UNIVERSITÀ DEGLI STUDI DELLA BASILICATA

DIPARTIMENTO DI MATEMATICA, INFORMATICA ED ECONOMIA

COURSE: CLASSICAL MECHANICS For mathematicians and theoretical physicists			
ACADEMIC YEAR: 2018/2019			
TYPE OF EDUCATIONAL ACTIVITY: Characterizing			
TEACHER: Ermenegildo Caccese			
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phone: +39 0971 205884		mobile (optional):	
Language: Italian			
ECTS: 12	n. of hours: 96	Campus: Potenza Dept. DIMIE CdS Mathematics	Annual Course

EDUCATIONAL GOALS AND EXPECTED LEARNING OUTCOMES

(1) A knowledge of the basic topics in Classical Mechanics.

(2) The ability in solving problems concerning the dynamics of particles, systems of particles, and rigid bodies, from a mathematical point of view.

PRE-REQUIREMENTS

(1) Elementary Calculus.

(2) Elementary Linear Algebra.

(3) Elementary General Topology.

(4) Some basic knowledge of physics.

SYLLABUS

AN INTRODUCTION TO CLASSICAL MECHANICS
For mathematicians and theoretical physicists

Introduction
1 – Time and Space in Classical Mechanics
1.1 – Time, space, reference frames
1.2 – Kinematical description of a particle
1.3 – Kinematical description of an extended system
1.4 – Kinematical description of a rigid body
1.5 – Relative kinematics and the Galilei-Newton transformations
1.6* – Some further topics
2 – The Principles of Newtonian Dynamics
2.1 – First and the second law in a modern form
2.2 – The third law and the classification of forces
2.3 – The second law as a dynamical system
2.4 – The principle of relativity of Galilei
2.5 – Collective dynamical variables of an extended system
2.6 – The dynamics of an extended system
2.6 – The dynamics of a rigid body
2.7* – Some further topics
3 – Introduction to Lagrangian Dynamics
3.1 – The dynamical description of constrains
3.2 – D'Alembert's Principle and the equations of Lagrange
3.3 – Symmetries and constants of motion in the Lagrangian formalism
3.4* – Some further topics
4 – Investigation of the motion
4.1 – Dynamics in one or two degrees of freedom
4.2 – Dynamics of a free particle
4.3 – An introduction to celestial mechanics
4.4 – Particle collisions
4.5 – Dynamics of a rigid body
4.6 – Dynamics of an extended system

4.7 – Linear and nonlinear oscillations
5 – Introduction to Hamiltonian Dynamics
5.1 – The Legendre transformation and the equations of Hamilton
5.2 – An introduction to the Hamiltonian formalism
5.3 – Applications of the Hamiltonian formalism
5.4 – Symmetries and constants of motion in the Hamiltonian formalism
5.5* – Introduction to the theory of completely integrable Hamiltonian systems
5.6* – Some further topics
6 – Complementary Topics*
6.1 – Introduction to the theory of dynamical systems
6.2 – Variational principles in mechanics
6.3 – The Hamilton-Jacobi equation
6.4 – Introduction to the theory of perturbation
6.5 – Introduction to statistical mechanics
6.6 – Introduction to continuum mechanics
6.7 – Introduction to Newton's theory of gravitation
6.8 – Introduction to the theory of relativity

Appendix – Mathematical Tools
A.1 – Linear algebra. Classical groups. Affine Geometry
A.1.1 – The action of a group on a space
A.1.2 – The geometry of a vector space
A.1.3 – Tensors associated to a vector space
A.1.4 – The geometry of an Euclidean vector space
A.1.5 – The geometry of the group of Euclidean rotations
A.1.6 – The geometry of affine and Euclidean affine spaces
A.2 – Differential equations
A.2.1 – Differential equations: the main results
A.2.2 – Linear differential equations of order I and II
A.2.3 – More on spectral theory of matrices
A.2.4 – Linear systems of differential equations
A.2.5* – Partial linear differential equations
A.3 – Calculus
A.3.1 – Vector fields and tensor fields
A.3.2 – Curves and surfaces in an affine Euclidean space
A.3.3 – Calculus on the group of Euclidean rotations
A.4 – Introduction to Differentiable Manifolds*
A.4.1 – Local Euclidean spaces and differentiable manifolds
A.4.2 – Vector bundles associated with a manifold
A.4.3 – Absolute differential calculus
A.4.4 – Exterior differential calculus
A.4.5 – Introduction to Riemannian geometry

[Arguments marked with an asterisk are optional]

TEACHING METHODS

(1) Lectures and exercise sessions.
(2) Periodic collective discussions.

EVALUATION METHODS

(1) Two written examinations.
(2) A final oral examination.

TEXTBOOKS AND ON-LINE EDUCATIONAL MATERIAL

For the course
(1) Lecture notes
(2) M. Fabrizio. *Elementi di meccanica classica*. Zanichelli. 2002
Classical treatises
(1) T. Levi-Civita, U. Amaldi. *Lezioni di meccanica razionale. 3 volumi*. Zanichelli. 1974 (reprint of the 1949 edition)
(2) E. Whittaker. *A Treatise on the Analytical Dynamics of Particles and Rigid Bodies*. Cambridge University Press. 1937.

Modern treatises

(1) A. Fasano, S. Marmi. *Meccanica analitica*. Bollati Boringhieri. 2002

(2) H. Goldstein, C. Poole, J. Safko. *Meccanica classica*. Zanichelli 2005 (edizione riveduta)

(4) V. I. Arnol'd. *Mathematical Methods of Classical Mechanics*. Springer-Verlag. 1978.

Mathematical Tools

(1) Lecture notes

(2) M. P. Do Carmo. *Differential Geometry of Curves and Surfaces*. Prentice-Hall. 1976

(3) D. A. Sánchez. *Ordinary Differential Equations and Stability Theory – An Introduction*. Dover. 1979.

(4) M. W. Hirsch, S. Smale, R. L. Devaney. *Differential Equations, Dynamical Systems and An Introduction to Chaos*. Academic Press. 2004 (new edition).

(5) W. M. Boothby. *An Introduction to Differentiable Manifolds and Riemannian Geometry*. Academic Press. 1986.

INTERACTION WITH STUDENTS

(1) Direct meetings.

(2) Short communications by e-mail or telephone.

Office hours: Wednesday, 10.30-12.30 a. m.; Thursday, 3.00-5.00 p. m.

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EXAMINATION SESSIONS (FORECAST)[1]

14.02.2019; 14.03.2019; 11.04.2019; 9.05.2019; 13.06.2019; 18.07.2019; 12.09.2019; 10.10.2019; 14.11.2019; 12.12.2019.

SEMINARS BY EXTERNAL EXPERTS NO

FURTHER INFORMATION

[1] Subject to possible changes: check the web site of the Teacher or the Department/School for updates.