**UNIVERSITY OF MISSISSIPPI**
Department of Physics and Astronomy
Intro to Cosmology (Phys. 436) — Prof. Leo C. Stein — Fall 2023

**Intro to Cosmology Syllabus**

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| Class schedule: | MWF 1300–1350, Lewis 228 |
| Office hours: | F 1000-1100, Lewis 205 |
| Course website: | https://duetosymmetry.com/teaching |
| Professor: | Leo C. Stein (he/him; you can call me "Leo" or "Dr. Stein") |
| Email: | ⟨lcstein@go.olemiss.edu⟩ |
| Office: | 205 Lewis Hall |

Accessing homeworks will be through Blackboard. If you are in this course and do not have access to the virtual classroom, email Leo ASAP!

## Course goals and learning outcome

Course outline (time permitting): • Doppler Effect (and a little Special Relativity), • Kinematics of Newtonian Cosmology, • Dynamics of Newtonian Cosmology, • Introduction to Non-Euclidean Spaces, • Black-Body Radiation and the Early History of the Universe, • The Accelerating Universe and the Cosmological Constant, • Big-Bang Nucleosynthesis, • Problems of the Conventional (Non-Inflationary) Hot Big Bang Model, • The Inflationary Universe Model, • Primordial Density Fluctuations and the Cosmic Microwave Background, • Eternal Inflation and the Multiverse .

Goals: Big picture view of history of the universe; applications of relativity; how to mathematically describe an expanding universe; basic ideas of non-Euclidean spaces; measuring distances in a curved universe; thermodynamics in an expanding universe; the origin of the elements in the big bang; which observations inform this understanding.

## Texts

Required: Ryden, Barbara. *Introduction to Cosmology*, 2nd edition (Cambridge Univ. Press).
Other recommendations (not required) include Weinberg's *The First Three Minutes*, and Liddle's *An Introduction to Modern Cosmology*.

## Evaluation

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| Grade type: | Letter grade A–F |
| Grade ranges: | (subject to change)<br>• A: 88% and up<br>• B: 75–87%<br>• C: 65–74%<br>• D: 55–64%<br>• F: <55% |
| Grade breakdown: | (subject to change)<br>• 50% Homework<br>• 20% Midterm<br>• 30% Final |

## Homework, tests, and final exam

Homework assignments will be announced via the course web site, and they must be turned in by midnight on the due date. Late homework will be penalized 20% per day (exceptions and extensions permitted with good cause). Homeworks and exams may be physically handed in, or submitted as PDFs or JPGs via the

course web site. Homework must be easy to read: please clearly write down your name and the problem set number, do not use a red pen. The midterm and final exam will be open-book and open-notes, and a calculator will be permitted.

## Attendance

There is no strict attendance requirement, but you are strongly advised to attend class. Attendance has a strong correlation with performance. I recommend that you read the book sections in advance and come ready to participate. If you miss an exam or cannot turn in homework, please inform me beforehand and get a doctor's note if applicable. Absences from tests count as zeros, unless they are justified. If you must be absent during a test for a University sponsored event, you must discuss this with me before the test date.

## Academic Integrity

Violations of the University's policy of academic integrity will result in a failing grade and other disciplinary actions. A student with a documented case of plagiarism or cheating in this course will receive a failing grade for the course and may face disciplinary action by the University, including expulsion.

In particular, do not turn in problem set solutions copied from online or a solutions manual. Copying solutions does nothing to enhance your learning. If I see this then you will get an automatic 0 for the problem set. It if happens more than once I will report it to the chair of the department.

## Disability Access and Inclusion

The University of Mississippi is committed to the creation of inclusive learning environments for all students. If there are aspects of the instruction or design of this course that result in barriers to your full inclusion and participation, or to accurate assessment of your achievement, please contact the course instructor as soon as possible. Barriers may include, but are not necessarily limited to, timed exams and in-class assignments, difficulty with the acquisition of lecture content, inaccessible web content, and the use of non-captioned or non-transcribed video and audio files. If you are approved through SDS, you must log in to your Rebel Access portal at `https://sds.olemiss.edu` to request approved accommodations. If you are NOT approved through SDS, you must contact Student Disability Services at 662-915-7128 so the office can: 1) determine your eligibility for accommodations, 2) disseminate to your instructors a Faculty Notification Letter, 3) facilitate the removal of barriers, and 4) ensure you have equal access to the same opportunities for success that are available to all students.

