UAB
Universitat Autònoma de Barcelona

Cosmology

2026/2027

Code: 42858
Credits: 6

Degree programme	Type	Course
High Energy Physics, Astrophysics and Cosmology	OP	1

Contact lecturer

Name : Lluís Galbany Gonzalez

Email : lluis.galbany@uab.cat

Teaching staff

Alex Alarcon Gonzalez

Diego Blas Temiño

Isaac Tutusaus Lleixa

Group languages

You can consult this information at the end of the document.

Prerequisites

Introduction to the Physics of the Cosmos

Objectives

The course is intended to provide students with a introductory lectures to Cosmology. The standard Cosmological model, the open questions and the current research lines in the field.

Learning outcomes

- CA13 (Present the results of cosmology-related exercises, explaining concepts in a clear and accessible way to a specialized and non-specialized audience.) Present the results of cosmology-related exercises, explaining concepts in a clear and accessible way to a specialized and non-specialized audience.
- KA20 (To define the bases of the Big Bang theory and the theory of cosmic perturbations in cosmology.) To define the bases of the Big Bang theory and the theory of cosmic perturbations in cosmology.
- KA21 (Identify the challenges facing modern cosmology.) Identify the challenges facing modern cosmology.
- SA46 (Analyze the problems of the classical Big Bang theory.) Analyze the problems of the classical Big Bang theory.
- SA47 (Apply the theory of cosmic perturbations to the problem of structure formation in the universe.) Apply the theory of cosmic perturbations to the problem of structure formation in the universe.

- SA48 (Analyze the theory of cosmic expansion and its main elements.) Analyze the theory of cosmic expansion and its main elements.
- SA49 (Analyze the solutions to the problems of the classical Big Bang theory.) Analyze the solutions to the problems of the classical Big Bang theory.
- SA50 (Use bibliographic tools, online and in English, to delve into the key concepts of current cosmology.) Use bibliographic tools, online and in English, to delve into the key concepts of current cosmology.

Contents

1) Introduction to the course

2) Practical projects

3) Flash Intro

4) Inflation

5) Baryogenesis

6) Dark matter & Dark Energy

7) Thermal history - Homogeneous Universe

8) Inhomogeneous Universe

9) Gravitational instability - Growth of structure

10) Probes of structure

11) Observational probes

12) Models beyond LCDM

Learning activities and methodology

Title	Hours	ECTS	Learning outcomes

Class Projects	39	1.56
Home problems	39	1.56
Lectures on basic concepts	45	1.8

Theory lectures and exercises.

Classwork and Homework.

In this course, the use of Artificial Intelligence (AI) technologies is permitted as an integral part of the development of assignments, provided that the final outcome reflects a significant contribution from the student in terms of analysis, interpretation, and personal reflection. Students must clearly identify which parts of their work have been generated or assisted by AI technologies, specify the tools used, and include a critical reflection on how these tools have influenced both the development process and the final outcome of the activity. Failure to disclose the use of AI will be considered a breach of academic integrity and may result in a penalty in the assessment of the assignment or, in more serious cases, the application of further disciplinary sanctions in accordance with academic regulations.

Annotation: within the schedule set by the centre or degree programme, 15 minutes of one class will be reserved for students to evaluate their lecturers and their courses or modules through questionnaires.

Assessment

Continuous assessment activities

Title	Weight	Hours	ECTS	Learning outcomes
Problems	33%	5	0.2	KA20, SA46, SA47, SA48, SA49, SA50
Resit Exam	33%	3	0.12	KA20, SA46, SA47, SA48, SA49
Exam	33%	3	0.12	KA20, SA46, SA47, SA48, SA49
Research project	33%	16	0.64	CA13, KA21, SA50

This subject/module does not foresee the single assessment system.

Attendance to class is a mandatory requirement. 33% of the grade comes from assignments of problems and another 33% from the completion of a research project in groups. The remaining 33% comes from a written exam. To be able to participate in the written exam, you must have obtained a grade higher than 3.5/10 in the assignments of problems and the project.

Bibliography

- An introduction to Moderm Cosmology, A.Liddle, Horizon P&D (1999, 2003)
- Modern Cosmology, S. Dodelson, Elsevier (2020)
- Cosmological Physics, J.A.Peacock, Cambridge U. Press (1999)
- Extragalactic Astronomy and Cosmology, Peter Schneider, (2010)
- Introduction to Cosmology, Barbara Sue Ryden (2010)

Software

PART I : Introduction

1) Introduction to the course

2) Practical projects

3) Flash Intro (Homogeneous Universe, GR Equations: Friedmann Eq. and Acceleration scalar & tensor, Metric, Distances, Redshift)

PART II : Standard model problems

4) Inflation (Flatness and Horizon problem, Inflation models and perturbations, Power spectrum and GWs)

5) Baryogenesis (Puzzle of the entropy in the Universe, Some solutions)

6) Dark matter & Dark Energy (Motivation, and some cosmological studies - freeze-out)

PART III: Observational probes

7) Thermal history - Homogeneous Universe (Boltzmann equations, Recombination, Ionization history)

8) Inhomogeneous Universe (CMB temperature, polarization, SZ effect, Sachs-Wolfe effect).

9) Gravitational instability - Growth of structure (Evolution of scales vs. time, Equations of Motion for Perturbations, Solution to Linear Order, Growing Mode / Decaying Mode, Evolution during Matter Domination, Evolution during Radiation Domination -Suppression of Growth, Linear Power Spectrum, Random Fields -skewness / kurtosis, Baryon Acoustic Oscillations)

10) Probes of structure (Gravitational Lensing: Weak lensing and Strong Lensing, Galaxy Formation - Halo model - Numerical simulations, Galaxy clusters - Galaxy clustering)

11) Observational probes (SN Ia/II, BAO, RSD, 3x2pt, 5x2pt, H0/s8 tension)

12) Models beyond LCDM (Modified gravity, Evolving DE)

Course groups and languages

The information provided is provisional until November 30. After this date, you will be able to consult the language of each group through this link. To access the information, you will need to enter the course CODE

Type of teaching	Group	Language	Semester	Shift
(TEm) Theory (master)	1	English	second semester	morning-mixed