Course unit English denomination	**Aerospace propulsion**
SS	IIND-01/G Aerospace Propulsion
Teacher in charge (if defined)	teaching not yet assigned
Teaching Hours	20
Number of ECTS credits allocated	4
Course period	01/2026 - 06/2026
Course delivery method	☒ In presence - *basically in presence, with possible Zoom connection, upon authorisation, for the doctoral students who are out of Padova* ☐ Remotely ☐ Blended
Language of instruction	English
Mandatory attendance	☐ Yes (% minimum of presence) ☒ No
Course unit contents	Description at sub-system level of Chemical propulsion system, Tsiolkovsky equation. Performance parameters, specific impulse, system specific impulse. Characteristic velocity. Nozzle simplified equations, converging diverging nozzles, pressure profile within the nozzle, nozzle performances at different altitude. Solid rocket motors, general description, main components, equilibrium pressure, main operative parameters, erosive combustion. Liquid Rocket Motors, main components, pressurization systems. Electric propulsion, plasma propulsion, low thrust conditions, Tsiolkovsky equations in case of low thrust conditions, electro-thermal, electrostatic and electromagnetic propulsion systems.
Learning goals	Introduction to space propulsion systems
Teaching methods	Frontal lectures
Course on transversal, interdisciplinary, transdisciplinary skills	☐ Yes ☒ No

Available for PhD students from other courses	☒ Yes – *courses are open, upon authorisation by the Coordinator and the teacher, considering the spaces and the curriculum of the applicant* ☐ No
Prerequisites (not mandatory)	Mechanic of fluids
Examination methods (if applicable)	Small thesis work and oral presentation
Suggested readings	handouts
Additional information	

Course unit English denomination	**Exploring the solar system and its environment**
SS	PHYS-05/B Physics of the Earth System, Planets, Space and Climate
Teacher in charge (if defined)	teaching not yet assigned
Teaching Hours	20
Number of ECTS credits allocated	4
Course period	01/2026 - 06/2026
Course delivery method	☒ In presence - *basically in presence, with possible Zoom connection, upon authorisation, for the doctoral students who are out of Padova* ☐ Remotely ☐ Blended
Language of instruction	English
Mandatory attendance	☐ Yes (% minimum of presence) ☒ No
Course unit contents	The course is divided in two sections, in the first one there will be a technical-scientific description of the space missions and instruments, while the second one a theoretical description of the physical characteristics of the Solar System. Introduction to the main physical characteristics of the Solar System planets. Introduction and description of the main space missions that explored or will explore the Solar System, from the scientific objectives to the instruments on board. We will discuss some details of some instruments where Padova is strongly involved, as BepiColombo and Exomars. Description and discussion of the model for the formation of planets and its application to the Solar System and the known exoplanetary systems. Overview of the main physical properties of the planets with focus on their magnetic fields and their interaction with the solar wind, formation of the magnetospheres. Brief summary of the non-gravitational forces acting on the minor bodies populating many known planetary systems and related to the absorption and scattering of the solar radiation.
Learning goals	Introduction to the space missions and instruments related to the exploration of the Solar System. Introduction to the main physical characteristics of the Solar System

Teaching methods	The course takes place with presentations by teachers on space missions and instruments, and on the formation of the Solar System. No laboratory or other activities are planned
Course on transversal, interdisciplinary, transdisciplinary skills	☐ Yes ☒ No
Available for PhD students from other courses	☒ Yes – *courses are open, upon authorisation by the Coordinator and the teacher, considering the spaces and the curriculum of the applicant* ☐ No
Prerequisites (not mandatory)	none
Examination methods (if applicable)	colloquium
Suggested readings	Presentations, scientific articles and specific books
Additional information	

