COURSE OF STUDY *Physics (LM-17)*

ACADEMIC YEAR *2024-2025*

ACADEMIC SUBJECT *Technologies for Space Applications*

General information	
Year of the course	1st
Academic calendar (starting and ending date)	2nd semester: March - May 2025
Credits (CFU/ECTS):	3
SSD	FIS/01
Language	English
Mode of attendance	Compulsory

Professor/ Lecturer	
Name and Surname	Silvia Rainò
E-mail	silvia.raino@uniba.it
Telephone	+39 080 5443174
Department and address	Dipartimento Interateneo di Fisica, "M. Merlin" Università degli Studi di Bari Aldo Moro, via Edoardo Orabona 4, I-70125 Bari (Italy) Office R77
Virtual room	Teams – 74uqtyb
Office Hours (and modalities: e.g., by appointment, on line, etc.)	By appointment: online or in-person

Work schedule			
Hours			
Total	Lectures	Hands-on (laboratory, workshops, working groups, seminars, field trips)	Out-of-class study hours/ Self-study hours
75	16	15	44
CFU/ECTS			
3	2	1	

Learning Objectives	*Provide the basic elements relating to the understanding, definition and implementation of the main characterization tests of an instrument intended for a space mission, both from a dynamic and thermal point of view*
Course prerequisites	*Properties of the damped and forced harmonic oscillator, resonance. Mechanical waves, elements of calorimetry.*

Teaching strategie	*Classroom lessons. Organization of seminars, reading and discussion of scientific publications on ongoing experiments related to the main topics of the course.*
Expected learning outcomes in terms of	
Knowledge and understanding on:	o Characteristics of environmental tests for space applications o Test plans and procedures o Vibration tests (random sinusoidal, shock) o Basic elements of shaker operation o Thermal and thermal-vacuum tests o Measurement devices: accelerometers and strain gauges o Applications to high energy physics detectors for space applications

Applying knowledge and understanding on:	o Understanding the main characteristics of spatial tests o Ability to distinguish the type of tests to be performed based on the test items o Deep understanding of the procedures and methods for the performance of the main mechanical and thermal tests o Ability to read, understand and analyse test results
Soft skills	● *Making informed judgments and choices* o Understand and define test strategies. o Understand and critically report on test results o Research and describe the tests performed for space missions of scientific interest ● *Communicating knowledge and understanding* o Report with slides on topics discussed during the seminar activities and in the classroom during the course lessons o Report on the results of scientific publications on the topics covered during the course o Report on laboratory activities: procedure, realization and results o Write reports and make reviews ● *Capacities to continue learning* o Write a report on a selected topic o Create a bibliography on the selected topic o Give a presentation/seminar
Syllabus	
Content knowledge	*1. General overview of basic mechanics: damped oscillations, forced oscillations, resonance, mechanical waves, Fourier series.* *2. Test plans and procedures defined by major space agencies. Distinction of the different types of test items: engineering model, proto-flight, flight. Qualification and acceptance test.* *3. Basics of vibration mechanics. One degree of freedom model. Mechanical vibration tests: sinusoidal, random, shock. Basic elements on the functioning of an electrodynamic shaker. Accelerometers.* *4. Thermal and thermal-vacuum tests. Review of the elastic properties of solids: specific load, relative elongation, Young's modulus. Thermal and thermal-vacuum tests. Thermal balance. Cryogenic testing.* *5. Study of test procedures performed on payloads of space missions already in orbit: the example of the tests performed on the detectors of the tracking system of the LAT telescope on board the Gamma-Ray Large Area Space Telescope (GLAST). The cryogenic tests for the James Webb Telescope* *6. Notes on particle detectors for space applications. Silicon PMs. Vibrational and thermal laboratory tests on SiPM prototypes. Functional tests.*
Texts and readings	o GEVS, NASA General Environmental Verification and Specification for STS and ELV Payloads, Subsystems, and Components; o Slides of the course o Scientific publications provided by the professor of the course
Notes, additional materials	
Repository	*Slides and publications shared on the Teams platform (in the course channel)*

Assessment	
Assessment methods	*Oral exam on topics covered during the course including:* ● *Theoretical questions on the topics covered in class* ● *Discussion of the results of the tests carried out in laboratory classes* *- Review and report on anindependent research of your choice relating to the topics covered during the course. The student will be able to use digital aids such*

	as Power Point or tablets or even paper aids to discuss formulas, describe experimental set-ups or reproduce graphs.
Assessment criteria	● *Knowledge and understanding:* o Motivation and goal of mechanical and thermal tests for space applications o Main characteristics of mechanical tests (resonance search, random vibration, shock) o Main characteristics of thermal and thermal-vacuum tests ● *Applying knowledge and understanding:* o Procedure and execution of mechanical tests o Procedure and execution of thermal and thermal-vacuum tests ● *Autonomy of judgement*: o Critical understanding of the results of vibration and thermal tests ● Communicating knowledge and understanding o Report critically on the topics of the course o Discuss scientific publication ● Capacities to continue learning: o Read a scientific report and be able to make a report of it
Final exam and grading criteria	*Clear exposition of topics (30%)* *Precision in information details (30%);* *Ability to critically discuss the required topics and create autonomous connections (40%)*
Further information	
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