# COURSE DESCRIPTION CARD - SYLLABUS

Course name
Technical Mechanics [S1FT2>MechTech]

## Course

Field of study
Technical Physics

Year/Semester
1/2

Area of study (specialization)
–

Profile of study
general academic

Level of study
first-cycle

Course offered in
Polish

Form of study
full-time

Requirements
compulsory

## Number of hours

Lecture
30

Laboratory classes
0

Other
0

Tutorials
30

Projects/seminars
0

## Number of credit points

5,00

## Coordinators

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## Lecturers

## Prerequisites

Knowledge: basic knowledge of mechanics in the field of basic physics course in the field of technical physics, vector and tensor calculus, differential and integral calculus. Skills: the ability to solve elementary problems in mechanics based on the acquired knowledge, the ability to obtain information from indicated sources. Social competences: understanding the need to broaden one's own competences.

## Course objective

1. Provide students with general and specific knowledge of technical mechanics, related to the issues specified in the course program. 2. Developing students' skills in solving problems in technical mechanics based on the acquired knowledge.

## Course-related learning outcomes

Knowledge:
1. Knowledge of physical concepts within the scope of the technical mechanics course program
2. Knowledge of the laws of technical mechanics and their explanations in the scope covered by the course program and knowledge of the scope of their applicability
3. Knowledge of general calculation methods used in solving problems in technical mechanics

Skills:
1. Ability to apply the laws and calculation methods of technical mechanics in solving common problems within the scope of the course program
2. Ability to use the indicated sources of knowledge with understanding (list of basic literature) and to acquire knowledge from other sources

Social competences:
1. Active involvement in solving given problems

## Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:

Learning effect Form of evaluation Evaluation criteria
W03 written/oral exam 3 50.1%-70.0%
4 70.1%-90.0%
5 od 90.1%
W07 written/oral exam 3 50.1%-70.0%
4 70.1%-90.0%
5 od 90.1%
U01 test 3 50.1%-70.0%
4 70.1%-90.0%
5 od 90.1%
U02 test 3 50.1%-70.0%
4 70.1%-90.0%
5 od 90.1%
K01, K08 oral answers during exercises
The student independently seeks a solution based on the acquired knowledge and shows great commitment to solving problems - the student receives an additional point to the result of the test for each presentation of the solution to the problem at the blackboard.

## Programme content

1. Mathematical description of mechanical quantities
2. Kinematics
3. Dynamics
4. Analytical mechanics
5. Statics

## Course topics

I. Mathematical description of physical quantities
1. Cartesian coordinate system, vector description of mechanical quantities.
2. Scalar and vector products of vectors.
3. Mixed product of vectors and its geometric interpretation.
4. Linear vector function and its tensor form.
5. Tensor decomposition into symmetric and antisymmetric parts.
6. Scalar and vector fields, gradient, divergence and rotation operators.
II. Kinematics
7. Leading vector, velocity and acceleration in the Cartesian system.
8. Natural coordinate system.
9. Speed and acceleration in the natural coordinate system.
10. Velocity of a material point in curvilinear coordinates.
11. Acceleration of a material point in curvilinear coordinates.
12. Polar coordinate system.
13. Cylindrical coordinate system.
14. Spherical coordinate system.
15. Definition of a rigid body.
16. Velocity and acceleration of points of a rigid body in translational motion.
17. Velocity of points of a rigid body in rotation of the body around a fixed axis of rotation.

