UNIVERSITÀ DEGLI STUDI DI PALERMO

DEPARTMENT	Ingegneria
ACADEMIC YEAR	2021/2022
BACHELOR'S DEGREE (BSC)	CYBERNETIC ENGINEERING
SUBJECT	RATIONAL MECHANICS
TYPE OF EDUCATIONAL ACTIVITY	A
AMBIT	50283-Matematica, informatica e statistica
CODE	04954
SCIENTIFIC SECTOR(S)	MAT/07
HEAD PROFESSOR(S)	GARGANO FRANCESCO Professore Associato Univ. di PALERMO
OTHER PROFESSOR(S)	
CREDITS	6
INDIVIDUAL STUDY (Hrs)	96
COURSE ACTIVITY (Hrs)	54
PROPAEDEUTICAL SUBJECTS	
MUTUALIZATION	
YEAR	2
TERM (SEMESTER)	1° semester
ATTENDANCE	Not mandatory
EVALUATION	Out of 30
TEACHER OFFICE HOURS	**GARGANO FRANCESCO** Tuesday 10:00 11:00 Ex dipartimento di Metodi e modelli Matematici, primo piano

DOCENTE: Prof. FRANCESCO GARGANO

PREREQUISITES	Basic knowledge of the main concepts of differential and integral calculus for functions of one and more real variables. Geometry of Euclidean spaces and linear algebra, linear algebra of matrices and vector analysis
LEARNING OUTCOMES	Knowledge and understanding The student will have gained, at the end of the course knowledge of the basic laws of a mechanical system. The student will be able to determine the condition ensuring the equilibrium of a system. The student will know how to use the laws of physics and the mathematical equations that describe them, to solve simple problems of mechanics. Applying knowledge and understanding The student will be able to use the laws of physics and the mathematical tools for solving complex mechanical problems; the student will know the validity and the limits of the laws of the models used, and which model to apply in certain contexts. The student will gain the ability to solve problems correctly. The ability acquired is verified through active participation of the student during the lessons to solve problems and issues. Judgment autonomy The full understanding of the fundamental concepts, methodologies and main techniques introduced in the course will give to the student the ability to recognize the most appropriate methodology for the qualitative analysis of the mathematical models used in the description of physical systems. The student will also acquire the ability to critically analyze scientific texts and to formalize and analyze, both qualitatively and rigorously and in full autonomy, problems that are new to him. The achievement of the educational objectives will be achieved through both lectures and through the classroom exercises, to achieve a greater understanding of the topics covered in the course. The achievement of the objectives is verified through the written and oral test. Communication skills The student, after developing a mathematical model that describes the equilibrium or the dynamics of a mechanical system, will be able to describe the techniques used to construct the model. The student will acquire the ability to clearly expose the results obtained from the analysis of the problem. The assessment of communication skills will be judged during the oral test Learning ability The student will know the essential laws to deduce a mathematical model that correctly describe a physical system. The student acquires the ability to contextualize their knowledge in wide multidisciplinary areas by adjusting their knowledge on the contextualized problem.
ASSESSMENT METHODS	The final assessment aims to check whether the student has acquired knowledge and understanding of the topics, whether the student has acquired the ability to apply this knowledge, whether he/she has developed interpretative competence and independent judgment in concrete cases, as well as communication skills and language properties of the topics covered. The final exam consists of a written test and, eventually, an oral test. The written test requires the resolution of composite exercises that refer to all the parts covered by the program and always conform to the examples and exercises done during the course. The oral exam consists in a colloquium where the student has to answer at least two / three questions related to all the parts of the program; also, a critical discussion on the exercises proposed in the written test is proposed. There will also be a middle-course verification test with self-assessment on the following topics: - Reduction of the systems of applied forces - Geometries of the masses, determination of the center of gravity of complex systems, determination of the main inertial axis, cinematic of the rigid body . The middle-course test will not compete for the final vote. The final evaluation will be comprehensive of the two tests, and the final evaluation will be expressed in thirtieths and formulated on the basis of the following conditions: - Inadequate: if the student does not have an acceptable knowledge of the topics covered in the teaching; - Sufficient (rating 18-21): If the students has a basic understanding of the object of teaching subjects but an insufficient ability to use independently the acquired knowledge; - Satisfactory (rating 22-25): if the student has not fully acquired the main topics covered but has sufficient ability in using the knowledge acquired; - Good (score 26-28): if the student has a good knowledge of the subjects of the course, and has a discrete property of language and demonstrates a

