Bachelor in Physics (Academic Year 2022-23)

Classical Mechanics		Code	800498	Year	2nd	**Sem.**	1st
Module	General Core	**Topic**	Classical Physics		**Character**		Obligatory

	Total	Theory	Exercises
ECTS Credits	7.5	4.5	3
Semester hours	69	39	30

Learning Objectives (according to the Degree's Verification Document)

- Write the Lagrangian and Hamiltonian of a dynamical system in different types of generalized coordinates, and derive from them the corresponding equations of motion.
- Learn how to apply conservation laws to analyzing the motion of a mechanical system.
- Study the motion of a particle in a central potential.
- Learn the elementary kinematics and dynamics of rigid bodies.
- Study in greater depth the fundamentals of special relativity.

Brief description of contents
Review of Newtonian mechanics. Motion in a central force field. Introduction to analytical mechanics. Non-inertial reference frames. Rigid body motion. Complements on special relativity.

Prerequisites
Calculus, linear algebra, vector algebra and calculus, general physics.

Coordinator	Artemio González López			**Dept.**	FT
	Room	02.0307.0	**e-mail**	artemio@ucm.es	

Theory/Exercises – Schedule and Teaching Staff							
Group	Lecture Room	Day	Time	Professor	Period/ Dates	Hours	T/E	Dept.
B	10	Mo, We, Th	10:30-12:00 09:00-11:00 09:00-10:30	Artemio González López	Full term	69	T/E	FT

T: Theory, E: Exercises

Office hours				
Group	Professor	Schedule	E-mail	Location
B	Artemio González López	Tu, Fr: 11:00-13:00 + 2h online	artemio@ucm.es	02.0307.0

Syllabus

1. Review of Newtonian mechanics
Kinematics of a point particle. Inertial systems and Galilean relativity. Motion in a one-dimensional potential. Dynamics of a system of particles. Constants of motion.

2. Motion in a central potential
Reduction of the equivalent two-body problem. Constants of motion. Integration of the equations of motion. Bounded orbits. The Kepler problem. Scattering by a central potential. Rutherford's formula.

3. Fundamentals of Lagrangian and Hamiltonian mechanics
Introduction to the calculus of variations. Hamilton's principle for unconstrained systems. Constraints and generalized coordinates. Lagrange's equations. Constants of motion and Nöther's theorem. Small oscillations. Hamilton's canonical equations. Poisson brackets.

4. Motion relative to a non-inertial frame
Three-dimensional rotations. Relative angular velocity of two orthonormal frames. Equations of motion in a non-inertial frame. Motion relative to the rotating Earth. Foucault's pendulum.

5. Rigid body motion
Angular momentum and kinetic energy of a rigid body. Inertia tensor. The equations of motion of a rigid body. Euler's equations. Inertial motion of a symmetric top. Lagrange's top.

6. Introduction to relativistic mechanics

Bibliography

Basic:

- S.T. Thornton and J.B. Marion, *Classical Dynamics of Particles and Systems,* 5th edition, Brooks/Cole, 2004.

- J.R. Taylor, *Classical Mechanics,* University Science Books*,* 2005.

- E.F. Taylor and J.A. Wheeler, *Spacetime Physics,* Freeman, 1992.

- A.P. French, *Special Relativity* (M.I.T. Introductory Physics), 1st edition, W. W. Norton & Company, 1968.

- A. González López, Lecture Notes on Classical Mechanics, 2020 (http://jacobi.fis.ucm.es/artemio/Notas%20de%20curso/CM.pdf).

Complementary:

- F. Gantmacher, *Lectures in Analytical Mechanics,* MIR Publications, 1975.

- H. Goldstein, C. Poole, J. Safko, *Classical Mechanics,* 3rd edition*,* Addison Wesley, 2002.

- L.D. Landau, E.M. Lifshitz, *Mechanics* (Course of Theoretical Physics, vol. 1), 3rd edition, Butterworth-Heinemann, 1976.

- L. Meirovitch, *Methods of Analytical Dynamics,* Dover, 2010.

- F.A. Scheck, *Mechanics: From Newton's Laws to Deterministic Chaos,* 4th edition, Springer, 2005.

- W. Rindler, *Introduction to Special Relativity,* Oxford, 1991.

Online Resources

Material and announcements related to the course will be posted in UCM's "Campus Virtual".

Methodology
Lectures will consist of theoretical explanations (including examples) and problem solving sessions. The corresponding problems will be made available to the students in advance through UCM's "Campus Virtual" at the beginning of each topic.
The instructor will answer both theoretical and problem-related questions from the students during his office hours.

Evaluation Criteria		
Exams	**Weight:**	70%
The final exam will consist of a number of practical problems similar in difficulty to those solved during the lectures.		
Other Activities	**Weight:**	30%
Two or three times during the course, exercises similar to those discussed in problem-solving sessions will be proposed to the class to be individually solved in writing by the students during lecture hours.		
Final Mark		
The final grade will be computed according to the formula $$G = \max(E,\ 0.7\,E + 0.3\,A),$$ where E and A are respectively the "Exams" and "Other activities" grades (both in the range 0-10). The grade obtained in the "Other activities" category in the first semester term will be carried over to the second semester evaluation (when applicable).		