PHYS 430: Astrophysics Spring-2023

Instructor: Dr. Truong Le (he,him,his)
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Credits for the course: 1
Lectures Time: TTh 8:30-10:00 am
Lectures Room: Trexler 374

Class Environment: I consider this classroom to be a place where we will treat one another with respect, creating an environment that welcomes individuals of all ages, backgrounds, beliefs, ethnicities, genders, gender identities, gender expressions, national origins, religious affiliations, sexual orientations, ability and other visible and nonvisible differences. Please advise me of this preference early in the semester so that I may make appropriate changes to my records. To minimize distraction, please put your cell phone to silent mode before any lecture. The instructor has the right and the authority to expel anyone who disrupts the lecture or behaves inappropriately at any time. **This syllabus will continue to change with students' notice.**

Office Hours: MWF (10-12 pm), and by appointment.

Course Description: Quantitative treatment of basic astronomical principles. Topics include cosmological models, galaxies, stars, and the interstellar medium.

Prerequisites: PHYS 203

Course Material: Required and recommended

- **Text (required):** *Astronomy - A physical perspective* by Marc L. Kutner.
- **Text (recommended):** *Astrophysics in a Nutshell* by Dan Maoz.

Learning Objectives: Students will be able to

- show a broad appreciation of the scale and astronomical contents of the universe and the astrophysical processes involved.
- show how the fundamental properties of stars are measured - their luminosity, surface temperature, size, mass, and distance - and how these are related by simple physical models.
- describe the life cycle of stars of differing masses and the astrophysical processes that determine their evolution, including their source of energy, until they end their life as white dwarfs, neutron stars or black holes.
- explain how we have learnt about the size and form of our own galaxy and the regions of gas and dust that can become the birthplace of new stars.
- understand how the dynamics of galaxies and clusters indicate the presence of dark matter.
- demonstrate an understanding of the origin and evolution of our Universe, including an appreciation of the evidence for the Big Bang and outstanding problems in cosmology

Participation/Attendance: You will work on a tutorial (worksheet) every class. You will need to submit your tutorial online (inquire) after every class. This course expects you to spend at least 12 hours per week in and out of class.

Problem Sets: Un-/assigned problems (like those in the problem sets) are **"when and where"** you will learn the course material. For better and for worse, there is no way to learn the depth of the material within the one-hour sessions that we will have together. Due to the nature of problem solving, I expect that you

will work together toward a solution. However, I also expect that you will create an original solution to each assigned problem. Substitutions and simplifications should **NOT** be left to the "reader" (that's me) to figure out. If necessary, words and phrases need to be properly placed so that I can follow your train of thought. Problem sets are your final draft essays and/or compositions that display the fruit of your higher-level critical thinking skills, so you need to view them in that light.

If you do not, I will return them to you for completion. **NOTE:** the submitted problems are EQUAL in weight to the two exams. You need to submit all assigned problems on-time before the due date to receive full credit. **Late submission: 10% will be deducted if submitted by 3 pm on the due date, and additional 10% thereafter.**

Quiz: You will take a short quiz near the end of every class with your group/individually over the tutorial/homework that you have done/submitted, and one quiz will be submitted per group if it is a group quiz. The aim is to see how well you understand the tutorial/homework.

Written Exams: There will be three take home exams in this course. The problems in the exams will involve problems similar in difficulty to those in the problem sets. They will include several conceptual questions, in short-answer format, as well as several calculation questions.

Note: Quizzes and exams will be open book/notes. Any missed quiz or exam will count as zero points unless it is an excused absence (illness, participation in a scheduled College event, etc.), which should be cleared with me before the quiz or exam. The missed quiz or exam may be made up in a way decided by the instructor.

Score on the Quiz and Exam are determined by the following rubric:

Score	Description
5	The solution is correct and the writing is clear. The instructor can easily see that the student fully understands how to solve the problem.
4	The solution is mostly correct, but there may be some flaws. The writing is reasonably clear. There is evidence that the student understands the key concepts involved in solving the problem, but may not fully grasp all of the details.
3	The solution is partly correct, but there are significant errors. The writing may be hard to follow in places. There is evidence that the student does not fully understand the key concepts required to solve the problem, or that the student is unable to use those concepts in an appropriate way.
2 or less	The solution is either completely incorrect or incomprehensible. This may indicate that there are serious flaws in all aspects of the solution, or that the writing was so poor that it was impossible to follow.

Grading: Your grade in this class will be determined by a combination of class participation, homework, quizzes, and exams. The separate weightings will be:

Participation/Attendance 15%

Homework 30%

Quiz 10% (individual/group)

Three Exams 45% (each-weighted equally)

Final Grade Final course grades will be assigned using the following scale:

A	93% or more	C+	77-79.9%
A-	90-92.9%	C	73-76.9%

B+	87-89.9%	C-	70-72.9%
B	83-86.9%	D	60-69.9%
B-	80-82.9%	F	below 60%

Accessible Education Services (AES): located in the Goode-Pasfield Center for Learning and Teaching in Fintel Library. AES provides reasonable accommodations to students with documented disabilities. To register for services, students must self-identify to AES, complete the registration process, and provide current documentation of a disability along with recommendations from the qualified specialist. Please contact Becky Harman, Assistant Director of Academic Services for Accessible Education, at 540-375-2247 or by e-mail at aes@roanoke.edu to schedule an appointment. If you have registered with AES in the past and would like to receive academic accommodations for this semester, please contact Becky Harman at your earliest convenience to schedule an appointment and/or obtain your accommodation letter for the current semester.

Academic Integrity: Your learning and integrity are at the core of your RC education. For this reason, you must follow the rules outline in the College AI policies. See https://www.roanoke.edu/inside/az index/academic _affairs/academic integrity. **If I become aware of a possible violation of these guidelines, I am contractually obligated to report it to the Academic Integrity committee.**

1-4 weeks (Exam1-Feb 10)

- **Properties of stars:** brightnesses (luminosities, fluxes, and magnitudes); colours (blackbody radiation, the Planck, Stefan-Boltzmann and Wien laws, effective temperature, interstellar reddening); spectral types; spectral lines (Bohr model, Lyman & Balmer series, Doppler effect); HertzSprung-Russell diagram; the main sequence (stellar masses, binary systems, mass-luminosity relations); distances to stars (parallax, standard candles, P-L relationships).

5-10 weeks (Exam2-Mar 24)

- **The life and death of stars:** energy source (nuclear fusion, p-p chain, CNO cycle, lifetime of a star); basic stellar structure (hydrostatic equilibrium, equation of state); evolution beyond the main sequence; formation of the heavy elements; supernovae; stellar remnants (white dwarfs, neutron stars, black holes, degeneracy pressure, Schwarzschild radius).
- **Galaxies:** Constituents of galaxies; stellar populations; the interstellar medium; HII regions; 21cm line; spirals and ellipticals; galactic dynamics; galaxy rotation curves and dark matter; active galaxies and quasars. **11-15 weeks (Exam3-Apr 25)**
- **Cosmology:** Galaxies and the expanding Universe; Hubble's Law; the age of the Universe; the Big Bang; cosmic microwave background (blackbody radiation); big bang nucleosynthesis (cosmic abundances, binding energies, matter & radiation); introductory cosmology (the cosmological principle, homogeneity and isotropy, Olber's paradox); cosmological models (critical density, geometry of space, the fate of the Universe); dark energy and the accelerating Universe.

I have read and understood this syllabus. Sign, date, and submit this page for 10 points toward your participation grade on your first day of clas.

Student's signature: **Date:**