COURSE DATA

DATA SUBJECT

Code: 34261
Name: Astrophysics
Cycle: Undergraduate Studies
ECTS Credits: 4.5
Academic year: 2026-27

STUDY (S)

Degree	Center	Acad. year	Period
1105 - Degree in Physics	Facultat de Física	3	First quarter
1928 - Double Degree Program Physics-Mathematics	Facultat de Física	4	Second quarter
1929 - Double Degree Program in Physics and Chemistry	Facultat de Química	4	First quarter

SUBJECT-MATTER

Degree	Subject-matter	Character
1105 - Degree in Physics	Physics of the earth and the cosmos	COMPULSORY
1928 - Double Degree Program Physics-Mathematics	Cuarto Curso (Obligatorio)	COMPULSORY
1929 - Double Degree Program in Physics and Chemistry	Cuarto Curso (Obligatorio)	COMPULSORY

COORDINATION

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SUMMARY

Astrophysics applies the methods and knowledge of modern physics to the study of the motion, structure, composition, and evolution of astronomical objects, from the bodies of the Solar System to stars and galaxies.

The course is organised into three blocks, preceded by an introductory topic devoted to the emergence of Astrophysics as a scientific discipline, its subject of study, its methods, the scales of the Universe, and the concepts of angular resolution and sensitivity in astronomical observations. The first block (Topics 1–3) addresses the motion of astronomical objects, the description of the Solar System and its components, as

well as the current status of exoplanet discoveries, the general properties that are emerging from these discoveries, and the place of the Solar System within the broader population of planetary systems. The second block (Topics 4–7) is devoted to Stellar Physics, covering the fundamental properties of stars, the parameters used to describe them, and their structure and evolution. The third block focuses on Galaxies and Cosmology. It examines our Galaxy and other galaxies in the Universe, introducing some of the most relevant topics in contemporary astronomical research, such as dark matter, active galaxies, and supermassive black holes. Finally, basic concepts of Cosmology are presented, including the Big Bang model and the cosmological paradigm supported by current observations: a flat Universe undergoing accelerated expansion.

Students wishing to broaden their knowledge in this field may take the optional fourth-year courses Observational Astrophysics and Relativity and Cosmology, offered within the Physics Degree programme.

PREVIOUS KNOWLEDGE

RELATIONSHIP TO OTHER SUBJECTS OF THE SAME DEGREE

There are no specified enrollment restrictions with other subjects of the curriculum.

OTHER REQUIREMENTS

It is advised to have completed the first two years of the degree. All the specific subjects of Physics are important for this course. Specific subjects of Mathematics are also important, in particular Integral Calculus and Differential Equations.

It should be emphasized that Astrophysics is, by its very nature, a field of science where most of the specialties of Physics converge.

COMPETENCES / LEARNING OUTCOMES

1105 - Degree in Physics

Basic & applied Research: acquire an understanding of the nature and ways of physics research and of how physics research is applicable to many fields other than physics, e.g. engineering; be able to design experimental and/or theoretical procedures for: (i) solving current problems in academic or industrial research; (ii) improving the existing results.

Be able to understand and master the use of the most commonly used mathematical and numerical methods.

Communication Skills (written and oral): Being able to communicate information, ideas, problems and solutions through argumentation and reasoning which are characteristic of the scientific activity, using basic concepts and tools of physics.

Foreign Language skills: Have improved command of English (or other foreign languages of interest) through: use of the basic literature, written and oral communication (scientific and technical English), participation in courses, study abroad via exchange programmes, and recognition of credits at foreign universities or research centres.

Knowledge and understanding of the fundamentals of physics in theoretical and experimental aspects, and the mathematical background needed for its formulation.

Learning ability: be able to enter new fields through independent study, in physics and science and technology in general.

Modelling & Problem solving skills: be able to identify the essentials of a process / situation and to set up a working model of the same; be able to perform the required approximations so as to reduce a problem to an approachable one. Critical thinking to construct physical models.

Physics general culture: Be familiar with the most important areas of physics and with those approaches which span many areas in physics, or connections of physics with other sciences.

Problem solving: be able to evaluate clearly the orders of magnitude in situations which are physically different, but show analogies, thus allowing the use of known solutions in new problems .

Students must be able to apply their knowledge to their work or vocation in a professional manner and have acquired the competences required for the preparation and defence of arguments and for problem solving in their field of study.

Students must be able to communicate information, ideas, problems and solutions to both expert and lay audiences.

Students must have acquired knowledge and understanding in a specific field of study, on the basis of general secondary education and at a level that includes mainly knowledge drawn from advanced textbooks, but also some cutting-edge knowledge in their field of study.

Students must have developed the learning skills needed to undertake further study with a high degree of autonomy.

Students must have the ability to gather and interpret relevant data (usually in their field of study) to make judgements that take relevant social, scientific or ethical issues into consideration.

Theoretical understanding of physical phenomena: have a good understanding of the most important physical theories (logical and mathematical structure, experimental support, described physical phenomena).

