Term Information

Effective Term	Spring 2025

General Information

Course Bulletin Listing/Subject Area	Astronomy
Fiscal Unit/Academic Org	Astronomy - D0614
College/Academic Group	Arts and Sciences
Level/Career	Undergraduate
Course Number/Catalog	3810
Course Title	Order of Magnitude Astronomy
Transcript Abbreviation	Order of Magnitude
Course Description	This course focuses on developing the skills needed to approach problems at an order-of-magnitude level. It provides students with mathematical techniques and critical thinking skills that can be used to create approximate solutions to problems that may at first seem impossible to solve.
Semester Credit Hours/Units	Fixed: 1

Offering Information

Length Of Course	14 Week
Flexibly Scheduled Course	Never
Does any section of this course have a distance education component?	No
Grading Basis	Satisfactory/Unsatisfactory
Repeatable	No
Course Components	Recitation
Grade Roster Component	Recitation
Credit Available by Exam	No
Admission Condition Course	No
Off Campus	Never
Campus of Offering	Columbus, Lima, Mansfield, Marion, Newark

Prerequisites and Exclusions

Prerequisites/Corequisites	Physics 1251, 1261, or 1271, or permission of instructor.
Exclusions	
Electronically Enforced	No

Cross-Listings

Cross-Listings

Subject/CIP Code

Subject/CIP Code	40.0201
Subsidy Level	Baccalaureate Course
Intended Rank	Freshman, Sophomore, Junior, Senior

Requirement/Elective Designation

The course is an elective (for this or other units) or is a service course for other units

Course Details

Course goals or learning objectives/outcomes

- Students learn critical thinking skills in a quantitative context.
- Students practice problem-solving skills applicable to both astronomical and real-world situations.
- Students recognize and develop techniques and patterns of thinking useful in solving problems.
- Students gain experience working in small groups to develop solutions to complex problems.

Content Topic List

- Week 1: Estimating large or uncertain numbers
- Week 2: Energy density and lifetime of stars
- Week 3: Efficiency of energy sources
- Week 4: Fluid dynamics and projectile motion
- Week 5: Angular momentum and impact energy
- Week 6: Explosions and shockwaves
- Week 7: Energy sources for interstellar travel
- Week 8: Gravity and planetary accretion
- Week 9: Deflecting asteroids
- Week 10: Conversion of radiative energy to chemical energy
- Week 11: Equilibrium temperature of solar system objects
- Week 12: Tidal forces and black holes
- Week 13: Jetpacks and momentum conservation
- Week 14: Hydrostatic equilibrium in the Sun

Sought Concurrence

No

Attachments

- Astron3810-syllabus.pdf: Astronomy 3810 syllabus
  (Syllabus. Owner: Ryden,Barbara Sue)
- AstronomyCurriculumMap.xlsx: Astronomy curriculum map
  (Other Supporting Documentation. Owner: Ryden,Barbara Sue)
- OoM_Approval_Syllabus.pdf: Astronomy 3810 revised syllabus
  (Syllabus. Owner: Westraadt,Lindsay)
- 3810 response letter.docx: Astronomy 3810 revision cover letter
  (Cover Letter. Owner: Westraadt,Lindsay)

Comments

- Revised syllabus with cover letter outlining revisions has been uploaded. *(by Westraadt,Lindsay on 10/02/2024 06:12 PM)*
- Please see Subcommittee feedback email sent 09/11/2024. *(by Hilty,Michael on 09/11/2024 02:41 PM)*
- Updated astronomy curriculum map (including Ast 3810) has been uploaded. *(by Ryden,Barbara Sue on 06/05/2024 04:05 PM)*
- If this new course will be able to count in your major (even as an elective), please upload an updated curriculum map. Many thanks. *(by Vankeerbergen,Bernadette Chantal on 05/02/2024 05:27 PM)*

