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 the 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	none
Exclusions	
Electronically Enforced	Yes

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)

Comments

- 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
Pending Approval	Jenkins,Mary Ellen Bigler Hanlin,Deborah Kay Hilty,Michael Neff,Jennifer Vankeerbergen,Bernadette Chantal Steele,Rachel Lea	08/16/2024 02:42 PM	ASCCAO Approval

Astronomy 3810 – Order of Magnitude

Fall 2024
Tuesday 3:00 pm – 3:55 pm
McPherson 1005

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.

Course Goals and Learning Objectives:

Astronomy 3810 is an Undergraduate Order of Magnitude course. Order of Magnitude means we are solving problems and bounding problems to a rough approximation using our understanding of units, physical and astrophysical concepts, and what we already know to solve seemingly intractable problems and to provide a structure for thinking about new ideas. Students will learn critical thinking skills and problem-solving techniques they can use outside of this course, in their other courses, and in their daily lives. 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 main problem (with sub-problems) 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 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 different groups' prospective approaches, contrasting different ideas, illuminating what further information might be needed for a solution, and prodding the students about their assumptions and uncertainties. There will be a cycle where groups share ideas, the instructor facilkitates discussion, and then the students return to their groups to reconsider their ideas and calculations. The goal will be to reach potantiel solutions by the end of each class period.

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.

Grading and Assignments:

This is a 1 credit course and is graded Satisfactory/Unsatisfactory (S/U). There are no homework assignments for this class. All points will be earned through attendance and active class participation in the student groups and in class discussion. Students may occasionally be asked to go to the board to sketch ideas or algebraic steps. In such cases, students will not asked to solve the problem in front of the class, but merely be the scribe tasked with writing down suggestions from the class groups. There are no examinations and any outside related course work will be posted to CarmenCanvas.

Class Attendance and Participation:

Students are expected to participate in class. This includes attendance, asking questions, talking with your group partners, and offering comments to the class during discussions. Continuous engagement with the course is essential to learning the material. Students are expected to attend class and engage with assignments and discussion prompts for every scheduled meeting. You can miss up to three classes without the need for an excuse. If you miss more than that, you will receive an Unsatisfactory unless you arrange 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.

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 3335-5-487). For additional information, see the Code of Student Conduct http://studentlife.osu.edu/csc/.

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 isolating while waiting for a COVID-19 test result, please let me know immediately. Those testing positive for COVID-19 should refer to the Safe and Healthy Buckeyes site for resources. Beyond five days of the required COVID-19 isolation period, I may rely on Student Life Disability Services to establish further reasonable accommodations. You can connect with them at slds@osu.edu; 614-292-3307; or https://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 at https://equity.osu.edu.

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.

Diversity:

The Ohio State University affirms the importance and value of diversity in the student body. Our programs and curricula reflect our multicultural society and global economy and seek to provide opportunities for students to learn more about persons who are different from them. We are committed to maintaining a community that recognizes and values the inherent worth and dignity of every person; fosters sensitivity, understanding, and mutual respect among each member of our community; and encourages each individual to strive to reach his or her own potential. Discrimination against any individual based upon protected status, which is defined as age, color, disability, gender identity or expression, national origin, race, religion, sex, sexual orientation, or veteran status, is prohibited.

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.