To know how to apply the knowledge acquired to professional activity, to know how to
solve problems and develop and defend arguments, relying on this knowledge.

DESCRIPTION OF CONTENTS

1. Motions of planets and stars.

General introduction. Equations and properties of the movements. Equation of the orbits. Elements of the orbit. Scape velocity. The two-body problem. Restricted three-body problem and mass-transfer in binary systems. The virial theorem.

2. The Solar System.

General properties. The formation of the Solar System. Structure of the planets. Atmospheres. Magnetospheres. The Sun. Planets and asteroids. Comets, the Oort's cloud and the Kuiper's belt.

3. Exoplanets and Astrobiology.

Methods of exoplanet detection. Properties and habitability. Introduction to astrobiology.

4. Stars. Stellar parameters. Spectral Classification.

Magnitudes. Stellar parameters: masses, luminosities, temperatures and radii. Mass-luminosity relationship. Spectral lines. Spectral classification: spectral types and luminosity classes. Hertzsprung-Russell diagram.

5. Radiative transfer.

Intensity and flux. Radiative transfer equation: conservation, emission and absorption. Radiation force. Blackbody radiation and thermal radiation. Diffusion approximation.

6. Stellar structure.

Equation of state. Hydrostatic balance. Production of energy in the stellar interior: nuclear reactions and reaction rates. Stellar nucleosynthesis. Energy balance. Sources of opacity and temperature gradient. Stellar structure equations and stellar models.

7. Stellar evolution.

Characteristic time scales. Star formation and protostellar evolution. Main sequence stage. Evolution towards red giant. Late evolutionary stages according to star mass and evolution in binary systems. Novae, supernovae, neutron stars, white dwarfs and black holes.

8. Galactic astronomy.

Distance measurements and stellar statistics. Structure and general characteristics of the Galaxy. The galactic center. Galactic kinematics and dark matter.

9. Extragalactic astronomy.

The discovery of other galaxies. Extragalactic distance indicators. Classification of galaxies. Stellar populations. Dark matter. Photometric properties. Active galaxies and supermassive black holes. Clusters and groups of galaxies.

10. Cosmology.

Expansion of the universe. Hubble-Lemaître's Law. Age of the universe. Critical density. Cosmological equations. Distances in cosmology. Cosmic background radiation. Density of matter and radiation. The early universe. Thermal history. Primordial nucleosynthesis. Dark energy. Current cosmological paradigm: accelerated flat universe.

WORKLOAD

PRESENCIAL ACTIVITIES

Activity	Hours
Tutorials	7,00
Theory	38,00
Total hours	**45,00**

NON PRESENCIAL ACTIVITIES

Activity	Hours
Attendance at other activities	0,00
Individual or group project	17,50
Independent study and work	25,00
Preparation of lessons	15,00
Preparation for assessment activities	10,00
Resolution of case studies	0,00
Total hours	**67,50**

TEACHING METHODOLOGY

Contact teaching 40%

Theoretical and practical classes: It addresses the conceptual and formal matter and resolution of problems or cases as the application of theoretical concepts. They are based mainly on lectures with dialogue and the use of teaching tools such as experimental demonstrations, animations or videos, graphic solutions, projected presentations, etc.)..

Group tutoring sessions or work in small groups: focus on student work and their active participation: resolving doubts in dealing with theoretical concepts and problem solving, reinforcement in areas of greatest difficulty, questionnaires conceptual , experimental demonstrations relevant to the case studies and associated with a component of continuous assessment, verification of student progress in the field.

Student's personal work 60%

- Study of the theoretical foundations.

- Resolution and problems, multiple choice questions, and works (individually or in groups)

- Individual tutorials: querying of the teacher on student concerns and difficulties encountered in the study and resolution of problems, or discussion on topics of interest, bibliography, etc.

EVALUATION

The assessment methods are as follows:

1. Written examinations:

- One part will assess the understanding of the theoretical and conceptual aspects of the course, as well as its formalism, through theoretical questions, conceptual questions, numerical exercises, and simple specific cases.

- Another part will evaluate the ability to apply the formalism through problem solving, as well as the ability to critically assess the results obtained.

- In both parts, clear reasoning and adequate justification will be taken into account.

2. Continuous assessment: Based on:

- Several 30-minute tests conducted during the lectures, consisting of questions and problems related to the material covered in class.

- Oral presentation of solved problems.

- Preparation of practical assignments, either individually or in small groups.

Remarks: The final grade will be the higher of the following: the grade obtained in the written examination, or the grade resulting from the weighted average of 75% of the written examination grade and 25% of the continuous assessment grade. However, a minimum grade of 3.5 out of 10 in the written examination is required to pass the course. The continuous assessment grade will be retained for both examination sessions of the academic year. The weighting of the written examination and continuous assessment components will be the same in both the first and second examination sessions.

REFERENCES

Basic

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Additional

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