

# ASTROPHYSICAL GAS DYNAMICS

Tuesday & Thursday | Classroom | 2:00-3:15p

## Contact Info

### Prof. Stella Offner

*My pronouns: she/her/hers*

### Help Sessions:

Th 11:00-12:00

Or by appointment

Location: PMA 15.312A or

<https://utexas.zoom.us/j/6557782889>

### Email:

[soffner@astro.as.utexas.edu](mailto:soffner@astro.as.utexas.edu)

*Or via Canvas message*

**Email Policy:** Email at any time with questions specific to your personal situation! For any questions about class procedure and grading, **first** check this syllabus.

## What is AST 382C all about?

The dynamics of gases underpins our understanding of a broad range of astrophysical phenomena from stellar structure to galaxy evolution. This course introduces the fundamentals of classical gas dynamics, including the equations of motion, shocks, instabilities and fluid behavior in different limits. We will apply the principles of gas dynamics to investigate self-gravitating, magnetized, and ionized gases. We will cover astrophysical problems relating to shock waves, turbulence, accretion disks, winds and jets. We will read and discuss some current and seminal papers relating to gas dynamics.

The main topics are:

1. Fundamentals of fluid behavior (Lectures 1-6)
2. Waves and Shocks (Lectures 7-16)
3. Numerical modeling of gas dynamics (Lecture 12-14)
4. Instabilities (Lectures 17-22)
5. Magnetized gases / Magnetohydrodynamics (Lectures 23-28)

## Course Learning Objectives: You will...

- Understand the basics of fluid behaviors in different limits.
- Be able to estimate order-of-magnitude gas/fluid properties for different astrophysical problems.
- Obtain experience writing your own hydrodynamic code to solve the equations of gas dynamics.
- Be able to derive behavior from the equations of gas dynamics and solve classic analytic problems.
- Gain familiarity with magnetized gas behaviors and dynamics
- Gain experience reading, interpreting and evaluating relevant journal articles

## Reading & Resources:

Class content is drawn from a broad range of reference materials. Only the first two are required reading, the rest are supplementary. Sources that can't be found online can be found in the PMA library. \* are on 2-hour reserve.

- "The Physics of Fluids and Plasmas" by Choudhuri (Required, not free)
- "Feynman Lectures", Vol II Chpt 40, 41 (Required, online)
- "Fluid Mechanics" by Landau & Lifshitz (online)
- "Gas Dynamics" by F. Shu\*
- "Galactic Dynamics" by Binney & Tremaine\*
- "Astrophysical Flows" by Pringle & King\*
- "Accretion Power in Astrophysics" by Frank, King & Raine\*
- "An Introduction to Fluid Dynamics" by Batchelor
- "Physical Fluid Dynamics" by Tritton
- "Elementary Fluid Dynamics" by Acheson\*

## What is expected of me in this class?

- Attend class and **participate!** Be prepared to discuss, ask questions and share your ideas.
- Complete assignments on time. **Work collaboratively** on the homework. **Ask for help** if you have questions!
- Do the required reading (and suggested reading, time permitting!) and come to class prepared.
- Don't procrastinate on the homework! Be prepared to spend 2-3 hours outside class for each hour of class time (**5-7 hours per week**).

## What happens in lecture?

- My goal is that you learn mostly by *doing* (e.g., reading, in-class activities and discussions, HW), rather than by only listening.
- A typical class will start with a *brief review* of the previous class and include opportunities to discuss, short activities and time for questions.
- Some class time will be spent discussing and presenting journal articles.

## Classroom Safety and COVID-19

There are several important ways YOU can help preserve the safety of our learning environment:

- **If you feel ill or have a positive COVID test please DO NOT come to class in person.** The lectures will be recorded and the class notes will be posted online after class.
- If you experience cold-like symptoms or have close contact with someone who tested positive for COVID but have a negative COVID test, please do **wear a face covering** that covers your mouth and nose if you attend class. Just courtesy.
- **Get vaccinated and boosted.** [Vaccinations are widely available](#), free and not billed to health insurance. The vaccine will help protect against the transmission of the virus to others and reduce serious symptoms in those who are vaccinated.

- **Get tested.** If you are experiencing any symptoms of COVID-19, please follow [university guidelines](#), including getting tested. If you test positive, you should isolate yourself at home. Contact the [Behavior Concerns and COVID-19 Advice Line \(BCCAL\)](#) to report your positive result. BCCAL can also assist you with isolation options, class absence notification or other support.
- **Proactive Community Testing** remains an important part of the university's efforts to protect our community. Tests are fast and free, and I recommend testing at least once weekly.
- Visit [protect.utexas.edu](https://protect.utexas.edu) for more information.

