UNIVERSITÀ DEGLI STUDI DI BARI ALDO MORO

CONSIGLIO INTERCLASSE IN MATEMATICA

General information	**Academic year 2022-2023**
Academic subject	**Mathematical Physics 1**
Degree programme	Mathematics
Programme year	Second
Term	Second semester (February 27, 2023 – May 26, 2023)
European Credit Transfer and Accumulation System credits (ECTS)	8
Language	Italian
Attendance	Not compulsory

Lecturer	
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Department and office	Department of Mathematics, room 29 second floor
Virtual meeting room	Microsoft Teams code: K5u648f
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Office hours	Monday, Wednesday, and Friday from 10 to12. (by e-mail appointment) Online with Microsoft Teams, code: awa1at0

Syllabus	
Learning objectives	Mathematical formulation, understanding and resolution of physical problems concerning the equilibrium of olonomic systems
Course prerequisites	Mathematical knowledge which usually is acquired during the first year of a degree of L–35 class, especially classical mathematical analysis of one and several variables, linear algebra.
Course contents	**Elements of vector and matrix algebra**: Vectors. Linear operators and their representations. Tensor product. Symmetric and antisymmetric operators. Unit operators, orthogonal and rotation operators. Projection operators. Eigenvalue problems. Positive definite operators. **Differential properties of the curves**: the Frenet frame. **Applied vectors**: Moment vectors with respect to a point or axis. Vector systems. Variation of the moment vector. Couple of applied vectors. Central axis of a vector system. Reduction of systems of applied vectors at a given point. Moments Transport Theorem. Systems whose parallel moment is null. Systems of parallel applied vectors. **Kinematics of a rigid body**: The mathematical model of a rigid body. Body-fixed frames of reference. Angular velocity and Poisson formulas. The velocity field in a rigid body. Rigid motions and their classification. Euler angles. Lagrangian and Eulerian approach. Eulerian velocity. Mozzi theorem. **Relative kinematics**: Rate of change of a vector in a rotating frame. Velocity and acceleration addition theorems. Rolling of two surfaces. **Planar rigid motions**: Center instantaneous of rotation. Analytical detection of the center. **Kinematics of holonomic systems**: Constraints. Lagrangian coordinates and configuration space. Virtual and possible displacements. Reversible and irreversible displacements. **Mass point geometry**: The concepts of mass and density. Center of mass and its location. Inertia tensor. Huygens-Steiner theorem. Ellipsoid of inertia. Moment of inertia. The planar case. **Mass point kynematics**: Linear and angular moments. Kinetic energy. Center of mass frame of reference. Konig theorems. Application to a rigid body and

	to a holonomic system. **Work and potential**: The concept of force. The work of a force. Conservative force. Work of a system of forces. Systems of conservative forces. Application to a rigid body and to a holonomic system. **Classical mechanics principles**: Friction. Constraints without friction. Principle of the constraint reactions. Pure rolling constraint. **Statics of a point**: Static equilibrium and rest. Point constrained on a surface without friction. Point constrained on a curve without friction. **Principle of virtual works**: A necessary and sufficient equilibrium condition. Application to a rigid free body, to a rigid body with a fixed point, with a fixed axis or with a sliding axis on a fixed line, to a holonomic system. **Statics equations**: A necessary condition for the equilibrium. The case of a rigid body: the statics equations are necessary and sufficient for equilibrium. Applications of the statics equations to a rigid free body, to a rigid body with a fixed point, to a rigid body with a fixed axis, or with an axis sliding on a fixed line, to a holonomic system. **Dynamics of a material point**: First integral, general and particular integrals. Kinetic energy theorem. The first integrals of the kinetic energy, of total mechanical energy. **Relative dynamics**: Kinetic energy theorem. The two-body problem. **Equations of the motion**: Dynamics of a system. General and particolar integrals. Kinetic energy theorem. The first energy integral. Equation of mass center motion. **Lagrange equations**: D'Alembert principle. Lagrange equations. Lagrange equations for potential forces. Generalized potentials. General and particular integrals of the motion of a holonomic system. First integrals. Cyclic coordinates.
Reference books	Alberto Strumia: Meccanica Razionale I, II. Edizioni Nautilus Bologna. Mauro Fabrizio: Introduzione alla Meccanica Razionale e ai suoi metodi matematici. Zanichelli, 1997. Mauro Fabrizio: Elementi di Meccanica Classica, Zanichelli, Bologna.
Additional course materials	Didactic material provided by the teacher

Work schedule				
	Total	Lectures	Hands-on learning (recitations)	Self-study
Hours	170	40	30	100
ECTS credits	8	5	3	

Teaching methods	
	Lectures and supplementary distance learning

Expected learning outcomes	
Knowledge and understanding	Acquiring fundamental concepts of the classical mechanics, understanding physical, mathematical and geometrical aspects of a given problem
Applying knowledge and understanding	Ability to use theoretical knowledge in various statics problems
Making judgements	Ability to identify mathematical tools and techniques to study physical problems written as mathematical models.
Communication skills	Students should acquire the mathematical language and formalism necessary to read and comprehend textbooks, to explain the acquired knowledge.

Learning skills	Acquiring suitable learning methods, supported by text consultation and by solving the questions periodically suggested during the course.

Assessment and feedback	
Assessment methods	Oral exam
Evaluation criteria	*Knowledge and understanding*: Oral exam including an application exercise *Applying knowledge and understanding*: Oral exam including an application exercise *Making judgements*: Oral exam including an application exercise *Communication skills*: Oral exam including an application exercise *Learning skills*: Oral exam including an application exercise
Grading policy	The final grade is awarded out of thirty, the exam is passed when the grade is greater than or equal to 18. The final evaluation is formulated considering the knowledge acquired by the student, the ability to understand and use it for the purpose of formulating and solving a physical problem.

Additional information	