UNIVERSITÀ DEGLI STUDI DELLA BASILICATA

DIPARTIMENTO DI MATEMATICA, INFORMATICA ED ECONOMIA

COURSE: CLASSICAL MECHANICS For mathematicians and theoretical physicists			
ACADEMIC YEAR: 2017/2018			
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

A knowledge of the basic topics in Classical Mechanics. The ability of solve problems of dynamics of bodies, from a mathematical point of view.

PRE-REQUIREMENTS

Elementary Calculus. Elementary Linear Algebra. Elementary General Topology

SYLLABUS

An introduction to CLASSICAL MECHANICS For mathematicians and theoretical physicists

Introduction

1 – *Time and Space in Classical Mechanics*

1.1 Time, space and reference frames. 1.2. Particles' kinematics. 1.3. Extended systems' kinematics. 1.4. Rigid bodies' kinematics. 1.5. The Galilei transformations. 1.6*. Further topics

2 – *General principles of Newtonian Dynamics*

2.1. The three laws of Newton in a modern form. 2.2. Galilei's Principle of Relativity. 2.3. Classifications of Newtonian forces. 2.4. Fundamental dynamical variables of an extended system. 2.5. The dynamics of an extended system. 2.6. The Euler's equations for a rigid body. 2.7*. Further topics

3 – *Investigation of the motion of particles and systems*

3.1. The equation of motion of a particle as a dynamical system. 3.2. Symmetries and constants of motion in the dynamics of a particle. 3.3. Examples of integration of the equation of motion. 3.4. The equations of motion of an extended system as a dynamical system. 3.5. Symmetries and constants of motion in the dynamics of an extended system. 3.6. Examples of integration of the Euler's equations. 3.7*. Further topics

4 – *Introduction to Lagrangian dynamics*

4.1. The equation of motion of a constrained system. 4.2. A geometrical approach to mechanics. 4.3. A more formal introduction to the Lagrangian formalism. 4.4. Examples and applications of the Lagrangian formalism. 4.5*. Symmetries and constants of motion in the Lagrangian formalism. 4.6*. Further topics

5 – *Introduction to Hamiltonian dynamics*

5.1. Legendre transformation and the Hamilton equations. 5.2. A more formal introduction to the Hamiltonian formalism. 5.3. Examples and applications of the Hamiltonian formalism. 5.4*. Symmetries and constants of motion in the Hamiltonian formalism. 5.5*. An introduction to the theory of completely

integrable Hamiltonian systems

6* – *Complementary topics*

6.1. Introduction to the variational principles of mechanics. 6.2. On the Hamilton-Jacobi equation. 6.3. Introduction to perturbation theory. 6.4. Introduction to statistical mechanics. 6.5. Introduction to continuum mechanics. 6.6. Introduction to Newton's theory of gravitation. 6.7. Introduction to the special theory of relativity

Appendix 1 – *Linear algebra, classical groups and affine geometry*

A.1.1. Action of a group on a space. A.1.2. Vector geometry and the general linear group. A.1.3. Affine geometry and the affine group. A.1.4. Euclidean geometry and the orthogonal group.

Appendix 2 – *Introduction to tensor calculus*

A.2.1. Tensors associated to a vector space. A.2.2. Vector and tensor fields on an affine space. A.2.3. The theory of curves and surfaces in an Euclidean space. A.2.4. Calculus on the group of Euclidean rotations

Appendix 3 – *Differential equations and dynamical systems*

A.3.1. Ordinary differential equations. A.3.2*. Partial differential equations. A.3.3. Dynamical systems

Appendix 4* – *Introduction to differential geometry*

A.4.1 Locally Euclidean spaces and differentiable manifolds. A.4.2. Examples of manifolds and vector bundles. A.4.3. Riemannian manifolds. A.4.4. Vector and tensor fields on a manifold. A.4.5. Curves and submanifolds. A.4.6. Exterior calculus on a manifold. A.4.7. Absolute differential calculus on a Riemannian manifold

[Arguments marked with an asterisk are optional]

TEACHING METHODS

Lectures and exercise sessions. Periodic collective discussions.

EVALUATION METHODS

Written examination with a subsequent oral examination.

TEXTBOOKS AND ON-LINE EDUCATIONAL MATERIAL

1. Lecture notes. 2. M. Fabrizio. *Elementi di meccanica classica*. Zanichelli. 2002.

Classical Textbooks

3. T. Levi-Civita, U. Amaldi. *Lezioni di meccanica razionale*. *3 Volumi*. Zanichelli. 1974 (reprint of the 1949 edition). 4. E. Whittaker. *A Treatise on the Analytical Dynamics of Particles and Rigid Bodies*. Cambridge University Press. 1937.

Modern treatises

5. A. Fasano, G. Marmi. *Meccanica analitica*. Bollati-Boringhieri. 2002. 6. H. Goldstein, C. Poole, J. Safko. *Meccanica classica*. Zanichelli. 2005 (new edition). 7. V. I. Arnol'd. *Mathematical Methods of Classical Mechanics*. Springer-Verlag.

Mathematical Methods

8. lecture Notes. 9. M. P. Do Carmo. *Differential Geometry of Curves and Surfaces*. Prentice-Hall. 1976. 10. D. A. Sánchez. *Ordinary Differential Equations and Stability Theory – An Introduction*. Dover. 1979. 11. M. W. Hirsch, S. Smale, R. L. Devaney. *Differential Equations, Dynamical Systems and An Introduction to Chaos*. Academic Press. 2004 (new edition). 12. W. M. Boothby. *An Introduction to Differentiable Manifolds and Riemannian Geometry*. Academic Press. 1986. 13. F. W. Warner. *Foundations of Differentiable Manifolds and Lie Groups*. Springer-Verlag. 1983. 14. R. Abraham, J. E. Marsden, T. Ratiu. *Manifolds, Tensor Analysis, and Applications*. Springer-Verlag. 1988.

INTERACTION WITH STUDENTS

Direct meetings. Short communications by e-mail or telephone.

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

EXAMINATION SESSIONS (FORECAST)[1]

07/02/2018; 07/03/2018; 04/04/2018; 09/05/2018; 06/06/2018; 11/07/2018; 12/09/2018; 10.10.2018; 14.11.2018; 12.12.2018

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.