SYLLABUS OF A MODULE

Polish name of a module	**MECHANIKA II**
English name of a module	**MECHANICS II**
ISCED classification - Code	0715
ISCED classification - Field of study	*Mechanics and metal trades*
Languages of instruction	*English*
Level of qualification: ***1 – BSc (EQF 6)*** ***2 – MSc (EQF 7)*** ***3 – PhD (EQF 8)***	*1 – BSc (EQF 6)*
Number of ECTS credit points	*6*
Examination: ***EO – exam oral*** ***EW – exam written*** ***A - assignment***	*EW – exam written*

Number of hours per semester:

Lecture	Tutorials	Laboratory	Seminar	E-learning	Project
30 E	30	0	0	0	0

MODULE DESCRIPTION

MODULE OBJECTIVES

O1. Students will understand the discipline-specific knowledge in classical mechanics, covering the dynamics of both a particle and a rigid body.

O2. Students will know the concepts of dynamics and demonstrate a proficiency in the fundamental concepts in this area of science.

O3. Students will be able to formulate and solve problems using their knowledge and skills in mechanics and posses the ability to analyse the obtained results.

PRELIMINARY REQUIREMENTS FOR KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. Knowledge of mathematics.
2. Knowledge of statics and kinematics of a particle and a rigid body {Mechanics I).
3. Ability to use various sources of information.
4. Ability to work independently and in a team.
5. Ability to present and interpret the obtained results.

LEARNING OUTCOMES

LO 1 – Ability to understand methods of analysing the motion of a particle (kinematic relationships, Newton's laws, conservation of energy, momentum, and angular momentum).

LO 2 - Ability to find and combine moments of inertia and construct inertia tensors as well as to find the principal moments and principal directions at any point in a rigid body or system of particles.

LO 3 – Ability to determine the kinematic relationships between position, velocity, and acceleration for two-dimensional motion of systems of particles and rigid bodies; to apply Newton's equation in two dimensions to calculate the motion due to applied forces or to calculate the forces resulting from a specified motion; to analyse two and three dimensional motion of particles and rigid bodies using conservation laws for energy, momentum, and angular momentum; to apply analytical dynamics concepts to solve the problems of motion of system of particles under applied loads.

LO 4 – Ability to model and analyse vibration of one-degree-of-freedom system.

MODULE CONTENT

Type of classes – LECTURE	**Number of hours**
Lec 1-2 Kinetics of a Particle. Newton's Law of Motion. Equations of Motion: Rectangular Coordinates. Equations of Motion: Normal and Tangential Coordinates. Work of a Force. Principle of Work and Energy. Conservative Forces and Potential Energy.	**4**
Lec 3 Systems of Particles. Application of Newton's Law to the Motion of Particles. Effective Forces. Linear and Angular Momentum of a System of Particles. Motion of the Mass Center of a System of Particles. Angular Momentum of a System of Particles about the Mass Center. Conservation of Momentum for a System of Particles. Kinetic Energy of a System of Particles. Work-Energy Principle. Conservation of Energy for a System of Particles. Principle of Impulse and Momentum for a System of Particles. System Gaining or Loosing Mass.	**2**
Lec 4-5 Moments of Inertia of Masses. Determination of the Moment of Inertia of a Three-Dimensional Body by Integration. Moments of Inertia of Composite Bodies. Moment of Inertia of a Body with Respect to an Arbitrary Axis through the Origin. Ellipsoid of Inertia. Principal Axes of Inertia.	**4**
Lec 6-7 Planar Kinetics of Rigid Bodies: Force-Mass-Acceleration Method. Angular Momentum of a Rigid Body. Equations of Plane Motion. Force-Mass-Acceleration Method: Plane Motion. Differential Equations of Motion.	**4**
Lec 8-9 Planar Kinetics of Rigid Bodies: Work-Energy and Impulse-Momentum Methods. Part A: Work-Energy Method. Work and Power of a Couple. Kinetic Energy of a Rigid Body. Work-Energy Principle and Conservation of Mechanical Energy. Part B: ImpulseMomentum Method. Impulse-Momentum Principles. Rigid-Body Impact	**4**