Course unit English denomination	**Fundamental concepts of high energy astrophysics and cosmology**
SS	PHYS-05/A Astrophysics, Cosmology and Space Science
Teacher in charge (if defined)	teaching not yet assigned
Teaching Hours	20
Number of ECTS credits allocated	4
Course period	01/2026 - 06/2026
Course delivery method	☒ In presence - *basically in presence, with possible Zoom connection, upon authorisation, for the doctoral students who are out of Padova* ☐ Remotely ☐ Blended
Language of instruction	English
Mandatory attendance	☐ Yes (% minimum of presence) ☒ No
Course unit contents	1/ Cosmic Ray Physics: The Cosmic Ray (CR) Spectrum at Earth. Brief review of the standard model of elementary particles and interactions. Composition and abundance of CRs. Primary and secondary CRs. Experimental detection of CRs and some history. CR propagation and trapping in Earth magnetic field. Acceleration of CRs. Source of CRs. Multimessenger astrophysics. 2/ Fundamental Concepts of Cosmology of the Early Universe: Thermal history of the Universe: Inflation in the primordial universe, Baryogenesis. Primordial nucleosynthesis of light elements. Hydrogen recombination: Radiation decoupling. Cosmic Microwave Background. Expansion of the Universe and its relation to the energy density of fields, Cosmological Principle. Geometric properties. Hubble constant and deceleration parameter. Definitions of distance in Cosmology; redshift and Hubble's law (approximate treatment at low redshift). Dark Matter evidence, structure formation.
Learning goals	Knowledge of the fundamental concepts of high energy astrophysics and cosmology: characteristics of cosmic rays and acceleration mechanisms, chronology and evolution of the Universe.
Teaching methods	Frontal lessons, presentations

Course on transversal, interdisciplinary, transdisciplinary skills	☐ Yes ☒ No
Available for PhD students from other courses	☒ Yes – *courses are open, upon authorisation by the Coordinator and the teacher, considering the spaces and the curriculum of the applicant* ☐ No
Prerequisites (not mandatory)	Elementary notions of general physics (energy, charge...) and mathematics (linear equations, integrals)
Examination methods (if applicable)	Presentation about a related topic.
Suggested readings	Lecture slides and notes References to relevant papers will be provided. T. Stanev, High Energy Cosmic Rays, Springer, 2020, J.G. Roederer and H. Zhang, Dynamics of Magnetically Trapped Particles, Springer, 2014, S. Mohanty “Astroparticle Physics and Cosmology” Springer 2020
Additional information	

Course unit English denomination	**Introduction to Computational Fluid Dynamics**
SS	IIND-01/F - Fluid Dynamics
Teacher in charge (if defined)	teaching not yet assigned
Teaching Hours	20
Number of ECTS credits allocated	4
Course period	01/2026 - 06/2026
Course delivery method	☒ In presence - *basically in presence, with possible Zoom connection, upon authorisation, for the doctoral students who are out of Padova* ☐ Remotely ☐ Blended
Language of instruction	English
Mandatory attendance	☐ Yes (% minimum of presence) ☒ No
Course unit contents	The course will introduce to the computational description of fluid flows for engineering and aerospace applications. The lectures will review the laws governing fluid dynamics, the main aspects of turbulent flows with related modelling approaches and the fundamental aspects of computational fluid dynamics. Moreover, the last part of the course will be devoted to practice with a commercial solver in order to set-up and run CFD simulations of aerodynamic problems with different meshing techniques and physics models.
Learning goals	Knowledge of basic fluid dynamics and turbulence. Ability to conduct engineering CFD simulations.
Teaching methods	Slides and a computer room will be used for practical tests and tutorials will be made available for software exercises.
Course on transversal, interdisciplinary, transdisciplinary skills	☒ Yes ☐ No
Available for PhD students from other courses	☒ Yes – *courses are open, upon authorisation by the Coordinator and the teacher, considering the spaces and the curriculum of the applicant* ☐ No

Prerequisites (not mandatory)	Basic knowledge of fluid mechanics
Examination methods (if applicable)	Report on computer exercises explained in the classroom
Suggested readings	Slides
Additional information	

Course unit English denomination	**Measurement fundamentals and image analysis based techniques**
SS	SC 09/E4 Misure - SSD IMIS-01/A Misure meccaniche e termiche
Teacher in charge (if defined)	teaching not yet assigned
Teaching Hours	20
Number of ECTS credits allocated	4
Course period	01/2026 - 06/2026
Course delivery method	☒ In presence - *basically in presence, with possible Zoom connection, upon authorisation, for the doctoral students who are out of Padova* ☐ Remotely ☐ Blended
Language of instruction	English
Mandatory attendance	☐ Yes (% minimum of presence) ☒ No
Course unit contents	Elements of statistics and inference; uncertainty analysis and propagation methods. Analog-to-digital conversion of time-varying signals and related problems. Programming fundamentals of PC-based acquisition systems. Measurement techniques based on visible and infrared imaging systems. Contactless shape, stress and strain measurements.
Learning goals	at the end of the course, the students, using a suitable PC software package, are expected to be able to: • analyze measurement data using the main statistics tools; • evaluate the measurement uncertainty from experimental data and/or prior knowledge according to the ISO Guide; • write a simple software code for the acquisition of a measurement signal and properly select the analog-to-digital conversion parameters.
Teaching methods	Lessons and practical use also of thermographic systems and 3D scanner
Course on transversal, interdisciplinary, transdisciplinary skills	☒ Yes ☐ No

