SYLLABUS
ASTR 400A
Theoretical Astrophysics
Fall 2019

LECTURES: Tuesday/Thursday: 12:30 p.m. - 1:45 p.m.
Steward Observatory, Room 204

INSTRUCTOR: Dr. Nathan Smith
OFFICE: Steward Observatory, room N512
TELEPHONE: (520) 621-4513 (*voice messages are not checked regularly, if ever*)
EMAIL: profsmith170@gmail.com (*best way to contact Dr. Smith*)
OFFICE HOURS: Tu/Th (2:00 p.m. – 3:00 p.m.) or by appointment

TEACHING ASST: Mr. Yujing Qin (pronounced "Eugene")
OFFICE: Steward Observatory, room 302
EMAIL: qinyj@email.arizona.edu
OFFICE HOURS: W/F (10:00 a.m. – 11:00 a.m.) or by appointment

MIDTERM EXAMS: held in class
Midterm 1, Tues. Sep. 24, Chap 1, 2, 3
Midterm 2, Thurs. Oct. 17, Chap 4, 5, 6, 7
Midterm 3, Tues. Nov 12, Chap 8, 9
FINAL EXAM: Wednesday, Dec 18, 1:00 p.m. - 3:00 p.m., Steward 204, Chap 1-12

REQUIRED TEXTBOOK: *An Introduction to the Theory of Stellar Structure and Evolution* by D. Prialnik (Cambridge) *2nd edition*

OTHER USEFUL TEXTS (not required):
Stellar Interiors by Hansen, Kawaler, & Trimble (2nd edition)
Stars and Stellar Processes by M. Guidry
An Introduction to Modern Astrophysics by Carroll & Ostlie

COURSE WEBSITE: http://D2L.arizona.edu

PREREQUISITES: MATH 254 and 12 units of upper division physics are prerequisites. ASTR 300A and 300B strongly encouraged.

COURSE OVERVIEW AND GOALS: This course is a continuation of the series of required major courses, following 300A&B. The main topic of the course is a focus on understanding stellar structure and evolution, a field of astronomy that brings many different branches of physics to bear on the fundamental objects of astronomical study—stars. Toward the end of the semester, we may discuss other related topics as well, including observational studies of transients, compact objects, gravitational waves, star and planet formation, and feedback from stars and its influence on the hydrodynamics and thermodynamics of the ISM.

TOPIC SCHEDULE & READING ASSIGNMENTS:
(Assigned chapters must be read before class on Tuesday of the listed week)

Week	Topic	Chapters	Notes
1. Aug 27/29	Introduction/overview/observed properties	1	…
2. Sep 3/5	Equilibrium, Virial Theorem, timescales	1, 2	HW1(T)
3. Sep 10/12	Gas & radiation physics, pressure sources	3	HW2(Th)
4. Sep 17/19	Transport of energy	3	Group review (Th)
5. Sep 24/26	Nuclear energy generation	4	Midterm Exam 1 (T)
6. Oct 1/3	Nuclear (cont.), stellar structure, simple models	4,5	HW3(T)
7. Oct 8/10	Stability, simple evolution of stellar interior	6, 7	HW4(T)
8. Oct 15/17	Interior (cont.)	7	Midterm Exam 2 (Th)
9. Oct 22/24	Mass loss, Evolution of Low-mass Stars	8,9	HW5(T)
10. Oct 29/31	White Dwarfs, Novae, Supernovae	9	…
11. Nov 5/7	Evolution of high-mass stars, HRD	9	HW6(T)
12. Nov 12/14	Supernovae, GW sources	10	Midterm Exam 3 (T)
13. Nov 19/21	Supernovae, neutron stars, black holes	10	HW7(T)
14. Nov 26	Interacting binary stars	11	11/22 Thanksgiving
15. Dec 3/5	Binaries (cont.), ISM	11,12	HW8(T), Projects due (Th)
16. Dec 10	Star formation	12	HW9

