**Astrophysics and Cosmology**  
**Physical Engineering optional course**

**Details:**

62 h (T/P)

**Instructors:**

Enrique García-Berro  
Jordi José

**Language:**

Catalan, Spanish, or English, depending on the topic and the instructor.

**Bibliography:**


**Invited seminars:**

a) Astronomical instrumentation: Gloria Sala, at the end of chapter 1.  
b) Numerical techniques in astrophysical flows: Domingo García, at the end of chapter 4.  
c) Dark matter content of galaxies: Santiago Torres, at the end of chapter 5.

**Project-based learning:**

a) Integration of the equations of motion of a planet.  
b) Free fall collapse.  
c) Stellar evolution: simulations of light curves of binary systems.  
d) Integration of zero temperature white dwarf structures: the mass-radius relationship.  
f) Determination of the Hubble constant  
g) Big Bang Nucleosynthesis.

**Syllabus, instructors and approximate timetable:**

1. *Introduction* (1 h, EGB).  
   2.1. Equations of motion: Kepler’s laws.  
   2.2. The Solar System.  
   2.2.1. Terrestrial planets.
2.2.2. Giant planets.

2.3. Exoplanets.

3. **Stellar structure** (18 h).
   3.1. Relevant observational characteristics and timescales (2 h, EGB).
   3.2. Stellar interiors
       3.2.1. The equations of stellar structure (3 h, EGB).
       3.2.2. Equation of state (2 h, EGB).
       3.2.3. Nuclear physics of stars (7 h, JJ).
       3.2.4. Neutrino losses (1 h, JJ).
       3.2.5. Sources of opacity (1 h, EGB).
   3.3. Stellar atmospheres (2 h, EGB)

4. **Stellar evolution** (14 h).
   4.1. The main sequence phase (1 h, EGB).
   4.2. Red giants (1 h, EGB).
   4.3. Stellar remnants: white dwarfs, neutron stars and black holes (6 h, EGB).
   4.4. Stellar explosions: core-collapse supernovae, novae and thermonuclear supernovae (8 h, JJ).

5. **The Sun** (3 h, JJ).
   5.1. The radiative core.
       5.1.1. Nuclear reactions.
       5.1.2. Neutrino emission.
   5.2. Convective layer.
   5.3. Atmosphere.
       5.3.1. Photosphere.
       5.3.2. Chromosphere.
       5.3.3. Corona.
   5.4. The Solar cycle.
   5.5. Solar activity.

6. **Galaxies** (6 h, EGB).
   6.3. Galactic chemical evolution.
   6.4. Active galaxies and quasars.

7. **Large-scale structure of the Universe** (6 h, JJ).
   7.1. Clusters of galaxies.
   7.2. The extragalactic distance scale.
   7.3. The accelerated expansion of the Universe.
   7.4. Gamma-ray bursts.

8. **Cosmology** (5 h, JJ).
   8.1. The observational basis of modern cosmology.
   8.2. The cosmological principle.
   8.3. Cosmological models.
   8.4. The Big Bang and the inflationary Universe.

**Evaluation:**

Final exam: 65%, Project-Based Learning: 35%.