UNIVERSITÀ DEGLI STUDI DI PALERMO

DEPARTMENT	Ingegneria
ACADEMIC YEAR	2023/2024
BACHELOR'S DEGREE (BSC)	ROBOTICS 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)	SAMMARTINO MARCO Professore Ordinario 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	**SAMMARTINO MARCO** Tuesday 16:00 18:00 Dipartimento di Ingegneria, Edificio 8, ex Dipartimento di Metodi e Modelli Matematici, 1^o piano Wednesday 13:00 14:00 Dipartimento di Ingegneria, Edificio 8, ex Dipartimento di Metodi e Modelli Matematici, 1^o piano

DOCENTE: Prof. MARCO SAMMARTINO

PREREQUISITES	Differential and integral calculus for functions of real variables, basic knowledge of the geometry of Euclidean spaces, and of linear algebra.
LEARNING OUTCOMES	Knowledge and understanding The student at the end of the course will have gained knowledge of the basic laws of a mechanical system. The student will know how to use the laws of physics and the mathematical equations that describe them, to solve the simplest 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 the active participation of the student during the lessons to solve problems and issues. Communication skills The student, after developing a mathematical model that describes the static 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 examination. Learning ability The student will have learned the basic 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 of the contextualized problem. Moreover, the student will acquire the capability of numerically simulating some of the dynamical systems treated during the course.
ASSESSMENT METHODS	The overall assessment will be made on the basis of the following criteria. The final test will be judged: - Inadequate: if the candidate does not have an acceptable knowledge of the topics covered in the teaching; - Sufficient (rating 18-21): If he has a basic understanding of the object of the subjects and a basic ability to use the acquired knowledge; - Satisfactory (rating 22-25): if he has satisfactory knowledge of the topics covered and a sufficient capability to use the acquired knowledge; - Good (score 26-28): if he has a good knowledge of the topics covered, has a good property of language and a good capability of using the acquired knowledge; - Excellent (score 29- 30 cum laude): if he demonstrates excellent knowledge and mastery of the laws of mechanics, excellent property 'language and if it is able to apply autonomously the acquired knowledge to solve problems.
EDUCATIONAL OBJECTIVES	The aim of the course is to provide the student the knowledge of the mathematical tools to describe the motion of a material system, the reduction of applied vectors, the general methodologies to address the study of mechanical systems, and the capability to numerically simulate a simple dynamical system.
TEACHING METHODS	The course is semi-annual (first semester). The teaching consists of lectures and classroom exercises. The aim of the course is to provide the students with the main tools to deal with a rigorous approach to mathematical problems typically encountered in the quantitative description of physical processes. Students will acquire the following knowledge: -Vectors -Curves -Cinematics and dynamics in absolute and relative systems. -Geometry of the masses. Barycenters. Inertia ellipsoid and the principal inertial axes. -Rigid bodies, Euler angles. -The law of mechanics. Some applications. The armonic oscillator. - These topics will be presented and analyzed rigorously in lectures, while a deeper understanding will be gained from the exercises.

	Part of the exercises is devoted to the resolution of the exam problems. The exercises are designed to test the skills attained by students in the application of acquired knowledge and are useful training for the final test exam. It is also planned a mid-course test on the following topics: - Curves -Geometry of the masses, determination of the center of gravity of complex systems, determination of the inertial axes, calculus of the kinetic energy of a rigid body. -Simple applications of the law of mechanics.
SUGGESTED BIBLIOGRAPHY	P.Biscari, T.Ruggeri, G.Saccomandi, M.Vianello, Meccanica Razionale per l'Ingegneria, Springer, 3rd edition, ISBN 9788847057722. F.Brini, A.Muracchini, T.Ruggeri, L.Seccia, Esercizi e temi d'esame di meccanica razionale, 5th edition, Societa' Editrice Esculapio ISBN 9788893851180.

SYLLABUS

Hrs	Frontal teaching
2	Definition of applied vectors system. Resultant and momentum of a system. Scalar product, vector product. Matrices. Orthogonal matrices.
4	Cinematics of a material point. Scalar and vectorial Velocity and acceleration. Examples.
4	Curve on the space. Curvilinear abscissa. Frenet's Trihedron. Curvature and osculating circle. Central motion and Binet law, areolar velocity.
6	Cinematic of rigid bodies. Absolute and comoving axes. The fundamental law of a rigid motion and Poisson formulas. Planar motion. instantaneous center of zero velocity and acceleration.
2	Cinematics 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
4	Dynamics for a material point. Mass and foundamental laws of the dynamics. Inertial system. Examples of direct problem of the dynamics and solution of differential equation. Dynamics in non inertial systems.
6	Material system. Centre of gravity and its properties. Moment of inertia. Operator and tensor of inertia. Inertia ellipsoid. Euler angles.
3	MATLAB files. Script files. Debugging. Importing and exporting data.
5	An introduction to MATLAB. Programming in MATLAB. A work session in MAlab. Vectors and matrices. Elementary functions.
2	Graphics. Plot and fplot commands. Bidimensional graphics.

Hrs	Practice
8	Centre of gravity. Inertia moments and inertia tensor.
6	Curves in the plane and in space. Exercises on the intrinsic reference system.
2	Harmonic oscillator: Damped, forced, resonant.