Lec 10-11 Rigid-Body Dynamics in Three Dimensions. Kinematics. Impulse-Momentum Method. Euler's Equations of Motion. Work-Energy Method. Force-Mass-Acceleration Method. Rotation of a Rigid Body about a Fixed Axis. Dynamic Reactions.	**4**
Lec 12-13 Elements of Analytical Mechanics. Constraints. Virtual Work. Generalised Coordinates. Lagrange's Equations of Motion.	**4**
Lec 14-15 Vibrations. Undamped Free Vibrations of Particles. Undamped Forced Vibrations of Particles. Damped Free Vibrations of Particles	**4**
Sum	**30**
Type of classes– TUTORIALS	**Number of hours**
T 1 – 2 Newton's laws of motion. D'Alembert principle.	**4**
T 3 – 4 Integration of the equations of motion of a particle.	**4**
T 5 Conservation of linear and angular momentum.	**2**
T 6 Work of a force. Power.	**2**
T 7 Principle of work and energy. Conservation of energy.	**2**
T 8 – 9 Mass moment of inertia. Steiner's theorem.	**4**
T 10 Dynamics of a rigid body in a planar motion.	**2**
T 11 – Rigid-body dynamics in three dimensions	**2**
T 12 – 13 Virtual work. Lagrange's equations.	**4**
T 14 –15 Vibration of a single degree-of-freedom system.	**4**
Sum	**30**

TEACHING TOOLS

1. – Lectures - presentation with the use of a projector
2. – Tutorials and problems to solve by students
3. – Self learning and solving additional problems from text books

WAYS OF ASSESSMENT (F – FORMATIVE, S – SUMMATIVE)

F1. - assessment of preparation for laboratory exercises tutorials
F2. - assessment of the ability to apply the acquired knowledge while solving the dynamic problems
F3. - assessment of activity during tutorials
S1. - assessment of the ability to solve the problems posed and the manner of the obtained results presentation

S2. - assessment of mastery of the teaching material being the subject of the dynamics lecture - exam

*) in order to receive a credit for the module, the student is obliged to attain a passing grade in all laboratory classes as well as in achievement tests.

STUDENT'S WORKLOAD

L.p.	Forms of activity	Average number of hours required for realization of activity
1. Contact hours with teacher		
1.1	Lectures	30
1.2	Tutorials	30
1.3	Laboratory	0
1.4	Seminar	0
1.5	Project	0
1.6	Consulting teacher during their duty hours	5
1.7	Examination	5
	Total number of contact hours with teacher:	70
2. Student's individual work		
2.1	Preparation for tutorials and tests	40
2.2	Preparation for laboratory exercises, writing reports on laboratories	-
2.3	Preparation of project	-
2.4	Preparation for final lecture assessment	-
2.5	Preparation for examination	30
2.6	Individual study of literature	10
	Total number of hours of student's individual work:	80
	Overall student's workload:	150
Overall number of ECTS credits for the module		6 ECTS
Number of ECTS points that student receives in classes requiring teacher's supervision:		6 ECTS
Number of **ECTS** credits acquired during practical classes including laboratory exercises and projects:		0 ECTS

BASIC AND SUPPLEMENTARY RESOURCE MATERIALS

1. Set of lecture notes and problems for individual solution (based on literature presented below). Handouts for tutorial classes.
2. Ferdinand Beer, Jr., E. Russell Johnston, David Mazurek, Phillip Cornwell, Brian Self: “Vector Mechanics for Engineers”, McGraw-Hill Education, 12th Edition, New York, 2018
3. S.P.Nitsure: “Engineering Mechanics”, Technical Publications, Pune, 2006
4. Russell C. Hibbeler: “Engineering Mechanics: Combined Statics & Dynamics”, Mastering Engineering Series, Prentice Hall, 2009
5. Louis Brand: “Vectorial Mechanics”, Wharton Press, 2007
6. J.L. Meriam, L.G. Kraige: “Engineering Mechanics” ,Vol 1 - Statics, Vol 2 - Dynamics, John Wiley&Sons, New York, 2016
7. R. Resnick, D. Halliday, K.S. Krane: “Physics”, Vol 1, John Wiley&Sons, New York, Fourth Edition, 1992
8. Fasano A., Marmi S.: Notes on Analytical Mechanics. Oxford University Press, 2006
9. Chaichian M., Merches I., Tureanu A.: Mechanics: An Intensive Course. Springer-Verlag, Berlin Heidelberg, 2012
10. Fowles G. R., Cassiday G. L.: Analytical Mechanics. Cengage Learning, 7 edition, 2004
11. Meirovitch L.: Analytical Methods in Vibrations, Macmillan Company New York, 1967, reprinted by Pearson Education POD 1997
12. 9. Massachusetts Institute of Technology, Professor Walter Lewin’s lectures http://videolectures.net/mit801f99_lewin_intro/

MODULE COORDINATOR (NAME, SURNAME, E-MAIL ADDRESS)

Prof. dr **hab. Inż.** Jacek Przybylski, jacek.przybylski@pcz.pl