Course guide
230488 - ASTRO - Astrophysics and Cosmology

Last modified: 25/05/2023

Unit in charge: Barcelona School of Telecommunications Engineering
Teaching unit: 748 - FIS - Department of Physics.

Degree: BACHELOR'S DEGREE IN ENGINEERING PHYSICS (Syllabus 2011). (Optional subject).

Academic year: 2023 **ECTS Credits:** 6.0 **Languages:** English

LECTURER

Coordinating lecturer: Consultar aquí / See here: https://telecos.upc.edu/ca/estudis/curs-actual/professorat-responsables-coordinadors/responsables-assignatura

Others: Consultar aquí / See here: https://telecos.upc.edu/ca/estudis/curs-actual/professorat-responsables-coordinadors/professorat-assignat-idioma

PRIOR SKILLS

Those of the bachelor degree.

REQUIREMENTS

Having passed previous courses.

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Generical:
3. ABILITY TO IDENTIFY, FORMULATE, AND SOLVE PHYSICAL ENGINEERING PROBLEMS. Planning and solving physical engineering problems with initiative, making decisions and with creativity. Developing methods of analysis and problem solving in a systematic and creative way.

Transversal:
1. THIRD LANGUAGE. Learning a third language, preferably English, to a degree of oral and written fluency that fits in with the future needs of the graduates of each course.
2. SELF-DIRECTED LEARNING - Level 3. Applying the knowledge gained in completing a task according to its relevance and importance. Deciding how to carry out a task, the amount of time to be devoted to it and the most suitable information sources.

TEACHING METHODOLOGY

Classical lectures and Project-Based Learning.

LEARNING OBJECTIVES OF THE SUBJECT

Study the essential properties of the Universe. Develop mathematical models to describe the properties of astronomical objects. Design the fundamental characteristics of terrestrial and on-board astronomical instrumentation.

STUDY LOAD

Type	Hours	Percentage
Hours large group	65,0	43.33
Self study	85,0	56.67

Total learning time: 150 h

CONTENTS

1. Introduction

Description:
An introduction to the course.

Specific objectives:
Provide an overall view of the course: understanding our Universe, with the help of Physical tools.

Related activities:
None.

Related competencies :
08 CRPE EF. ABILITY TO IDENTIFY, FORMULATE, AND SOLVE PHYSICAL ENGINEERING PROBLEMS. Planning and solving physical engineering problems with initiative, making decisions and with creativity. Developing methods of analysis and problem solving in a systematic and creative way.

03 TLG. THIRD LANGUAGE. Learning a third language, preferably English, to a degree of oral and written fluency that fits in with the future needs of the graduates of each course.
07 AAT N3. SELF-DIRECTED LEARNING - Level 3. Applying the knowledge gained in completing a task according to its relevance and importance. Deciding how to carry out a task, the amount of time to be devoted to it and the most suitable information sources.

Full-or-part-time: 1h
Theory classes: 1h

2. Planets and the Solar System.

Description:
2. Planets and the Solar System.
2.1. The Solar System.
2.1.1. Terrestrial planets.
2.1.2. Giant planets.
2.2. Exoplanets.

Specific objectives:
Understanding our Solar System and the search for other planetary systems.

Related activities:
None.

Related competencies :
08 CRPE EF. ABILITY TO IDENTIFY, FORMULATE, AND SOLVE PHYSICAL ENGINEERING PROBLEMS. Planning and solving physical engineering problems with initiative, making decisions and with creativity. Developing methods of analysis and problem solving in a systematic and creative way.

03 TLG. THIRD LANGUAGE. Learning a third language, preferably English, to a degree of oral and written fluency that fits in with the future needs of the graduates of each course.
07 AAT N3. SELF-DIRECTED LEARNING - Level 3. Applying the knowledge gained in completing a task according to its relevance and importance. Deciding how to carry out a task, the amount of time to be devoted to it and the most suitable information sources.

