ASTR 367 – Astrophysics I – Fall 2023

Instructor: Prof. Loren Anderson, 304-293-4884
Class times: MWF 9:30-10:20 in G06 White Hall
Office hours: After class every day (MWF 10:20 onward). If that doesn't work for you, just let me know and we will set up a time to meet. Also, please feel free to stop by my office and if the door is open, I'm free.

Overview: The goal of this course is to give you a good working understanding of stellar properties, how stars generate energy, and how stars are born and die. We will become familiar with the properties (e.g. temperatures, ages, chemical compositions) of stars and the different states of matter that make up stars. We will understand hydrostatic equilibrium, nuclear fusion and energy transport. We will follow the lifecycles of different types of stars and understand the properties of the different end-points.

We will concentrate on understanding the physics of stars using simple calculations. Many of our calculations will be order-of-magnitude and back-of-the-envelope.

While this course is designed to prepare students for careers as astrophysicists, the physics we will cover has a broad range of applications, and the approach to problems should help in many areas of physics.

Text: The required text for this class is *An Introduction to Modern Astrophysics*, by Carroll & Ostlie (ISBN 0-8053-0402-9). The current edition has been out forever and it's easy to find for purchase or otherwise. We will be covering material from Chapters 1-18.

I will also use material from scientific papers and other texts, which when integral to the lecture I will hand out in class.

Assessment: 60% Homework; 15% Midterm, 25% Final

Homework will be assigned roughly once per week in class. Unless otherwise stated, homework will be due one week from when it was assigned, at the beginning of class. **No late homework will be accepted**, but the lowest two grades will be dropped. I encourage you to talk with each other about the homework, <u>but the actual solutions must be your own. This last point is very important! Any academic dishonesty will not be tolerated, and punishments will range from failure on the assignment to an unforgivable F in the course.</u>

Grading: 85-100% = A; 75-84% = B; 65-74% = C; 55-64% = D; < 55% = F

Attendance: There is no specific attendance requirement. Since we will have lots of class discussion and I will be using material from sources other than the textbook, you will do a lot better in the course if you attend.

Exams: There will be one midterm and a cumulative final exam. If you cannot make it to the final, you **must** let me know well in advance so we can schedule a makeup exam.

Syllabus:
Aug. 16 (W), 18 (F), 21 (M): Introduction and Overview. Astrophysical units, distances, measuring brightnesses and luminosities, colors, the HR diagram

Aug. 23 (W), 25 (F): Equations of Stellar Structure. Hydrostatic equilibrium, the Virial theorem, ideal gas equation of state

Aug. 28 (M), Aug 30 (W): Basic properties of stars and dependencies. Characteristic timescales for evolution, mass-radius and mass-luminosity relations, minimum and maximum stellar masses

Sept. 1 (F), 6 (W): Gas and radiation. Equations of state, sources of pressure in stars, radiative transfer

(Sept. 4 (M) Labor Day – No Class)

Sept. 8, (F) 11 (M), 13 (W): Nuclear Fusion. Processes for energy generation in stars

Sept. 15 (F): Catch-Up, Review, and Problem Solving

Sept. 18 (M): In-class Exam

Sept. 20 (W): Exam review

Sept. 22 (F), 25 (M), 27 (W): Energy transport in stars Radiation, convection, conduction

Sept. 29 (F), Oct. 2 (M), 4(W): Homology relations Relationships between stellar properties

Oct. 6 (F) Fall Break - No Class

Oct. 9 (M), 11 (W), 13 (F): Stellar Evolution. Life on the main sequence, post-main sequence evolution

Oct. 16 (M), 18 (W), 20 (F): Stellar modeling

Oct. 23 (M), 25 (W): Star formation. Processes of formation (criteria, timescales, and properties)

Oct. 30 (M), Nov. 1 (W): Stellar Pulsations Cepheids, non-radial pulsations, astroseismology

Nov. 3 (F), 6 (M), 8 (W): Stellar death Supernovae and their manifestations

Nov. 10 (F), 13 (M) Compact Objects: Degeneracy pressure and white dwarfs

Nov. 15 (W), 17 (F): Compact Objects and Relativity Neutron stars and black holes

Nov 20 (M) - Nov. 24 (F) Thanksgiving Break – No Class

Nov. 27, Nov. 29: Binary star systems Accretion, Roche lobes, CVs, novae

Dec. 1 (F) The Sun! Sunspots, the solar cycle, solar evolution

Dec. 4 (M), 6 (W): Review and Problem Solving

Dec. 12: Final Exam (2 - 4 pm) https://registrar.wvu.edu/calendars/final-examination-schedule