Workflow Information

Status	User(s)	Date/Time	Step
Submitted	Ryden,Barbara Sue	04/30/2024 03:35 PM	Submitted for Approval
Approved	Weinberg,David Hal	04/30/2024 03:53 PM	Unit Approval
Revision Requested	Vankeerbergen,Bernadette Chantal	05/02/2024 05:27 PM	College Approval
Submitted	Westraadt,Lindsay	08/16/2024 11:42 AM	Submitted for Approval
Approved	Thompson,Todd Alan	08/16/2024 11:45 AM	Unit Approval
Approved	Vankeerbergen,Bernadette Chantal	08/16/2024 02:42 PM	College Approval
Revision Requested	Hilty,Michael	09/11/2024 02:41 PM	ASCCAO Approval
Submitted	Westraadt,Lindsay	10/02/2024 06:21 PM	Submitted for Approval
Approved	Thompson,Todd Alan	10/07/2024 08:54 AM	Unit Approval
Approved	Vankeerbergen,Bernadette Chantal	10/20/2024 09:10 PM	College Approval
Pending Approval	Jenkins,Mary Ellen Bigler Hanlin,Deborah Kay Hilty,Michael Neff,Jennifer Vankeerbergen,Bernadette Chantal Steele,Rachel Lea	10/20/2024 09:10 PM	ASCCAO Approval

To the Natural and Mathematical Sciences Subcommittee,

We have updated the syllabus for Astronomy 3810 to include the following comments. We are listing our changes and responses in dark red following each of the bullets of feedback provided by the committee. As a note we appreciate the suggestions and changes in making this course better.

At this time, the Subcommittee asks that the following feedback items be satisfied within a revision:

- The Subcommittee would like to see additional information surrounding the course assessments and how students will be expected to demonstrate and reflect upon the knowledge they have learned during their time within the course. While they recognize there is information underneath the "Grading and Assignments" section on page 2 of the syllabus, there is no indication on how students will be assessed. Additionally, please indicate what percentage of the course assessments students are required in order to receive the "S" mark once the corrections to the grading scale are made (if the course is, of course, graded on the S/U scheme).
    - The Course Goals and Grading sections have been revised to clarify the matter:
        - The requirements for receiving an "S" mark as opposed to a "U" mark have been explicitly laid out. Students must participate in group discussions each week, as judged by the instructor.
        - An additional requirement was added that each student must serve as scribe once per semester. More detail was given to the role of this scribe.
        - 3 absences are allowed, which translates to 80% of the classes must be attended.
- The Subcommittee would like to see additional information in the course description submitted to curriculum.osu.edu about how this course is specific to the field of Astronomy and Astrophysics. Currently, the description seems as it could apply to many disciplines, while the course content appears to be focused on material offered by the Department of Astronomy.
    - Additional text has been added to the course description to explain that the course is targeted at A and A majors but is open to a wider audience if they are interested. The skills can be applied to many disciplines, which is why it is left open to those who have taken basic physics courses, as those courses provide all the tools needed to succeed in the class.
- The Subcommittee would like information surrounding the prerequisites of the course. They are concerned that, without prerequisites, students will enter the course without the necessary background knowledge. They recommend, perhaps, considering prerequisites that the department believes will provide students with the necessary background knowledge to be successful in the course (such as introductory science or mathematical coursework, as an example).
    - Prerequisite physics courses have been added. No math courses are required because the physics courses require the level of math needed. Although many of the problems are astronomy themed, an actual astronomy class is not required, as the relevant information they need will be provided in class. An astronomy course may provide context, but it is not required to succeed in the class.

Astronomy 3810 – Order of Magnitude

Fall 2024
Tuesday 3:00 pm – 3:55 pm
McPherson 1040

Instructor:	Jack Roberts	**Office:**	McPherson 4020
Office Hours:	TR 2-4 or by appointment	**Email:**	roberts.2158@osu.edu

Course Description:

Orders of magnitude (factors of 10) are used to make approximate comparisons. If x is an order of magnitude greater than y, then it is ten times larger. Comparisons on these scales are often sufficient to draw conclusions about phenomena in our universe at large and also in our daily lives. This course focuses on developing the skills needed to approach problems at an order-of-magnitude level. It provides students with mathematical techniques and critical thinking skills that can be used to create approximate solutions to problems that may at first seem impossible to solve. While the course is targeted towards physics and astronomy majors, these skills apply to many disciplines. The course is open to anyone who wishes to learn how to think on their feet with math and basic physics.

Prerequisites: Physics 1251, 1261, or 1271, or permission of instructor.

Course Goals and Learning Objectives:

This course aims to prepare students to think on large scales. Students will gain practice with skills that aid in problem-solving in fields all over science, such as dimensional analysis, the use of scaling relations, and intuition for reasonable cutoffs in estimation and approximation. The emphasis of the class is not on the answers to the questions posed in class but on the techniques and patterns of thinking used to arrive at the answers.