Full-or-part-time: 16h
Theory classes: 5h
Practical classes: 1h
Self study : 10h

3. Stellar structure.

Description:
3.1. Relevant observational characteristics and timescales.
3.2. Stellar interiors
3.2.1. The equations of stellar structure.
3.2.2. Equation of state.
3.2.3. Nuclear physics of stars.
3.2.4. Neutrino losses.
3.2.5. Sources of opacity.
3.3. Stellar atmospheres.

Specific objectives:
Understanding the equations of stellar structure and learning the ingredients necessary to model a star.

Related activities:
a) Modeling a Sedov explosion.
b) Free fall collapse.
c) Integration of zero temperature white dwarf structures: the mass-radius relationship.

Related competencies :
08 CRPE EF. ABILITY TO IDENTIFY, FORMULATE, AND SOLVE PHYSICAL ENGINEERING PROBLEMS. Planning and solving physical engineering problems with initiative, making decisions and with creativity. Developing methods of analysis and problem solving in a systematic and creative way.

03 TLG. THIRD LANGUAGE. Learning a third language, preferably English, to a degree of oral and written fluency that fits in with the future needs of the graduates of each course.
07 AAT N3. SELF-DIRECTED LEARNING - Level 3. Applying the knowledge gained in completing a task according to its relevance and importance. Deciding how to carry out a task, the amount of time to be devoted to it and the most suitable information sources.

Full-or-part-time: 40h
Theory classes: 10h
Practical classes: 6h
Guided activities: 1h
Self study : 23h

4. Stellar evolution.

Description:
4.1. The main sequence phase.
4.2. Red giants.
4.3. Stellar remnants: white dwarfs, neutron stars and black holes.
4.4. Stellar explosions: core-collapse supernovae, novae and thermonuclear supernovae.

Specific objectives:
Understanding the different evolutionary phases of stars.

Related activities:
a) Stellar evolution: from the main sequence to the giant phase (using the TYCHO stellar evolutionary code).
b) Solving a simple nuclear network.

Related competencies :
08 CRPE EF. ABILITY TO IDENTIFY, FORMULATE, AND SOLVE PHYSICAL ENGINEERING PROBLEMS. Planning and solving physical engineering problems with initiative, making decisions and with creativity. Developing methods of analysis and problem solving in a systematic and creative way.

03 TLG. THIRD LANGUAGE. Learning a third language, preferably English, to a degree of oral and written fluency that fits in with the future needs of the graduates of each course.
07 AAT N3. SELF-DIRECTED LEARNING - Level 3. Applying the knowledge gained in completing a task according to its relevance and importance. Deciding how to carry out a task, the amount of time to be devoted to it and the most suitable information sources.

Full-or-part-time: 38h
Theory classes: 9h
Practical classes: 5h
Guided activities: 1h
Self study : 23h

5. The Sun.

Description:
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.

Specific objectives:
Understanding the structure and main characteristics of the Sun.

Related activities:
None.

Related competencies :
08 CRPE EF. ABILITY TO IDENTIFY, FORMULATE, AND SOLVE PHYSICAL ENGINEERING PROBLEMS. Planning and solving physical engineering problems with initiative, making decisions and with creativity. Developing methods of analysis and problem solving in a systematic and creative way.

03 TLG. THIRD LANGUAGE. Learning a third language, preferably English, to a degree of oral and written fluency that fits in with the future needs of the graduates of each course.
07 AAT N3. SELF-DIRECTED LEARNING - Level 3. Applying the knowledge gained in completing a task according to its relevance and importance. Deciding how to carry out a task, the amount of time to be devoted to it and the most suitable information sources.

Full-or-part-time: 15h
Theory classes: 2h
Practical classes: 1h
Self study : 12h

6. Galaxies.

Description:
6.1. The Milky Way.
6.2. Morphological classification of galaxies: the Hubble sequence.
6.3. Galactic chemical evolution.
6.4. Active galaxies and quasars.