Wednesday Dec 18 **Comprehensive Final Exam 1:00-3:00 pm**

GRADING: Your final grade for the course will be based on total points you earn for the midterm/final exams and other assignments in the following proportion:

Homework/Prep./Group	240 pts (30%) drop lowest HW, and 2 lowest part.
2 Midterm Exams	120 pts (15%) x 2 (drop lowest of 3)
Project	120 pts (15%)
Final Exam	200 pts (25%)

Letter grades will not be given for each individual assignment, but in class we will give feedback for large-value items like mid-term exams and the project. If you would like feedback on your individual homework assignments, please come to office hours or schedule an appointment with Prof. Smith. Mistakes in grading individual assignments sometimes happen. All questions, disputes, or mistakes regarding the grading of exams and assignments must be brought to our attention within 1 week after the assignment is handed back or posted; such checks are encouraged. We reserve the right to change or curve the course grading, but a guideline for percentage vs. grade is as follows:
A = 90% B = 80% C = 70% D = 60% E < 60%

PREPARATION, HOMEWORK, AND IN-CLASS GROUP WORK: This course will emphasize problem solving, individually and in groups, both in class and individual homework. This will constitute much of the class time, with less emphasis on traditional lecturing. In other words, students will participate actively in the lecture session, sometimes being asked to present solutions to homework

problems on the board, or to discuss or solve new problems in groups. This in-class work will be a significant part of your grade (about half of the homework/participation component). It is therefore essential that students come to class ***prepared***, having done the relevant reading and homework in advance. With the exception of the first 2 days of class, students are expected to have read relevant chapters in the text (as noted above) before coming to class, and to have completed the homework before class on due dates. Since we will go over homework problems in class, no late homework will be accepted. However, we will drop the ***lowest*** homework and ***two lowest*** participation scores. Dropping these scores is meant to allow flexibility for any unforeseen disasters, illnesses, family emergencies, religious holidays, sporting events, late registration in the course, the bookstore running out of books, computer malfunctions, zombie attacks, etc. You may, of course, turn in the homework problem set early if you must miss class for an excused absence. You may discuss the concepts with classmates, but you must do your own work (except for designated group work).

TYPICAL RECIPE FOR SOLVING PROBLEMS: Much of the attention in this class will be spent on solving specific posed problems, either as in-class examples, group exercises, homework problem sets, or exams. In this course, I would like you to follow the list of steps given below when confronted with a problem to solve (even problems from the textbook). It may take more time to do a specific problem this way, but it is also likely to solidify your understanding more than just plugging and chugging. Moreover, showing your work by following these steps is more likely to convince me that you understand what you are doing and will provide me more opportunities to award partial credit in the event that you make a mistake somewhere. Unless otherwise noted, these are the steps you should follow (this will be discussed in class).

I. Draw a picture, if appropriate.
II. Explain in words how you intend to solve the problem; note any assumptions.
III. Write down equations that you will use, define any constants, and note the units of those constants.
IV. Without plugging in numbers, isolate the variable you want from the equations you have adopted.
V. Plug and chug to get a numerical answer, if that is requested in the problem.
VI. Interpret the result. Does the number make sense? Units? How would the result vary as you change parameters of the situation? Put it in context as appropriate.

MAKE-UP EXAM/HOMEWORK POLICY: We understand that occasional unavoidable absence or unforeseen circumstances may occur, and we do not want you to attend class if you are ill and contagious. For these normal situations (illness, mild injury, called in to work at the last minute, child is sick, oversleeping because your alarm didn't go off, etc.) we do not allow make-up assignments. Instead, the grading of the course has some flexibility built in: i.e. we drop the lowest homework score and the two lowest participation scores, as noted above. If you must miss class because of a recognized religious holiday or other ***pre-scheduled event***, turn in your assignment early, and/or consult Prof. Smith well ***BEFORE*** you miss an exam. In these cases you will most likely take the exam early. Failure to contact Prof. Smith before missing an exam for any scheduled event will yield a score of zero on the exam (which may be OK once, because we drop the lowest score). There are some unforeseen severe cases that do justify a makeup opportunity for term papers and exams (or multiple homeworks) after a deadline or exam, such as a death in the family, prolonged or severe illness or injury requiring medical treatment, etc. Notify Prof. Smith by email as soon as possible in such circumstances.