Format of Instruction:

The course will meet once per week for 55 minutes in the designated classroom and time. The format is an interactive seminar, with the instructor acting primarily as a facilitator. Each week a problem will be posed. Students will work together in small group discussions to develop ideas about how to approach the problem and then interact with the instructor and the other groups to converge on a path toward a solution. The goal is that all students will participate within the groups, even if someone in the group already "knows" the answers. Throughout the class, the instructor will collect input from the groups and discuss the merits of the various approaches, illuminating what further information might be needed for a solution and driving the students to think about their assumptions and uncertainties. There will be a cycle where groups share ideas, the instructor facilitates discussion, and then the students return to their groups to reconsider their ideas and calculations. The goal will be to reach approximate solutions by the end of each class period.

Grading and Attendance:

This is a 1 credit course and is graded Satisfactory/Unsatisfactory (S/U). There are no submitted assignments or examinations for this class. Instead, a passing grade is earned through attendance and active class participation in the student groups and in-class discussions. Participation in the group discussions is determined simply by attempted contributions, rather than the accuracy or correctness of those contributions, as the course aims to help students gain experience in problem-solving using methods that may be unfamiliar. During group discussions, the instructor will listen to the various discussions going on, both to check for understanding and to ensure students are participating in discussions. Additionally, students will occasionally be asked to serve as the "scribe." The scribe stands at the board to sketch ideas or algebraic steps during full class discussions. The scribe will not asked to solve the problem in front of the class, but merely write down suggestions from the class groups. In order to receive a Satisfactory (S) grade in the class, students must engage in group and full class discussions each week and perform the role of the scribe at least once in the semester.

If the instructor believes a student to not be participating at a satisfactory level, they will communicate this to the student. If the lack of participation continues, the student may not receive credit for the class that day.

Up to three classes can be missed without the need for an excuse. If a student misses more than three classes, either through lack of attendance or unsatisfactory participation, they will receive an Unsatisfactory (U) grade unless they have arranged for makeup credits with the instructor.

Students who need to miss class or who are not able to participate due to illness (COVID-19 or other illnesses), illness exposure, care for family members, or other reasons are expected to contact the instructor as soon as possible to arrange for accommodation. Note that, per university guidance, students are not required or expected to disclose COVID test results to faculty; nor will the instructor ask for information about any diagnoses. Students are not required to provide external medical documentation to support an absence related to COVID-19.

Students in special situations or those requiring specific, long-term, or other accommodation should seek support from appropriate University offices including but not limited to: Student Advocacy, Student Life Disability Services, and the Office of Institutional Equity.

Should in-person classes be canceled, students will be notified via CarmenCanvas or OSU email. In these instances, alternative methods of teaching (e.g., via Zoom) will be offered to ensure continuity of instruction for this class.

Course Materials:

Book / Printed Materials

There is no required textbook for the class. Students are required to bring scratch paper and a writing implement. The problems will be provided on a sheet of paper each week.

If students wish to learn more about specific mathematical tricks, *Street-Fighting Mathematics* by Sanjoy Mahajan is an excellent resource. The PDF can be found for free on MIT's programs website. While not required, this book provides excellent explanations of many mathematical tricks that will be helpful throughout this course.

Class Webpage:

CarmenCanvas (http://carmen.osu.edu) - The Carmen course site will be used to host weekly activities, post problems and solution sets, distribute and collect course materials and assignments, and make announcements of various kinds, including when the weekly activities are due.

Weekly Course Outline:

- Week 1: Fermi Problems
  - Topics: Large or Uncertain Numbers
  - Skills Used: Estimation, Breaking apart the problem, units
- Week 2: Bovine Betelgeuse
  - Topics: Chemical Energy Density, Stellar Lifetimes
  - Skills Used: Estimation from Intuition, Unit Conversions, scientific notation
- Week 3: Making a Death Star
  - Topics: Relative Energy Sources and Efficiencies
  - Skills Used: Deriving Equations from First Principles, Approximating Integrals
- Week 4: Ping Pong Ball Dynamics
  - Topics: Forces, Fluid Dynamics, Projectile Motion
  - Skills Used: Dimensional Analysis, Scaling Relations
- Week 5: Moon Formation Mechanisms
  - Topics: Angular Momentum, Impact Energy
  - Skills Used: Isolating Problem Components, Determining Plausibility
- Week 6: Taylor-Sedov Shockwaves
  - Topics: Energy Scales, Explosions, Supernovae
  - Skills Used: Dimensional Analysis, Uncertainty Bounds and Measurements
- Week 7: Spaceship Scoop
  - Topics: Energy Efficiency, Fluid Dynamics
  - Skills Used: Dimensional Analysis, Estimation, Astrophysics of galaxies
- Week 8: Build-A-Planet
  - Topics: Mean Free Path, Interaction rate, Solar System Formation, Gravity
  - Skills Used: Determining relevant timescales, relating physical quantities

