SPACE Area Courses (AA 2026-2027)

Pillar

Introduction to General Relativity
Lecturer: Prof. Capozziello
Period: Nov-Dec | Hours: 24
The course intends to provide an introduction to General Relativity for which knowledge of the basic principles of Special Relativity, Electromagnetism, and Classical Mechanics is required. It is aimed at graduates in engineering, physics and mathematics.

- **Introduction to Astrophysics**
  Module A: Prof. Risaliti
  Module B: Prof. Napolitano
  Period: Nov-Dec | Hours: 24
  The course covers the physical processes governing stars, including hydrostatic equilibrium, nuclear fusion, and radiation-matter interactions, followed by stellar evolution and the properties of white dwarfs and neutron stars. It also explores galaxy physics, focusing on classification, photometry, kinematics, and dynamics. Students will gain both observational and theoretical knowledge, providing a strong foundation for studying stellar and galactic evolution in astrophysics and cosmology

- **Introduction to Aerospace**
  Lecturer: Dr. Mungiguerra
  Period: Dec - Jan | Hours: 24
  This course provides the fundamentals of aerospace engineering, with specific focus on space missions. Fundamentals of space missions, orbital dynamics, orbital maneuvers and space environment will be provided. The architecture of a typical space system and the relevant subsystems will be presented. Basics of applied fluid dynamics will be presented, with an introduction to gas dynamics and aerodynamics of aerospace systems. Fundamentals of space launch and propulsion systems will also be provided.

- **Introduction to Cosmology**
  Lecturer: Prof. Benetti and Dr. Conzinu
  Period: Jan - Feb | Hours: 24
  The course addresses the theoretical foundations of modern cosmology and the observational basis of the standard cosmological model. The main physical concepts and fundamental events in cosmic history are introduced, including the theory of inflation, the generation of cosmic microwave background anisotropies from primordial inhomogeneities, and the structure formation process.

  Introduction to Astroparticle Physics
  Lecturer: Dr. Chianese and Dr. Marinelli
  Period: Mar - Apr | Hours: 24
  The course will address challenges in understanding the early and recent Universe, focusing on the connections between astrophysics and particle physics. It will review multi-messenger astrophysics, covering neutrinos, cosmic rays, and gamma rays, and present current knowledge of dark matter, including possible candidates like primordial black holes. Observational and experimental techniques will also be briefly explored.

- **Scientific Writing**
  Prof. Russo
  Period: Apr - May | Hours: 24
  The course offers an introduction to scientific publication in international journals, covering reasons for publishing, journal selection, writing style, ethics, editing, revisions, proofreading, and manuscript correspondence. It also includes the editorial structure of journals (Editor, associates, board members, publisher), the review process, review methods, and understanding bibliometric indices. Evaluation is based on exercises related to the course material.

Monographic

- **Complement of General Relativity**
  Lecturer: Prof. Capozziello
  Period: Dec | Hours: 12
  In this course, alternatives and extensions to general relativity are examined to address its limitations at different energy scales. Particular focus is given to renormalizability and the cosmological constant problem. To modify general relativity,

the Noether symmetry approach is introduced, along with its application to quantum cosmology. Finally, as a step toward a quantum framework for gravity, gauge theories and field theories in curved spacetime are explored.

- **Experimental methods in Astroparticle Physics**
  Lecturer: Prof. Guarino
  Period: Mar - Apr | Hours: 12
  This course covers modern experimental methods in astroparticle physics. It begins with particle detectors, then explores their integration into complex instruments. Techniques for cosmic ray physics, X-ray and gamma-ray astronomy, neutrino astronomy, dark matter searches, and gravitational wave detection are discussed. Numerous examples from astroparticle physics experiments illustrate these methods and their specific applications.

Space fluid dynamics
Lecturer: Stefano Mungiguerra
Period: May | Hours: 12
This course presents advanced research topics in fluid dynamics for space applications. This includes advanced gas dynamics, aerothermodynamics and plasma physics for hypersonic flight, space re-entry, and space propulsion, related thermal protection systems, and fluid dynamic research in microgravity conditions.

Space Program Life-cycle and Services
Lecturer: Alfredo Renga
Period: Mar - Apr | Hours: 12
The course aims to provide students with knowledge of engineering problems related to design and operations of space missions. Following an introduction on space program life-cycle, mission elements and architecture and phases of space mission, the course focuses on global navigation satellite systems. Concerning the first aspect, GNSS principles are presented and analyzed, including positioning, signal structure, error sources, and performance. Advanced concepts like multi-frequency and differential GNSS, and GNSS augmentation are also outlined.

Telescopes and Observations in Astronomy
Lecturer: Enrichetta Iodice
Period: Mar - Apr | Hours: 12
This course introduces the concepts and techniques of observational astronomy, from measuring astronomical quantities to acquiring and analysing data. After the basics (distances, coordinate systems, time, observables), it covers ground-based optical and space telescopes, with their limitations and future facilities, then imaging and photometry (detectors, data reduction, calibration) and spectroscopy, with its physical foundations and astrophysical applications.