## Modality

Lectures will be in-person unless otherwise stated. Being in the same room enhances engagement and facilitates interactivity. I also teach better when I can see everyone's faces! All lectures will be recorded and a link posted online.

## How is my performance assessed?

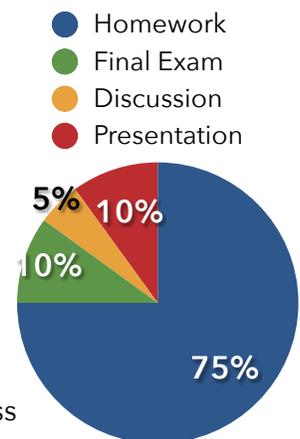
Your final course grade will be determined as follows:

**75% - Homework** There will be 7 homework assignments. Homework is due on Friday of the week it is assigned by 5. If you cannot hand in the homework (e.g., due to illness), contact me to let me know as soon as possible. Extensions will be given depending on circumstances.

**10% - Final Exam** There will be one final exam covering all the course material. This will be an oral exam modeled after the typical astronomy qualifying exam.

**10% - Presentation:** Each student will present one journal article to the class that is relevant to gas dynamics.

**5% - Discussion and Class Participation:** You will receive credit for this component by asking questions, participating in class discussion and being an active participant in discussions/activities.



## What are other policies on assignments and course structure?

### Course Website:

<https://utexas.instructure.com/courses/1351896>

**Course Webpage:** The course webpage on Canvas will be updated with course announcements and homework deadlines. It is your responsibility to check it on a regular basis.

**Late work:** If you cannot hand in a homework (e.g., due to illness) or do your scheduled presentation contact me to let me know as soon as possible. Extensions will be given depending on circumstances.

**Course Conduct:** Please silence cell phones before you enter the classroom. **No texting or using your cell phone** during class except for use in specified classroom activities. Please do not leave class early unless you have talked to me in advance, as a consideration to me and your fellow students. Students are encouraged to bring laptops to class to take notes and participate in some class activities. **Laptops should not be used for non-class activities;** students using their computers for non-class activities are a distraction to those around them. If laptop distraction becomes a problem, I reserve the right to reverse this policy.

### What is the grading scale?

93.0 - 100 A  
 90.0 - 92.99 A-  
 87.0 - 89.99 B+  
 83.0 - 86.99 B  
 80.0 - 82.99 B-  
 77.0 - 79.99 C+  
 73.0 - 76.99 C  
 70.0 - 72.99 C-  
 67.0 - 69.99 D+  
 63.0 - 66.99 D  
 60.0 - 62.99 D-

**Be respectful of others,** especially during in-class discussion, and even if you disagree with them.

**Students with Children:** I recognize the difficulty of being a full time student with children. If you have children, or other family commitments, please contact us to discuss any modifications of the course policies which will maximize your success in this course.

**Email:** Email is recognized as an official mode of university correspondence; therefore you are responsible for reading your email for university and course-related information and announcements. Please check your email regularly and frequently.

**Administrative Deadlines:** It is your responsibility to keep track of the administrative deadlines for dropping the course, changing to Pass/Fail etc.

**Syllabus Changes:** I reserve the right to make changes to the syllabus and class schedule if necessary. If any changes are made they will be announced through Canvas and new versions will be uploaded.

## Equity & Inclusion:

Please see this university [Resources Page](#) for a list of student resources. Note all faculty members, including myself, are also resources.

The University of Texas President's statement of community values can be found [here](#).

**Astronomy belongs to all people,** independent of race, religion, gender, gender identity, gender expression, or sexual orientation. It is important to me that **all** students feel welcome and comfortable in our UT astronomy community and are able to be their authentic selves. Incidents of discrimination, assault, harassment, threats, intimidation, profiling, or coercion based on membership or perceived membership will not be tolerated.

## Land Acknowledgement:

I would like to acknowledge that we are meeting on the Indigenous lands of Turtle Island, the ancestral name for what now is called North America.

Moreover, I would like to acknowledge the Alabama-Coushatta, Caddo, Carrizo/Comecrudo, Coahuil-tecan, Comanche, Kickapoo, Lipan Apache, Tonkawa and Ysleta Del Sur Pueblo, and all the American Indian and Indigenous Peoples and communities who have been or have become a part of these lands and territories in Texas. These people observed the night skies and marked the passing of the seasons here long before the founding of Texas.

### Where can I find..?

#### Canvas will have:

1. Important announcements
2. Lecture slides
3. Weekly assignments and modules
4. Syllabus
5. Gradebook

*Canvas will be our main form of communication, so check it regularly and stay up to date on assignments and communications.*

## Frequently Asked Questions:

### Do you record the lectures?

Yes! Links for the recordings will appear in the class Canvas page.