- Week 9: Saving the Dinosaurs
  - Topics: Impact Energy, Orbital Motion, Momentum and Energy Conservation
  - Skills Used: Dimensional Analysis, Estimation, Scaling Relations, Dealing with Uncertainties
- Week 10: Grass Growth
  - Topics: Chemical Energy Density, Energy Efficiency
  - Skills Used: Considering Limiting Factors, Dimensional Analysis, Physics of Light
- Week 11: Solar Steaks
  - Topics: Orbits, Equilibrium Temperatures, Radiation
  - Skills Used: Finding Equilibria, Determining Relevant Timescales
- Week 12: Satellite Tides
  - Topics: Tidal Forces, Orbits, Black Holes
  - Skills Used: Finding Reasonable Comparisons, Dimensional Analysis, Newtonian Gravity
- Week 13: Machine Gun Jetpack
  - Topics: Momentum Conservation and Recoil
  - Skills Used: Estimating Forces and Rates, Scaling Forces
- Week 14: Sun's Temperature
  - Topics: Stellar Structure, Hydro-static Equilibrium, Force Balance
  - Skills Used: Deriving from First Principles, Finding Boundary Conditions
- Week 15: Course Feedback and Q/A
  - Topics / Skills Used: - N/A

Academic Misconduct:

It is the responsibility of the Committee on Academic Misconduct to investigate or establish procedures for the investigation of all reported cases of student academic misconduct. The term "academic misconduct" includes all forms of student academic misconduct wherever committed; illustrated by, but not limited to, cases of plagiarism and dishonest practices in connection with examinations. Instructors shall report all instances of alleged academic misconduct to the committee (Faculty Rule 3335-5-48.7 (B)). For additional information, see the Code of Student Conduct.

Disability Services:

The university strives to maintain a healthy and accessible environment to support student learning in and out of the classroom. If you anticipate or experience academic barriers based on your disability (including mental health, chronic, or temporary medical conditions), please let me know immediately so that we can privately discuss options. To establish reasonable accommodations, I may request that you register with Student Life Disability Services. After registration, make arrangements with me as soon as possible to discuss your accommodations so that they may be implemented in a timely fashion.

If you are ill and need to miss class, including if you are staying home and away from others while experiencing symptoms of a viral infection or fever, please let me know immediately. In cases where illness interacts with an underlying medical condition, please consult with Student Life Disability Services to request reasonable accommodations. You can connect with them at slds@osu.edu; 614-292-3307; or slds.osu.edu.

Religious Accomodations:

Ohio State has had a longstanding practice of making reasonable academic accommodations for students' religious beliefs and practices in accordance with applicable law. In 2023, Ohio State updated its practice to align with new state legislation. Under this new provision, students must be in early communication with their instructors regarding any known accommodation requests for religious beliefs and practices, providing notice of specific dates for which they request alternative accommodations within 14 days after the first instructional day of the course. Instructors in turn shall not question the sincerity of a student's religious or spiritual belief system in reviewing such requests and shall keep requests for accommodations confidential.

With sufficient notice, instructors will provide students with reasonable alternative accommodations with regard to examinations and other academic requirements with respect to students' sincerely held

religious beliefs and practices by allowing up to three absences each semester for the student to attend or participate in religious activities. Examples of religious accommodations can include, but are not limited to, rescheduling an exam, altering the time of a student's presentation, allowing make-up assignments to substitute for missed class work, or flexibility in due dates or research responsibilities. If concerns arise about a requested accommodation, instructors are to consult their tenure initiating unit head for assistance.

A student's request for time off shall be provided if the student's sincerely held religious belief or practice severely affects the student's ability to take an exam or meet an academic requirement and the student has notified their instructor, in writing during the first 14 days after the course begins, of the date of each absence. Although students are required to provide notice within the first 14 days after a course begins, instructors are strongly encouraged to work with the student to provide a reasonable accommodation if a request is made outside the notice period. A student may not be penalized for an absence approved under this policy.

