BACHELOR 'S PROGRAMME
1st YEAR OF STUDY, 1st SEMESTER

COURSE TITLE	CLASSICAL MECHANICS
COURSE CODE	
COURSE TYPE	full attendance
COURSE LEVEL	1st cycle (bachelor's degree)
YEAR OF STUDY, SEMESTER	1st year of study, 1st semester
NUMBER OF ECTS CREDITS	6
NUMBER OF HOURS PER WEEK	7 (3 lecture hours + 4 seminar hours)
NAME OF LECTURE HOLDER	Assoc. prof. Sebastian POPESCU, PhD
NAME OF SEMINAR HOLDER	Assoc. prof. Sebastian POPESCU, PhD
PREREQUISITES	Advanced level of English

A GENERAL AND COURSE-SPECIFIC COMPETENCES

General competences:

→ Identification of roles and responsibilities in a team and application of networking techniques and effective work within a team.

→ Efficient valorization of resources and learning and communication techniques for one's own development.

Course-specific competences:

→ Identification and proper use of the main laws and physical principles in a given context.

→ Solving of Physics problems in given conditions, using numerical and statistical methods

→ Application of Physics knowledge in given situations in related fields, as well as in experiments, using standard laboratory equipment.

→ Communication and analysis of didactic, scientific and popularization of Physics-related information.

B LEARNING OUTCOMES

At the end of this class, the students will be able to:

→ Describe mechanical systems, using specific theories and tools (experimental and theoretical models, algorithms, schemes, etc.)

→ Derivation of working formulas for calculations with physical quantities using appropriate principles and laws of Mechanics.

→ Comparative assessment of the theoretical results offered by literature and of an experiment conducted in the framework of a professional project.

→ Application of the principles and laws of Mechanics in solving theoretical or practical problems, under qualified assistance conditions.

→ Elaboration of graphs and reports for explaining and interpreting physical results obtained by statistical methods.

→ Critical assessment of the results obtained by employing a physical model, including the degree of uncertainty of the obtained experimental results.

C LECTURE CONTENT

Material point model

1. Time and space in Newtonian mechanics, reference framework, movement, rest, trajectory, point body, position and displacement vectors, speed and velocity, acceleration, gravitational acceleration. Cartesian, polar and natural coordinates. Circular motion: angular velocity and acceleration. Centripetal acceleration.
2. Principles of Newtonian dynamics. Mass of a body, momentum, angular momentum, force, torque, Momentum and angular momentum theorems, conservation laws for momentum and angular momentum for a material point.
3. Work, power and efficiency. Potential energy, conservative forces, conservative field. Del operator, gradient vector. Kinetic energy. Kinetic energy theorem, energy conservation law.
4. Relative motion. Galilei transformations, Galileian relativity principle. Duration dilation and length contraction, Lorentz transformations. Relativistic momentum end energy. Inertial forces.
5. Central fields of forces: general properties, velocity and acceleration in plane polar coordinates, Binet equation, effective potential energy.

Material points system model

6. System of material points: mass and center of mass, external and internal forces, the two bodies problem, Koenig theorems, Variation theorems and conservation laws for a system of material points, internal energy and binding energy.
7. Gravitational interaction between bodies: Kepler laws, Newton law, gravitational field, Gauss law, weight and center of gravity, effective weight and imponderability, equivalence principle.

	8. Collisions: general properties and classifications, plastic collision, elastic collision, nonelastic collisions, coefficient of restitution, reaction energy. 9. Movement of variable mass bodies. **Rigid body model** 10. Kinematics of rigid bodies: general properties, plane-parallel movement. 11. Dynamics of rigid bodies: translation and rotation motions. Moment of inertia with respect to an axis, theorems of parallel and perpendicular axes, rigid rotation around a fixed axis, rolling friction, plane-parallel movement, linear rotator, free axis of rotation, centrifugal moments, precession of a gyroscope in gravitational field. **Fluid model** 12. General properties of a fluid: density, pressure, Archimedes force, the gradient theorem, fluid movement description (Lagrange, Euler). 13. Ideal incompressible fluid dynamics: ideal fluid, flowrate and current density, divergence theorem, physical meaning of divergence, continuity equation, Euler equation, curl theorem, physical meaning of curl, types of flows (rotational and potential), Bernoulli equation, applications, Coanda effect, Magnus effect. 14. Real fluids dynamics: Viscosity, Newton law, Poiseuille – Hagen equation, resistance forces in real fluids (Stokes and Newton), turbulent flow, Reynolds number, Lift force
D	RECOMMENDED READING FOR LECTURES
	1. A. Arya, Introduction to Classical Mechanics, 2nd ed., Pearson, 1997. 2. M. Alonso, E. J. Finn, Fundamental University Physics, vol. I, Mechanics, Addison-Wesley, 1967. 3. S. Popescu, Lectures in Classical Mechanics – lecture notes **Supplementary reading:** 4. H. D. Young, R. A. Freedman, A. L. Ford, Sears and Zemansky's University Physics, with modern Physics, 14th ed., Pearson, 2016.
E	SEMINAR CONTENT
	Material point model System of material points model Rigid body model Fluid Model Measuring physical quantities (length, mass, time) and use of measurement instruments. Error calculations. Determination of the elastic constant of a spring by a dynamic method. Study of movement under the action of a constant force. Atwood machine. Study of movement under the action of a constant force. The inclined plane. Determination of sliding coefficient of friction using a dynamic method. Determination of gravitational acceleration using Mach's pendulum. Study of inertial forces. Coriolis force. Study of collision processes. Determination of rolling friction coefficient. Study of precession motion of a gyroscope. Determination of dynamic viscosity coefficient using Stokes method. Study of fluid flow. Reynolds number.
F	RECOMMENDED READING FOR SEMINARS
	1. A. Arya, Introduction to Classical Mechanics, 2nd ed., Pearson, 1997. 2. M. Alonso, E. J. Finn, Fundamental University Physics, vol. I, Mechanics, Addison-Wesley, 1967. 3. S. Popescu, Lectures in Classical Mechanics – lecture notes 4. H. D. Young, R. A. Freedman, A. L. Ford, Sears and Zemansky's University Physics, with modern Physics, 14th ed., Pearson, 2016. 5. D. Luca, C. Stan, Practical works in Mechanics – Alexandru Ioan Cuza University of Iași Press, 1996.
G	EDUCATION STYLE
LEARNING AND TEACHING METHODS	Lecture, didactic explanation, heuristic conversation, video projection, problem solving method, case studies
ASSESSMENT METHODS	• Tests, written and oral examination • Weekly evaluation of homeworks and laboratory activity
LANGUAGE OF INSTRUCTION	English