### I'm sick and can't come to class, what do I do?

Stay home and get better. Download the notes PDF and watch the class recording to see what you missed. If you have a presentation scheduled for that day notify me asap.

## University Resources:

**Academic accommodations (D&A):** This class respects and welcomes students of all backgrounds, identities, and abilities. If there are circumstances that make our learning environment and activities difficult, or if you have medical information that you need to share with me, please let me know. I am committed to creating an effective learning environment for all students, but I can only do so if you discuss your needs with me as early as possible. I promise to maintain the confidentiality of these discussions. Any student with a documented disability who requires academic accommodations should contact Disabilities & Access at 512-471-6259 (voice) or 512-410-6644 (Video Phone) as soon as possible to request an official letter outlining authorized accommodations. For more information, visit <http://ddce.utexas.edu/disability/about/>. *I am also happy to meet with you to discuss your situation.*

**Counseling and Mental Health Center:** Do your best to maintain a healthy lifestyle this semester by eating well, exercising, getting enough sleep and taking some time to relax. This will help you achieve your goals and cope with stress. All of us benefit from support during times of struggle.

You are not alone. There are many helpful resources available on campus and an important part of the college experience is learning how to ask for help. Asking for support sooner rather than later is often helpful. If you or anyone you know experiences any academic stress, difficult life events, or feelings like anxiety or depression, we strongly encourage you to seek support. <http://www.cmhc.utexas.edu/individualcounseling.html>

## University and Course Policies:

**Academic integrity:** The core values of The University of Texas at Austin are learning, discovery, freedom, leadership, individual opportunity, and responsibility. Each member of the university is expected to uphold these values through integrity, honesty, trust, fairness, and respect toward peers and community. Students who violate University rules on scholastic dishonesty are subject to disciplinary penalties. Ethical conduct is expected at all times.

You are responsible for understanding UT's Academic Honesty and the University Honor Code which can be found at the following web address: <https://deanofstudents.utexas.edu/conduct/standardsconduct.php>

- **Sharing of Course Materials is Prohibited:** No materials used in this class, including, but not limited to, lecture hand-outs, videos, assessments (projects, homework assignments), and in-class materials, may be shared online or with anyone outside of the class unless you have my explicit, written permission. Unauthorized sharing of materials promotes cheating. It is a violation of the University's Student Honor Code and an act of academic dishonesty. I am well aware of the sites used for sharing materials, and any materials found online that are associated with you, or any suspected unauthorized sharing of materials, will be reported to Student Conduct and Academic Integrity in the Office of the Dean of Students. These reports can result in sanctions, including failure in the course.
- **Class Video Recordings:** Class recordings are reserved only for the use of members of this class (students and the instructor) and only for educational purposes and are protected under FERPA. Recordings should not be shared outside the class in any form. Violation of this restriction could lead to Student Misconduct proceedings.

**Plagiarism:** is defined as using *another's words, code, solutions or ideas without credit – this includes answers provided by ChatGPT or any other AI program*. Copying text from a source without using quotation marks or using code you didn't write *is plagiarism unless* a source reference is given. **You are encouraged to work together on homework but each student must turn in their own unique solution set.** Plagiarized assignments will receive a zero.

As a research university, the University of Texas at Austin takes plagiarism very seriously. Do not risk getting involved in a plagiarism infraction - the consequences simply aren't worth it. Always cite your sources, and when in doubt consult a professor or librarian. See the Student Judicial Services website: <http://deanofstudents.utexas.edu/conduct/academicintegrity.php> Incidences of academic dishonesty will be reported to Student Judicial Services.

**Personal or Family Emergencies:** If you experience a personal or family emergency (death in the family, protracted sickness, serious mental health issues) that forces you to miss multiple days of class, you should contact Student Emergency Services in the Office of the Dean of Students <http://deanofstudents.utexas.edu/emergency/>. They will work with you to communicate with your professors and let them know of your situation.

**Religious Days:** A student who misses a class for the observance of a religious holy day will be permitted to make up the missed work, if notice is given at least fourteen days prior to such an absence.

**Title IX:** Beginning January 1, 2020, Texas [Senate Bill 212](#) requires all employees of Texas universities, including faculty, report any information to the [Title IX Office](#) regarding sexual harassment, sexual assault, dating violence and stalking that is disclosed to them. Texas law requires that all employees who witness or receive any information of this type (including, but not limited to, writing assignments, class discussions, or one-on-one conversations) must be reported. If you would like to speak with someone who can provide support or remedies without making an official report to the university, please email [advocate@austin.utexas.edu](mailto:advocate@austin.utexas.edu). For more information about reporting options and resources, visit <http://www.titleix.utexas.edu/>, contact the Title IX Office via email at [titleix@austin.utexas.edu](mailto:titleix@austin.utexas.edu), or call 512-471-0419.