If students have questions or disputes related to academic accommodations, they should contact their course instructor, and then their department or college office. For questions or to report discrimination or harassment based on religion, individuals should contact the Office of Institutional Equity. (Policy: Religious Holidays, Holy Days and Observances)

Mental Health:

As a student you may experience a range of issues that can cause barriers to learning, such as strained relationships, increased anxiety, alcohol/drug problems, feeling down, difficulty concentrating and/or lack of motivation. These mental health concerns or stressful events may lead to diminished academic performance or reduce a student's ability to participate in daily activities. The Ohio State University offers services to assist you with addressing these and other concerns you may be experiencing. If you or someone you know are suffering from any of the aforementioned conditions, you can learn more about the broad range of confidential mental health services available on campus via the Office of Student Life's Counseling and Consultation Service (CCS) by visiting ccs.osu.edu or calling 614-292-5766. CCS is located on the 4th Floor of the Younkin Success Center and 10th Floor of Lincoln Tower. You can reach an on call counselor when CCS is closed at 614-292-5766 and 24 hour emergency help is also available 24/7 by dialing 988 to reach the Suicide and Crisis Lifeline.

Title IX:

Title IX makes it clear that violence and harassment based on sex and gender are Civil Rights offenses subject to the same kinds of accountability and the same kinds of support applied to offenses against other protected categories (e.g., race). If you or someone you know has been sexually harassed or assaulted, you may find the appropriate resources at http://titleix.osu.edu or by contacting the Ohio State Title IX Coordinator at titleix@osu.edu

Diversity:

The Ohio State University affirms the importance and value of diversity of people and ideas. We believe in creating equitable research opportunities for all students and to providing programs and curricula that allow our students to understand critical societal challenges from diverse perspectives and aspire to use research to promote sustainable solutions for all. We are committed to maintaining an inclusive community that recognizes and values the inherent worth and dignity of every person; fosters sensitivity, understanding, and mutual respect among all members; and encourages each individual to strive to reach their own potential. The Ohio State University does not discriminate on the basis of age, ancestry, color, disability, gender identity or expression, genetic information, HIV/AIDS status, military status, national origin, race, religion, sex, gender, sexual orientation, pregnancy, protected veteran status, or any other bases under the law, in its activities, academic programs, admission, and employment. (To learn more about diversity, equity, and inclusion and for opportunities to get involved, please visit: https://odi.osu.edu/ or https://cbsc.osu.edu)

		Credits
Required Courses (offered by the unit)	Astron 2895: Seminar	1
	Astron 2291: Intro Astrophys I	3
	Astron 2292: Intro Astrophys II	3
	Astron 3350: Methods of Observation	3
Required 5000-level course (pick one)	Astron 5205: Planetary Science	3
	Astron 5681: Stellar Evolution	3
	Astron 5682: Cosmology	3
Required Courses (offered outside the unit)	Math 2415: ODEs and PDEs	3
	Math 2568: Linear Algebra	3
	Physics 2300: Mechanics I	4
	Physics 2301: Mechanics II	4
	Physics 5400: Int. E&M I	4
	Physics 5500: Quan. Mech I	4
	Physics 5600: Stat Mech	4
Only one of these is required	Physics 5401: Int. E&M II	4
	Physics 5501: Int E&M II	4
Elective	Astron 5550: Adv. Astro Analysis	3
	Astron 3810: Order of Magnitude I	1
	Astron 4810: Order of Magnitude II (to be submitted)	1

Astronomy & Astrophysic		
Acquire a basic mastery of fundamental physics and astrophysics, including motion and structure through classical mechanics, electromagnetism, and modern physics	Develop analytical and problem solving skills involving physics and mathematics	Acquire a basic mastery of experimental methods
Advanced	Advanced	
Advanced	Advanced	
Beginning	Advanced	Advanced
Advanced	Advanced	Intermediate
Advanced	Advanced	Beginning
Advanced	Advanced	Beginning
	Advanced	
	Advanced	
Advanced	Advanced	Beginning
Advanced	Advanced	Beginning
Advanced	Advanced	
Advanced	Advanced	
Advanced	Advanced	
Advanced	Advanced	
Advanced	Advanced	
Beginning	Advanced	Advanced
Advanced	Advanced	
Advanced	Advanced	

:s Major Learning Goals		
Acquire a basic mastery of data analysis	Learn to effectively communicate professionally and colloquially (orally and in writing)	Learn about and participate in research and outreach activities consistent with their interest, ability, and postgraduate plans
	Beginning	Beginning
Advanced	Advanced	Intermediate
Advanced	Advanced	Intermediate
	Intermediate	Beginning
	Intermediate	Beginning