Astronomy 218 Syllabus

Honors Introductory Astronomy
Spring 2023
University of Tennessee Knoxville

Instructor Information

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Class Meeting Times

Lecture: Nielsen Physics Building 304, MWF 11:30am - 12:20pm

Lab: Nielsen Physics Building 108, [T 7:45pm - 9:35pm] or [W 7:40pm - 9:30pm]

Office Hours: South College 106, time TBD

Textbook

The textbook for the course is *Foundations of Astrophysics* by Barbara Ryden and Bradley M. Peterson. We will be using chapters 13-24 of the book for this course, covering stars, galaxies, and cosmology. Reading will be assigned with homework assignments.

Grading

Grades will be a weighted sum of grades in each of the following categories. The final letter grade will be assigned as follows, and grades within 1% of the boundary will be given a "+" or "-" (so a grade of 89.999% is a B+).

90-100%	A
80-90%	B
70-80%	C
60-70%	D
0-60%	F

Reading Quizzes **(5%)**

There will be a short question about the reading at the beginning of each class. You will have the chance to discuss with other students and there will be many of these, and it is meant to be a low-pressure discussion-inducing activity.

Homework **(25%)**

There will be weekly homework due on Friday at the beginning of class. Please upload to Canvas if possible, but I will also accept paper copies. *Collaboration* is encouraged (you must give credit to your sources), but *copying* is forbidden. See the honor code section below for definitions. There is a late penalty of 20 points per day, but you have one penalty-free day to use when you need.

Review Quizzes **(25%)**

In place of midterm exams, there will be a weekly review quiz based on all returned homework assignments and in the style of questions on the final exam. Collaboration is not allowed, but you may bring a single 8.5"x11" equation sheet. Your lowest quiz score will be dropped.

Final Exam **(10%)**

The final exam will cover the entire course at the level of the reading quizzes, homeworks, review quizzes, and labs. It is tentatively scheduled for Tuesday May 16 10:30am - 12:45pm, but check https://registrar.utk.edu/calendar for an updated schedule.

Laboratory **(25%)**

As part of this course, you will learn how to interact with the skies to actually verify the stories that your instructor (who is a theorist) tells you. The labs will include a combination of using astronomical imaging hardware, data analysis, computation, and laboratory activities that allow us to make sense of astronomical observations.

Scientific Literature Project **(10%)**

There will be a series of project steps that culminate in writing a summary of a current article in the style of astrobites (https://astrobites.org). This is designed to help you get started interacting with the scientific literature. The project description and resources will be posted on Canvas.

Honor Code

You may not obtain an unfair advantage over other students and all proper credit must be given. If you have any questions about the policy, please ask me.

Collaboration: Science is highly collaborative, and you are encouraged to collaborate verbally on homework. *You must cite* the people and resources you use for each question. However, you

should never see or hear solutions directly, including those from other students, Chegg, Course Hero, or the textbook solutions manual.

Logistics

- Students Disability Service: The University of Tennessee, Knoxville, is committed to providing an inclusive learning environment for all students. If you anticipate or experience a barrier in this course due to a chronic health condition, a learning, hearing, neurological, mental health, vision, physical, or other kind of disability, or a temporary injury, you are encouraged to contact Student Disability Services (SDS) at 865-974-6087 or sds@utk.edu.
- Sick policy: If you are sick or unwell, please let me know asap so we can make arrangements. If you have or were exposed to COVID-19, please follow the university guidelines at https://studenthealth.utk.edu/covid-19.
- Planned absences: If you know you will be absent from class (e.g. traveling to a conference) and will not be absent from class, let me know asap so we can arrange for you to submit assignments early.

Course Objectives

There are a lot of exciting things you can do in a single semester! I hope to get to all of it, but time will tell. By the end of the course, students should be able to:

- Recall:
  - What physics goes into modeling a star, white dwarf, neutron star, black hole, galaxy
  - Observables of interstellar gas and dust and the intergalactic medium
  - Mechanisms of generating light and cooling gas
  - The evolutionary pathways of different types of stars
  - Evidence for dark matter
  - Evidence for dark energy
  - Evidence for a black hole at the center of our and other galaxies
  - Evidence for the big bang
  - Evidence for accelerating expansion of the universe
  - Evidence for cosmological inflation
  - Size hierarchy of planets, stars, star clusters, dwarf galaxies, galaxies, galaxy groups, galaxy clusters, galaxy superclusters, and the observable universe
  - Typical relative speeds of planets, stars, stellar remnants, and galaxies
  - All known fundamental particles that make up the universe
  - The evolutionary history of the universe in terms of its ionization state and main constituents
  - The main nuclear reactions that power main-sequence stars

- Explain
  - How to measure the Milky Way galaxy's rotation curve
  - How to measure the mass of a galaxy
  - The origin of different galaxy morphologies and activity states
  - How the universe forms different elements
  - Why the night sky is mostly dark
  - How the cosmic microwave background and large scale structure inform us about the early universe
- Use astronomical instruments to collect and process data for:
  - General imaging
  - Parallax distance measurements
  - Apparent brightness under different filters
  - Spectral identification of elements
- Use astronomical data to calculate:
  - distances to stars, galaxies, and the big bang
  - star properties (brightness, color, size, age)
  - binary star orbital period
- Classify:
  - stars
  - galaxy morphologies
  - active galaxies
  - stellar explosions
- Calculate to an order of magnitude:
  - The size of a gas cloud that will collapse to form stars
  - The oscillation period of a star
  - The tidal disruption radius and event horizon radius of a black hole
  - The velocities of stars in a galaxy of given mass
  - The temperature of an accretion disk
  - Statistical properties of stars in a galaxy or stellar cluster and of galaxy in a galaxy cluster
- Calculate the rate of energy generation and transport in stellar models
- Determine the ionization state of elements in stellar atmospheres
- Evaluate high-energy transient models based on the accretion power
- Evaluate models of nuclear forces using observations of neutron stars
- Calculate the 3D velocity of a star relative to the Earth and the galactic center
- Create a Newtonian model of the expanding universe and demonstrate where it does not work
- Apply the basics of general relativity to accurately relate distance to redshift
- Use numerical tools to perform basic image and data processing

- Numerically integrate equations describing hydrostatic equilibrium and the evolution of the universe
- Summarize the context, methods, and results of current scientific articles