Specific objectives:
Learning the main properties of Galaxies.

Related activities:
a) Chemical evolution of the Galaxy: the closed box approximation.

Related competencies :
08 CRPE EF. ABILITY TO IDENTIFY, FORMULATE, AND SOLVE PHYSICAL ENGINEERING PROBLEMS. Planning and solving physical engineering problems with initiative, making decisions and with creativity. Developing methods of analysis and problem solving in a systematic and creative way.

03 TLG. THIRD LANGUAGE. Learning a third language, preferably English, to a degree of oral and written fluency that fits in with the future needs of the graduates of each course.
07 AAT N3. SELF-DIRECTED LEARNING - Level 3. Applying the knowledge gained in completing a task according to its relevance and importance. Deciding how to carry out a task, the amount of time to be devoted to it and the most suitable information sources.

Full-or-part-time: 19h
Theory classes: 3h
Practical classes: 3h
Guided activities: 1h
Self study : 12h

7. Large-scale structure of the Universe.

Description:
7.1. Clusters of galaxies.
7.2. The extragalactic distance scale.
7.3. The accelerated expansion of the Universe.
7.4. Gamma-ray bursts.

Specific objectives:
Learning the large scale structure of our Universe.

Related activities:
None.

Related competencies :
08 CRPE EF. ABILITY TO IDENTIFY, FORMULATE, AND SOLVE PHYSICAL ENGINEERING PROBLEMS. Planning and solving physical engineering problems with initiative, making decisions and with creativity. Developing methods of analysis and problem solving in a systematic and creative way.

03 TLG. THIRD LANGUAGE. Learning a third language, preferably English, to a degree of oral and written fluency that fits in with the future needs of the graduates of each course.
07 AAT N3. SELF-DIRECTED LEARNING - Level 3. Applying the knowledge gained in completing a task according to its relevance and importance. Deciding how to carry out a task, the amount of time to be devoted to it and the most suitable information sources.

Full-or-part-time: 18h
Theory classes: 4h
Practical classes: 2h
Self study : 12h

8. Cosmology

Description:
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.

Specific objectives:
Understanding the basic tools of modern cosmology.

Related activities:
None.

Related competencies :
08 CRPE EF. ABILITY TO IDENTIFY, FORMULATE, AND SOLVE PHYSICAL ENGINEERING PROBLEMS. Planning and solving physical engineering problems with initiative, making decisions and with creativity. Developing methods of analysis and problem solving in a systematic and creative way.

03 TLG. THIRD LANGUAGE. Learning a third language, preferably English, to a degree of oral and written fluency that fits in with the future needs of the graduates of each course.
07 AAT N3. SELF-DIRECTED LEARNING - Level 3. Applying the knowledge gained in completing a task according to its relevance and importance. Deciding how to carry out a task, the amount of time to be devoted to it and the most suitable information sources.

Full-or-part-time: 21h
Theory classes: 5h
Practical classes: 2h
Self study : 14h

GRADING SYSTEM

60% final examination, 40% Project-Based Learning.

EXAMINATION RULES.

To be defined.

BIBLIOGRAPHY

Basic:
- Karttunen, H. [et al.], editors. Fundamental astronomy: with 419 illustrations including 34 colour plates and 83 exercises with solutions. 6th ed. Heidelberg: Springer, 2017. ISBN 9783662571033.
- Carroll, B.W.; Ostlie, D.A. An introduction to modern astrophysics. 2nd ed. San Francisco: Pearson Addison-Wesley, 2007. ISBN 0805304029.

Complementary:
- José, Jordi. Stellar Explosions: hydrodynamics and nucleosynthesis. Boca Raton: CRC Press, 2016. ISBN 9781439853061.
- Zeilik, M.; Gregory, S.A. Introductory astronomy and astrophysics. 4th ed. Fort Worth: Saunders College, 1998. ISBN 0030062284.

RESOURCES

Computer material:
- Ordinador portàtil. Personal laptop computer