MIDTERM EXAMS: There are three midterm exams scheduled throughout the course, as listed above. Each of these emphasizes material in the previous few weeks, with relevant text chapters noted. Although there are three midterms, your grade will be based on the two best performances, and the lowest of the three scores will be dropped.

FINAL EXAM: Please note that the final exam is scheduled for Wednesday, December 18. Take this into account when making any holiday travel plans in December. The final exam is cumulative.

TERM PAPER: All students are required to submit a written project as part of the requirements for this course. The deadline for turning in your finished project is Thursday, Dec 5 (start of class). This deadline is firm; **absolutely no late term papers will be accepted except for a medical emergency**. Detailed instructions and guidelines for the project are available on D2L. Submit a ***printed hardcopy*** in class on the due date, and also upload a PDF file to the course website (D2L) dropbox before the start of class. Failure to do either by the deadline will earn you a score of zero on this assignment.

PARTICIPATION IN CLASS: Participation points may be awarded at any lecture in the form of in-class exercises and group work, and will figure into your final grade. Students are responsible for all information given out in the lecture, including any announced schedule changes, and so attendance is ***required***. If you must miss class, talk to another student, your instructor, or consult the D2L page to find out what you missed. We will conduct interactive group exercises in class; this will improve your understanding of the material and will count toward your grade. You will not be allowed to make up any missed participation points. To allow for unavoidable periodic absences, we allow two absences with no penalty. In other words, your two lowest participation scores will be dropped.

ACADEMIC INTEGRITY: Students are encouraged to share intellectual views and discuss freely the principles and applications of course materials. However, graded work, exercises, and exams must be the product of independent effort unless otherwise instructed. Presentation of any work other than your own, in whole or in part, is considered a violation of the Code of Academic Integrity. Any other technique that gains unfair advantage over other students is also considered academically dishonest. Any incidents of academic dishonesty will be dealt with harshly according to the University of Arizona's Code of Academic Integrity: http://deanofstudents.arizona.edu/codeofacademicintegrity . Consequences can range from loss of credit on an assignment, to full dismissal from the University, depending on the severity of the offense. In our class, the penalty for plagiarism, cheating on an exam, or computer fraud will be automatic failure of the course and, depending on the circumstances, we may seek your suspension or expulsion from the University.

STUDENTS WITH DISABILITIES: If you anticipate or experience issues related to the format or requirements of this course, please meet with Prof. Smith. We would like to discuss ways to ensure your full participation in the course. If you determine that formal, disability-related accommodations are appropriate, it is very important that you be registered with Disability Resources (621-3268; http://drc.arizona.edu) and notify Prof. Smith of your eligibility for reasonable accommodations well in advance of the first midterm exam. We can then plan how best to coordinate your accommodations.

BEHAVIOR IN CLASS: NO smoking, eating, drinking (except water), or pets are allowed in the lecture hall. All cell phones must be turned to silent mode or powered off completely, and must be placed ***completely out of sight***. To not interfere with students trying to listen to the lecture, you may not use a laptop in class except to take notes. If you intend to use a laptop in this manner, please sit toward the back or sides of the lecture hall to mitigate your screen from distracting those behind you. You are expected to be courteous and respectful to your classmates and instructors, and we ask that you strive to be inclusive in group exercises. You should also be aware of the University's policies on disruptive and threatening behavior:
http://policy.arizona.edu/education-and-student-affairs/threatening-behavior-students
http://policy.arizona.edu/education-and-student-affairs/disruptive-behavior-instructional-setting

UA NONDISCRIMINATION AND ANTI-HARASSMENT POLICY: The University is committed to creating and maintaining an environment free from discrimination; see
http://policy.arizona.edu/human-resources/nondiscrimination-and-anti-harassment-policy