtual work.	4
W7	Dynamics of a particle: free motion, motion under smooth and non-smooth frictional constraints. Concept of friction in mechanics. Lagrange's equations of the first kind,. Free, dumped and forced vibrations of the systems with one degree of freedom, resonance,magnification factor. Dynamic equations in terms of path coordinates.	12
W8	Dynamics of rigid bodies and system of particles. Center of mass, center of gravity, centroid, statical moments. Linear and angular momentum. Euler's balance and conservation laws. Angular momentum in the rotational motion of the rigid body. Moments and products of inertia. Parallel axes theorem (Steiner's theorem). Basics of the tensor calculus, eigenvectors and eigenvalues of the symmetric moment of inertia tensor. Principal and principal centroidal moments and axes of inertia. Equations of motion of a rigid body.	14
W9	Selected problems of analytical mechanics. Work and energy, potential system of forces. Principle of work and energy. Decomposition of kinetic energy of the rigid body (Koenig's theorem). D'Alambert's principle, globalized coordinates, globalized forces. Lagrange's equations of the second kind. Analysis of the stability of equilibrium of the system.	6

7 Narzędzia dydaktyczne

N1 Lecture

N2 Discussion

N3 Multimedia presentation

N4 Design exercise

N5 Consultation

N6 Whiteboard exercises

8 Obciążenie pracą studenta

Forma aktywności	Średnia liczba godzin na zrealizowanie aktywności
Godziny kontaktowe z nauczycielem akademickim, w tym:	
Godziny wynikające z planu studiów	90
Konsultacje przedmiotowe	6
Egzaminy i zaliczenia w sesji	8
Godziny bez udziału nauczyciela akademickiego wynikające z nakładu pracy studenta, w tym:	
Przygotowanie się do zajęć, w tym studiowanie zalecanej literatury	75
Opracowanie wyników	0
Przygotowanie raportu, projektu, prezentacji, dyskusji	90
Sumaryczna liczba godzin dla przedmiotu wynikająca z całego nakładu pracy studenta	**269**
Sumaryczna liczba punktów ECTS dla przedmiotu	9.00

9 Sposoby oceny

Ocena formująca

F1 Indyvidual project

F2 Test

F3 Colloquium

Ocena podsumowująca

P1 Written exam

P2 Weighted average of the midterm tests grades

P3 Test

Warunki zaliczenia przedmiotu

W1 All projects must be approved, and all midterm tests must be passed in order to qualify for the final exam

W2 The written exam consists of two parts: theory test and numerical tasks

Kryteria oceny

Efekt kształcenia 1

Na ocenę 3.0	A student understands the basic concepts of the theory of the equivalence of the systems of forces. He knows definitions and theorems.
Efekt kształcenia 2	
Na ocenę 3.0	A student can find the equivalent couple-force system at given point and find the simplest equivalent force system for both spatial and planar problems. He is able to reduce the parallel force system at the center of the system.
Efekt kształcenia 3	
Na ocenę 3.0	A student knows and understands the basic quantities describing motion of a particle and rigid body., and can derive the relations between them. He is able to find the distribution of velocities in the rigid body (especially in planar motion).
Efekt kształcenia 4	
Na ocenę 3.0	A student can distinguish between statically determinate, indeterminate and unstable structures, he can support the 2D structure to form the determinate system. He calculates the reactions at supports and forces in truss members for statically determinate structures using equations of equilibrium.
Efekt kształcenia 5	
Na ocenę 3.0	He can determine and analyze the tensor of inertia at any point, in particular at the centroid of the body.
Efekt kształcenia 6	
Na ocenę 3.0	A student knows und understands the laws of dynamics of rigid bodeis and systems of particles.
Efekt kształcenia 7	
Na ocenę 3.0	A student can analyze free, dumped and forced vibrations of the simple construction elements, with deriving corresponding differential equations of motion. He describes the specific quantities (e.g. magnification factor, dumping ratio) introduced in the forced vibrations.
Efekt kształcenia 8	
Na ocenę 3.0	A student is able to derive the differential equations of motion of a constrained particle and simple system of particles by means of one analytical methods of mechanics.

10 Macierz realizacji przedmiotu

Efekt kształcenia	Odniesienie danego efektu do szczegółowych efektów zdefiniowanych dla programu	Cele przedmiotu	Treści programowe	Narzędzia dydaktyczne	Sposoby oceny
EK1		Cel 1	p1 p2 w1 w2	N1 N2 N3 N4 N5 N6	F1 F2 F3 P1 P2 P3
EK2		Cel 1	p1 p2 w1 w2	N1 N2 N3 N4 N5 N6	F1 F2 F3 P1 P2 P3
EK3		Cel 2	p3 p4 w3 w4	N1 N2 N3 N4 N5 N6	F1 F2 F3 P1 P2 P3
EK4		Cel 3	p5 p6 w5 w6	N1 N2 N3 N4 N5 N6	F1 F2 F3 P1 P2 P3
EK5		Cel 4	p8 w8	N1 N2 N3 N4 N5 N6	F1 F2 F3 P1 P2 P3
EK6		Cel 5	p7 w7 w8	N1 N2 N3 N5 N6	F2 F3 P1 P2 P3
EK7		Cel 5	p7 w7	N1 N2 N3 N5 N6	F2 F3 P1 P2 P3
EK8		Cel 6	p9 w9	N1 N2 N3 N5 N6	F2 F3 P1 P2 P3

11 Wykaz literatury

Literatura podstawowa

[1] Bedford A., Fowler W. — *Engineering Mechanics*, Massachusetts, 1992, Addison-Wesley Publishin Company

[2] Banach Stefan — *Mechanics*, Warszawa, 1951, http://banach.univ.gda.pl/mechanics.html

[3] F, P..Beer, E. R. Johnston — *Vector Mechanics For Engineers .Statics, Dynamics.*, New York, 1988, McGraw Hill

[4] Hibbeler, Russell Charles — *Engineering mechanics :Statics, dynamics*, , 2007, Upper Saddle River : Pearson/Prentice Hall

Literatura uzupełniająca

[1] Marian Paluch — *Mechanika teoretyczna*, Kraków, 2000, Wydawnictwo PK

12 Informacje o nauczycielach akademickich

Osoba odpowiedzialna za kartę

dr hab. inż. prof. PK Dorota Jasińska (kontakt: djasinska@pk.edu.pl)

Osoby prowadzące przedmiot

2 Dr hab. inż., prof.PK Dorota Jasińska (kontakt: `jasinska@limba.wil.pk.edu.pl`)

3 Dr inż. Paweł Szeptyński (kontakt: `pszeptynski@pk.edu.pl`)

13 Zatwierdzenie karty przedmiotu do realizacji

(miejscowość, data) (odpowiedzialny za przedmiot) (dziekan)

Przyjmuję do realizacji (data i podpisy osób prowadzących przedmiot)

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