## Other

If a change in the syllabus becomes necessary during the semester, it will be discussed in class and then posted on the course website. The course website will also contain up-to-date information on the class schedule, homework assignments, and complementary material.

## Schedule (subject to change)

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| M | Aug | 21 | Lecture 01: | Admin; The big picture |
| W | Aug | 23 | Lecture 02: | Big picture of the standard cosmological model |
| F | Aug | 25 | Lecture 03: | Standard cosmological model |
| M | Aug | 28 | Lecture 04: | Doppler effect and special relativity |
| W | Aug | 30 | Lecture 05: | Doppler effect and special relativity |
| F | Sep | 01 | Lecture 06: | Kinematics of a homogeneous expanding universe |
| M | Sep | 04 | | Labor Day – Holiday |
| W | Sep | 06 | Lecture 07: | Kinematics of a homogeneous expanding universe |
| F | Sep | 08 | Lecture 08: | Dynamics of homogeneous expansion |
| M | Sep | 11 | Lecture 09: | Dynamics of homogeneous expansion |
| W | Sep | 13 | Lecture 10: | Dynamics of homogeneous expansion |
| F | Sep | 15 | Lecture 11: | Dynamics of homogeneous expansion |
| M | Sep | 18 | Lecture 12: | Introduction to non-Euclidean spaces |
| W | Sep | 20 | Lecture 13: | Introduction to non-Euclidean spaces |
| F | Sep | 22 | Lecture 14: | Closed universes |
| M | Sep | 25 | Lecture 15: | Closed universes |
| W | Sep | 27 | Lecture 16: | Open universes and the spacetime metric |
| F | Sep | 29 | Lecture 17: | Open universes and the spacetime metric |
| M | Oct | 02 | Lecture 18: | Spacetime metric and geodesic equation |
| W | Oct | 04 | Lecture 19: | Spacetime metric and geodesic equation |
| F | Oct | 06 | Lecture 20: | Geodesic equation cont'd. |
| M | Oct | 09 | Lecture 21: | Geodesic equation cont'd. |
| W | Oct | 11* | Lecture 22: | Black-body radiation and the early history of the universe |
| F | Oct | 13* | Lecture 23: | Black-body radiation and the early history of the universe |
| M | Oct | 16 | Lecture 24: | Black-body radiation and the early history of the universe |
| W | Oct | 18 | Lecture 25: | Black-body radiation and the early history of the universe |
| F | Oct | 20 | Lecture 26: | Black-body radiation and the early history of the universe |
| M | Oct | 23 | Lecture 27: | Cosmic microwave background spectrum and the cosmological constant |
| W | Oct | 25 | Lecture 28: | Cosmic microwave background spectrum and the cosmological constant |
| F | Oct | 27 | Lecture 29: | The cosmological constant |
| M | Oct | 30 | Lecture 30: | The cosmological constant |
| W | Nov | 01 | Lecture 31: | Supernovae Ia and vacuum energy density |
| F | Nov | 03 | Lecture 32: | Supernovae Ia and vacuum energy density |
| M | Nov | 06 | Lecture 33: | Nucleosynthesis and the early universe |
| W | Nov | 08 | Lecture 34: | Nucleosynthesis and the early universe |
| F | Nov | 10 | Lecture 35: | Nucleosynthesis and the early universe |
| M | Nov | 13 | Lecture 36: | (Buffer since we may fall behind schedule) |
| W | Nov | 15 | Lecture 37: | (Buffer since we may fall behind schedule) |
| F | Nov | 17 | Lecture 38: | (Buffer since we may fall behind schedule) |
| | | | | Nov 18–26 Thanksgiving Holidays |
| M | Nov | 27 | Lecture 39: | Problems of the conventional hot big bang model |
| W | Nov | 29 | Lecture 40: | Inflation |
| F | Dec | 01 | Lecture 41: | Inflation |
| | | | | Dec 04–08 Final exams |

*=Leo has another responsibility (e.g. travel). So far, this schedule is just a suggested order.