PHY 430: Astrophysics   Spring 2026

Instructor: Dr. Truong Le
Office: Trexler 172E
Email: tle@roanoke.edu

Lectures Room: Trexler Hall, 272
Lectures Time: MWF 10:50-11:50 am
Office Hrs: TW (1-3 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

Textbook: Astronomy - A Physical Perspective by Marc L. Kutner (recommended).

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/Tutorial: You will work on a tutorial (worksheet) every class in a group. You will need to show me your tutorial after every class for me to sign to indicate (complete/incomplete). Submit your own tutorial at the beginning of next class. Only one member's tutorial (asterisked, rotating alphabetically) will be graded for full group credit. Complete or incomplete tutorial will receive 10 points or 7 points, respectively. This course expects you to spend at least 12 hours per week in and out of class. You will rotate to a new group after every exam.

Homework: You will have 6 to 10 problems assigned after each class, based on the material covered in your reading and the lecture. 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. **Points will be deducted if your work is not clear**. You need to submit all assigned problems on-time at the beginning of the class. **Late submission: 10% will be deducted per day. No late submission will be accepted after the beginning of the next class.**

Project: Students will design and fly a high-altitude balloon payload to collect temperature, pressure, humidity, carbon dioxide, video, and audio data throughout its ascent and descent.

Exams: There will be three two-hour-exams in this course. The problems in the exams will involve problems similar in difficulty to those in the tutorials and homework. They will include several conceptual questions, in short-answer format, as well as several calculation questions.

Note: Exams will be open notes. Any missed 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 exam. The missed exam may be made up in a way decided by the instructor.

Score on the Homework 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 (tutorial), homework, project, and exams. The separate weightings will be:

Class Participation/Tutorials: 20%

Homework: 20%

Project: 10%

Three Exams: 50% (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%

MCSP Colloquium Series: This semester a series of talks will be offered which appeal to a broad range of interests related to math, computer science, and physics. Participation in at least two talks is mandatory. Within one week of attending a talk you must submit (via Inquire) a one-page single-spaced paper. This paper should not only include a summary of the main content of the talk, but also a personal contemplation of the experience. This will be part of the participation grade.

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/a-z_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.**

Preliminary Schedule: This may be adjusted by the instructor if necessary, but students will be notified of any changes, and there will be no changes to exam dates. The reading chapters are based on Kutner's textbook.

Class	Date	Topics Covered	Chapter
1	Jan. 12	Course info; where are we in the universe	1.1
2	14	Electromagnetic spectrum of light Telescopes and Earth's Atmosphere	2.1-2.3.1
3	16	Blackbody radiation, Wein's Displacement, Stefan-Boltzmann Laws, Temperature, and Luminosity	2.3-2.6
	19	**Martin Luther King, Jr. Day** (no class)	
4	21	Small Angle Formula, Angular Size, and Distance	2.6
5	23	Brightness and Stellar parallax	2.6
6	26	Apparent magnitude, Absolute magnitude, and Distance Modulus	2.5, 2.7
7	28	Spectral Lines in Stars, Hertzsprung-Russel Diagram, Mass-Luminosity relation and Spectroscopic Parallax	3.1-3.3, 3.5, 5.5
8	30	Doppler Shift, Star's Velocity, and Telescopes	4.1-4.9, 5.1-5.2
9	Feb. 2	Exam-1 Review	
		Exam-1 (Feb 9 - evening)	
10	4	Interstellar Medium and Protostars	8.1, 14.2.3-14.2.4
11	6	Mean Free Path, Opacity, and Optical Depth	6.1-6.2
12	9	Interstellar Extinction and Condition of Collapsing Clouds	14.1-14.2, 8.1
13	11	Condition of Collapsing Clouds, and Free-Fall Time - Part 1	8.1
14	13	Condition of Collapsing Clouds, and the Effect of Rotating Clouds-Part 2	8.1
15	16	The Virial Theorem, Luminosity of Collapsing Clouds, and the Sources of Energy in a Star - Part 1	8.2-8.3, 9.1-9.2
16	18	The Virial Theorem, Luminosity of Collapsing Clouds, and the Sources of Energy in a Star - Part 2	8.2-8.3, 9.1-9.2
17	20	p-p Fusion Barrier	9.2.3-9.3
18	23	Stellar Structure - Hydrostatic Equilibrium	9.4-9.4.1
19	25	Stellar Structure - Energy Transport	9.4.2
20	27	Stellar Evolution - White Dwarfs and Neutron Stars - Part 1	10.1-10.4.4, 11.1-11.2
		Spring Break (Feb. 28 - Mar. 8)	
21	Mar. 9	Stellar Evolution - White Dwarfs and Neutron Stars - Part 2	10.1-10.4.4, 11.1-11.2
22	11	Stellar Evolution - Black Hole Part - 1	7.6, 7.8, 11.5
23	13	Stellar Evolution - Black Hole Part - 2	7.6, 7.8, 11.5
24	16	Exam 2 Review	
		Exam 2 (Mar. 20 - evening)	

Class	Date	Topics Covered	Chapter
25	18	Brief Overview of the Milky Way Galaxy and Dark Matter	16
26	20	Brief Overview of Extragalactic & Hubble Expansion	17
27	23	Cosmology - Steady State Universe: Olber's Paradox - Part-1	20.1-20.2
28	25	Cosmology - Steady State Universe: Isotropic & Homogeneous - Part-2	20.1-20.2
29	27	Cosmology - Steady State Universe: Steady-State Model - Part-3	20.1-20.2
30	30	Cosmology - Pressureless "Dust": Model of the Universe Part-1	20.3
31	Apr. 1	Cosmology - Pressureless "Dust" Model of the Universe Part 2: Cosmological Principle	20.3
	3	**Good Friday (no class)**	
32	6	Cosmology - Pressureless "Dust" Model of the Universe Part 3: Evolution of Newtonian Universe	20.3
33	8	Cosmology - Pressureless "Dust" Model of the Universe Part 4: Flat Universe (k=0), WMAP-critical density $(\rho_{c,0})$	20.3
34	10	Cosmology - Pressureless "Dust" Model of the Universe Part 5: WMAP-observed density for baryonic + dark matter $(\rho_{m,0})$, WMAP-observed density for ONLY baryonic matter $(\rho_{m,0})$	20.3
35	13	Cosmology - Pressureless "Dust" Model of the Universe Part 6: General Hubble expansion	20.3
36	15	Cosmology - Pressureless "Dust" Model of the Universe Part 7: General Hubble expansion (special case) when $t = t_0$	20.3
37	17	Cosmology - Pressureless "Dust" Model of the Universe Part 8: General Hubble expansion in redshift (z)	20.3
38	20	Final Exam Review	
	21	**Last day of class**	
		FINAL EXAM: Apr. 24, 8:30-11:30 AM	