Available for PhD students from other courses	☒ Yes – *courses are open, upon authorisation by the Coordinator and the teacher, considering the spaces and the curriculum of the applicant* ☐ No
Prerequisites (not mandatory)	Basis of physics
Examination methods (if applicable)	Discussion or project work
Suggested readings	Material given by the teacher
Additional information	

Course unit English denomination	**Mechanical and thermal properties of materials for aerospace applications**
SS	IIND-01/D - Costruzioni e strutture aerospaziali
Teacher in charge (if defined)	teaching not yet assigned
Teaching Hours	20
Number of ECTS credits allocated	4
Course period	01/2026 - 06/2026
Course delivery method	☒ In presence - *basically in presence, with possible Zoom connection, upon authorisation, for the doctoral students who are out of Padova* ☐ Remotely ☐ Blended
Language of instruction	English
Mandatory attendance	☐ Yes (% minimum of presence) ☒ No
Course unit contents	Composite materials are finding an increasing use in the engineering fields where high specific properties (strength/density, stiffness/density) are required. Airplanes and spacecraft are typical structures in which the need of mass reduction makes composite materials very convenient. The lecture course is more concerned with the structural aspects of the use of composites and therefore it provides the preliminary elements for the structural design of structures made with heterogeneous materials and for the evaluation of their strength and stiffness. The second part of the lectures covers the structural design of instruments for space applications, definition and identification of main external /internal loads, resistance criteria for metallic materials and optical glasses; study of the expected thermal and mechanical disturbances during a space mission, methods of thermo-mechanical optimization for the reduction of disturbance effects.
Learning goals	Knowledge of the physical-mechanical properties to be evaluated in the selection of materials (composites, metals and optical glasses) to be adopted in the aerospace sector. Ability to identify the strategy to be followed to estimate the stiffness and strength of a structure.

	Awareness of the multiplicity of thermo-mechanical loading conditions typical of a space mission.
Teaching methods	Frontal lectures
Course on transversal, interdisciplinary, transdisciplinary skills	☐ Yes ☒ No
Available for PhD students from other courses	☒ Yes – *courses are open, upon authorisation by the Coordinator and the teacher, considering the spaces and the curriculum of the applicant* ☐ No
Prerequisites (not mandatory)	none
Examination methods (if applicable)	Oral examination, or “tesina” (written report)
Suggested readings	Provided by the teacher
Additional information	If the chosen method is 'Tesina', no more than 15 pages.

Course unit English denomination	**Planetary Optical Photogrammetry**
SS	PHYS-03/A Experimental Physics of Matter and Application
Teacher in charge (if defined)	teaching not yet assigned
Teaching Hours	20
Number of ECTS credits allocated	4
Course period	01/2026 - 06/2026
Course delivery method	☒ In presence - *basically in presence, with possible Zoom connection, upon authorisation, for the doctoral students who are out of Padova* ☐ Remotely ☐ Blended
Language of instruction	English
Mandatory attendance	☐ Yes (% minimum of presence) ☒ No
Course unit contents	The course aims to describe the optimized optical systems for the acquisition of images for photogrammetric use and to teach the extraction processes of topographic information from satellite images of planetary surfaces. Participants will receive an introduction of the fundamentals of optics and digital photogrammetry oriented to the acquisition systems for the extraction of Digital Elevation Models and orthophotos. The course will offer a complete overview of the three-dimensional reconstruction process starting from the design of an optical payload (current such as CaSSIS for ExoMars2016 and STC / SYMBIO-SYS for the BepiColombo mission or future such as PANCAM for the Daedalus mission), to the use of Spice Kernels and the photogrammetric current algorithmic basis.
Learning goals	To know the different optical instrumentation for satellite remote sensing and then analyze the acquired images by means of modern photogrammetric techniques.
Teaching methods	Given the interdisciplinary nature of the subject, the course will be delivered through brief lectures complemented by a 'flipped classroom' approach to facilitate understanding of the doctoral students' areas of interest and their challenges. For the more

	technical aspects, laboratory-based teaching may also be incorporated.
Course on transversal, interdisciplinary, transdisciplinary skills	☒ Yes ☐ No
Available for PhD students from other courses	☒ Yes – *courses are open, upon authorisation by the Coordinator and the teacher, considering the spaces and the curriculum of the applicant* ☐ No
Prerequisites (not mandatory)	Basic knowledge of optical instruments or their use in scientific fields is required.
Examination methods (if applicable)	Submission of a written report on a topic covered in the course.
Suggested readings	Educational presentations and supporting articles will be provided.
Additional information	