18. Acceleration of points of a rigid body in rotation of the body around a fixed axis of rotation.
19. Velocity and acceleration of points of a rigid body in the plane motion of a rigid body.
20. Velocity and acceleration of points of a rigid body in the general motion of a rigid body.
21. Transformation of the velocity of a material point in relative motion.
22. Transformation of the acceleration of a material point in relative motion.
III. Dynamics
23. Newton's laws of dynamics.
24. The concept of force, equations of motion of a material point, initial conditions.
25. Equations of motion of an electrically charged particle in a constant, uniform electric field.
26. Equations of motion of an electrically charged particle in a harmonically variable, uniform electric field.
27. Equations of motion of a harmonic oscillator.
28. Equations of motion of an electrically charged particle in a constant, uniform magnetic field.
29. Momentum and drive of a material point, the principle of conservation of momentum for a material point.
30. Elementary work, work, mechanical power.
31. Kinetic energy, the relationship between the increase in kinetic energy and elementary work.
32. Potential force field, potential energy, work in a potential force field.
33. The principle of conservation of energy in a potential force field.
34. Angular momentum of a material point and moment of force, principle of conservation of angular momentum for a material point.
35. Definition of central force and field velocity.
36. Kepler's laws.
37. The law of gravity, the first and second cosmic speed.
38. Definition of the static moment and center of mass of a material system.
39. Momentum and angular momentum of a rigid body in translational-rotational motion.
40. The moment of inertia tensor and its relationship with the angular momentum of a rigid body.
41. Kinetic energy of a rigid body, Koenig's theorem.
42. Main vector and main moment of the system of forces relative to the pole.
43. Equation of motion of a rigid body for translational and rotational motion.
44. Principles of conservation of momentum and angular momentum for a rigid body.
45. The principle of conservation of energy for a rigid body.
IV. Analytical mechanics
46. Bonds, types of bonds.
47. Generalized coordinates, number of degrees of freedom of a mechanical system.
48. Possible shifts, real shifts, possible speeds.
49. Virtual shifts, virtual shifts in generalized coordinates.
50. Virtual work and generalized forces.
51. Equations of motion in generalized coordinates, generalized momentum.
52. d'Alembert's principle.
53. Interpretation of the time derivative of generalized momentum.
54. The principle of virtual work - the condition of system equilibrium.
55. Lagrange equations of the second kind - the case of general forces.
56. Lagrange equations of the second kind - the case of potential forces.
V. Statics
57. Principles of statics.
58. Condition of equilibrium of a plane system of convergent forces.
59. Definition of moment of force in statics.
60. Varignon's theorem for the case of a plane system of convergent forces.
61. Method of determining the resultant of two parallel forces.
62. Definition of a force pair, moment of a force pair.
63. Equivalent pairs of forces lying in one plane.
64. Theorem on the reduction of a system of forces acting in one plane to a force and a pair of forces.
65. Conditions of equilibrium of forces acting in one plane.
66. Stiffness condition for a plane truss.
67. Resultant of the spatial system of convergent forces and the equilibrium condition.
68. The moment of the resultant force about a point and about an axis.
69. Combining pairs of forces acting in different planes.
70. General conditions of equilibrium of the spatial system of forces.

## Teaching methods

Lecture: multimedia presentation with a detailed explanation of the most difficult issues on the blckboard, solving sample tasks on the blackboard.
Exercises: problem solving, practical exercises, discussion, team work.

## Bibliography

Basic:
1. T. J. Hoffman, Podstawy mechaniki technicznej, Wydawnictwo Politechniki Poznańskiej, Poznań, 2000.
2. J. Leyko, Mechanika ogólna. Tom 1. Statyka i kinematyka, Tom 2. Dynamika, Wydawnictwo Naukowe PWN, Warszawa, 2011.
3. Zbiór zadań z mechaniki. Cz. 1. Statyka. Cz. 2. Kinematyka, Cz. 3. Dynamika, red.: J. Leyko, R. Kurowski,
J. Szmeltera, PWN, Warszawa, 1970.

Additional:
1. W. Rubinowicz, W. Królikowski, Mechanika teoretyczna, Wydawnictwo Naukowe PWN, Warszawa, 1998.
2. E. Karaśkiewicz, Zarys teorii wektorów i tensorów, Wydawnictwo Naukowe PWN, Warszawa, 1971.

## Breakdown of average student's workload

| | Hours | ECTS |
|---|---|---|
| Total workload | 125 | 5,00 |
| Classes requiring direct contact with the teacher | 60 | 2,50 |
| Student's own work (literature studies, preparation for laboratory classes/ tutorials, preparation for tests/exam, project preparation) | 65 | 2,50 |