Tadeusz Kosciuszko Cracow University of Technology

Course Card

Faculty of Civil Engineering

Field of study: Civil Engineering

Study profile: general academic

Study form: full-time

Field of study code: BUD

Study cycle: 1st

Specialty: no specialty

1 COURSE INFORMATION

Course name	Mechanika teoretyczna
Course name in English	Theoretical Mechanics
Course code	WIL BUD oIS B12 24/25
Course category	Przedmioty podstawowe
No. of ECTS points	9.00
Semester	2 and 3

2 CLASS TYPE, NUMBER OF HOURS ACCORDING TO THE STUDY PLAN

Semester	Lecture	Class exercise	Laboratory	Computer lab	Design exercise	Seminar
2	30	30	0	0	0	0
3	30	30	0	0	0	0

3 COURSE OBJECTIVES

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

Objective 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.

Objective 3 Familiarize the students with the concepts of statistics. The acquisition of the skills of identification and forma- tion of the statically determinate structures, and determining reactions at supports for statically determinate structures.

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

Objective 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.

Objective 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 PREREQUISITES IN TERMS OF KNOWLEDGE, SKILLS AND OTHER COMPETENCES

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

5 LEARNING OUTCOMES

LO1 Knowledge A student understands and explains the basic concepts of the theory of the equivalence of the systems of forces.

LO2 Skills 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.

LO3 Knowledge A student defines the basic kinematic quantities occuring in the motion of a particle and a rigid body and describes relations between them.

LO4 Skills 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.

LO5 Skills A student is able to analyse the tensor of inertia of the system of particels and rigid bodies.

LO6 Knowledge A student describes the basic quantities of dynamics of a particle and a rigid system, and describes the friction phenomenon in civil engineering.

LO7 Skills A student can analyse free, dumped and forced vibrations of the simple construction elements modelled as systems with the single degree of freedom.

LO8 Knowledge A student is capable of forming the differential equations of motion of material systems by means of the methods of analytical mechanics.

6 COURSE CONTENT

Design exercise		
No.	Subject matter of the course Detailed description of thematic blocks	No. of class hours
P1	Reduction of the spatial force system.	4
P2	Reduction of the planar and parallel force system.	4

Design exercise		
No.	Subject matter of the course Detailed description of thematic blocks	No. of class hours
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

Lecture		
No.	Subject matter of the course Detailed description of thematic blocks	No. of class hours
L1	Introduction to mechanics: fundamental concepts, division, mechanics and engineering	1
L2	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
L3	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
L4	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

Lecture		
No.	Subject matter of the course Detailed description of thematic blocks	No. of class hours
L5	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
L6	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
L7	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
L8	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
L9	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 TEACHING TOOLS

N1 Lecture

N2 Discussion

N3 Multimedia presentation

N4 Design exercise

N5 Consultation

N6 Whiteboard exercises

8 Student workload

Activity form	Number of hours of activity
Hours realized in contact with the teacher	
Hours resulting from the study plan	90
Consultation hours	6
Exams and tests during session	8
Hours of autonomous student work	
Preparing for classes, studying literature	75
Developing results	0
Preparing of reports, projects presentations, discussion	90
Total number of hours devoted to the subject	**269**
Total number of ECTS points	9.00

9 Methods of grading

Partial grades

F1 Individual project

F2 Test

F3 Colloquium

Summary grade

P1 Written exam

P2 Weighted average of the midterm tests grades

P3 Test

Conditions for passing the course

L1 All projects must be approved, and all midterm tests must be passed in order to qualify for the final exam

L2 The written exam consists of two parts: theory test and numerical tasks