Course unit English denomination	**Electromagnetic radiation detectors and imaging systems**
SS	PHYS-01/A Experimental Physics of Fundamental Interactions and Applications
Teacher in charge (if defined)	teaching not yet assigned
Teaching Hours	10
Number of ECTS credits allocated	2
Course period	01/2026 - 06/2026
Course delivery method	☒ In presence - *basically in presence, with possible Zoom connection, upon authorisation, for the doctoral students who are out of Padova* ☐ Remotely ☐ Blended
Language of instruction	English
Mandatory attendance	☐ Yes (% minimum of presence) ☒ No
Course unit contents	Photoemission detectors: Photoelectric effect; Quantum efficiency; Photocathode, photomultiplier, channeltron, microchannel plates (MCP); MCP detectors, image intensifiers; single anode and multi-anode readout. Semiconductor detectors: Atomic theory, Semiconductors; pn junction; Photodiodes; SPAD and SiPM; semiconductor detector spectral sensitivity. CCD operation and configurations; spectral response; Correlated Double Sampling. Passive and active CMOS (APS); Fill factor; Shutter mode; Hybrid detectors; Sensor-on-chip. Detector Noise Sources; Camera resolution, Modulation Transfer Function; Aliasing.
Learning goals	Understanding of the functioning principles of sensors of electromagnetic radiation as a function of the radiation energy, from X-ray to far infrared, with emphasis on sensors for satellite applications.
Teaching methods	Frontal lectures

Course on transversal, interdisciplinary, transdisciplinary skills	☐ Yes ☒ No
Available for PhD students from other courses	☒ Yes – *courses are open, upon authorisation by the Coordinator and the teacher, considering the spaces and the curriculum of the applicant* ☐ No
Prerequisites (not mandatory)	
Examination methods (if applicable)	Written test
Suggested readings	Provided by the teacher
Additional information	

Course unit English denomination	**Space optics**
SS	PHYS-03/A Experimental Physics of Matter and Application.
Teacher in charge (if defined)	teaching not yet assigned
Teaching Hours	20
Number of ECTS credits allocated	4
Course period	01/2026 - 06/2026
Course delivery method	☒ In presence - *basically in presence, with possible Zoom connection, upon authorisation, for the doctoral students who are out of Padova* ☐ Remotely ☐ Blended
Language of instruction	English
Mandatory attendance	☐ Yes (% minimum of presence) ☒ No
Course unit contents	Propagation models of light. Realization of an optical system: design, opto-mechanics, alignment and integration, calibration. Geometrical optics and wave optics. Reflection and refraction laws. Image formation. Diffraction limited system and Airy Disk. Paraxial optics. Lens and mirrors components in paraxial optics. Apertures and diaphragms, field of view and f-number. Optical path, chromatic aberration and first order aberrations. Wavefront aberrations. Point Spread Function. Resolution of an imaging system. Telescopes: Gregorian, Galileian, Cassegrain, Schmidt Camera with examples. Introduction to spectroscopic systems. Grating theory. Fundamental configurations with examples. Multispectral and Hyperspectral imaging. Ray-tracing with professional software. Design, analysis and optimization of a single lens and an achromatic doublet. Performance of optics systems by merit figures. Design and optimization of a Schmidt camera and of a Cassegrain telescope. Even-polynomial plate and Maksutov meniscus for spherical aberration correction. Field flattener.
Learning goals	Acquire fundamental skills in the field of optical engineering. Learn about the steps and phases involved in the realization of an optical instrument for space. Ability to design fundamental optical systems such as a two-mirror telescope and a camera. Basic knowledge of

	spectroscopic techniques. Ability to simulate the performance of a simple optical system via software. Knowledge of optimization methods. Basic knowledge of materials coatings for the different spectral ranges from UV to IR.
Teaching methods	Materials provided by teachers, such as slides and book chapters
Course on transversal, interdisciplinary, transdisciplinary skills	☒ Yes ☐ No
Available for PhD students from other courses	☒ Yes – *courses are open, upon authorisation by the Coordinator and the teacher, considering the spaces and the curriculum of the applicant* ☐ No
Prerequisites (not mandatory)	
Examination methods (if applicable)	Written test
Suggested readings	
Additional information	