	sufficient ability to independently apply the knowledge acquired; - Excellent (score 29- 30 cum laude): if able to show excellent knowledge and mastery of the laws of mechanics, excellent property language and if able to apply autonomously the acquired knowledge to solve problems.
EDUCATIONAL OBJECTIVES	The aim of the course is to provide to the student the knowledge of the mathematical tools to describe the the physical laws of a material system, the reduction of applied vectors, and the general methodologies to address the study of mechanical systems
TEACHING METHODS	The course is semi-annual (first semester). The teaching consists in lectures and classroom exercises. The aim of the course is to provide to the students the main tools to deal with a rigorous approach to mathematical problems typically encountered in quantitative description of physical processes. Students will acquire the following knowledge: -Reduction of systems of applied forces. -Kinematics and dynamics in absolute and relative systems. -Geometry of the masses. Inertia ellipsoid and the principal inertial axes. -static of a material system, determination of the equilibrium of the system by using the virtual work principle and cardinal equations. These topics will be presented and analyzed rigorously in lectures, while greater understanding will be gained from the exercises. Part of the exercises is dedicated to the resolution of previous problems proposed in previous written tests. The exercises are designed to test the skills gained by the students in the application of acquired knowledge. It is also planned a middle-course test on the following topics: - Reduction of system of applied forces. -Geometry of the masses, determination of the centre of gravity of complex systems, and determination of the inertial axes .
SUGGESTED BIBLIOGRAPHY	Libri di testo /textbooks: • Fabio Bagarello, Meccanica razionale per l'ingegneria , Mc Graw Hill. ISBN: 9788838672958 • Biscari, Ruggeri, Saccomandi, Vianello, Meccanica Razionale, 3 Edizione, Springer, Unitext, ISBN: 9788847057722 • Brini, Muracchini, Ruggeri, Seccia, Esercizi e temi d'esame di meccanica razionale, 5a Edizione, Società Editrice Esculapio, ISBN 9788893851183 • E. Di Benedetto. Classical Mechanics: Theory and Mathematical Modeling, Springer, ISBN 978-0-8176-4648-6

SYLLABUS

Hrs	Frontal teaching
3	Definition of applied vectors system. Resultant and momentum of a system. Law of the variation of the momentum. couple of applied vectors. Torsor. Reducibility and equivalence of a system. Basic operation on a system. Poisson's theorem on the reducibility. Trinomial invariant and reduction to torsor. Center of parallel applied vectors. Kinematics of a material point. Equation of the motion. Scalar and vectorial Velocity and acceleration.
2	Kinematics of a material point. Equation of the motion. Scalar and vectorial Velocity and acceleration. Curve on the space. Curvilinear abscissa. Frenet's Trihedron. Curvature and osculating circle. Central motion and Binet law, areolar velocity.
4	Cinematic of rigid bodies. Absolute and solidal axes. Fundamental law of a rigid motion and Poisson formulas. Planar motion. instantaneous center of zero velocity and acceleration. Mozzi's theorem a local motion in time.
3	Kinematics of relative motion for a point. Velocity and acceleration in absolute and relative system. Galileo principle and Coriolis theorem. Relative motion of rigid bodies, composition of angular velocity.
3	Constraint and friction, classification of the constraints and their reaction. Coulomb- Morin Laws. Motion of a material point constrained on a curve and surface. Rigid Contact motion over curve and surfaces. Conditions for a pure rolling and slipping
4	Material system. Centre of gravity and its properties. Moment of inertia. Operator and tensor of inertia. Inertia ellipsoid.
3	Work and conservative forces. Potential and Potential energy. Work of a rigid body. Definition of infinitesimal work, possible work, virtual work, elementary work. Power. Work of a solicitation acting over a rigid body.
7	Static of a material system. Virtual displacements and constraints. Principle of virtual work. Work of the virtual reaction. Equilibrium of material systems.
3	Dynamics of a material system. Quantity of motion and constraints. Momentum of the quantity of motion. Kinetic energy. Koenig's theorem. Orbital angular momentum.

Hrs	Practice
2	Systems of applied vectors..
4	Rigid bodies, slipping and pure roll motion
6	Geometry of masses.
10	Equilibrium of a material system. Constraint forces.