ASTRONOMY 4101B – Stellar Astrophysics, Winter 2021

1. Course Information

This course covers the astrophysics of stars and is aimed at undergraduate students in third and fourth year. I will assume a basic understanding of ordinary differential equations. The material that we might cover is vast, ranging from concepts of gravity and modern physics, to stellar interiors and atmospheres, and on to stellar evolution. My philosophy will be to provide a grounding in some of the basic physics of stars, encourage you to learn how to make quick estimates, do some numerical calculations, and appreciate the big picture. You will be expected to write short computer programs or work with pre-written codes, and present graphical results for the computational projects.

Time and Location

The course timetable is Tu 10:30 am – 12:20 pm, Th 10:30 am 11:20 pm. This is an online course with asynchronous lectures and synchronous interaction hours; the latter are not lectures. Lecture notes and audio files for any week will be posted by the start of that week. I may occasionally post some videos as well. The Tuesday time slot is the recommended time to listen to the lectures, but you can choose to use another time. There will be an interaction hour each Thursday 10:30 am (by Zoom). During some weeks, the Tuesday time slot 10:30 am – 12:20 pm may also be used, for interaction hours or student presentations. In the first week, the Tuesday time slot will be used for an informational meeting, so the first interaction hour is Tuesday, January 12, 10:30 am. A Zoom invite will be sent and attendance is strongly encouraged.

Prerequisites: Physics 2101A/B and 2102A/B; Calculus 2503A/B

Unless you have either the requisites for this course or written special permission from your Dean to enroll in it, you may be removed from this course and it will be deleted from your record. This decision may not be appealed. You will receive no adjustment to your fees in the event that you are dropped from a course for failing to have the necessary prerequisites.

Key Dates

Classes begin:	January 11
Reading Week:	February 13-21
Classes end:	April 12

2. Instructor Information

Instructor: Prof. Shantanu Basu
Contact: basu@uwo.ca
Email is a useful way to make quick inquiries. Longer discussion should take place during the interaction hours. Students should use their Western (@uwo.ca) email addresses when contacting their instructors.

Teaching Assistant: Mr. Arpan Das, adas45@uwo.ca

3. Course Materials

Textbook

There is no required textbook, but suitable textbooks that provide some useful content are:

Stellar Astrophysics, LeBlanc, F. 2010, Wiley, ISBN 978-0-470-69956-0 (paperback)
An Introduction to Modern Astrophysics, Carroll, B. W., and Ostlie, D. A. 1996, Addison-Wesley
An Introduction to Modern Stellar Astrophysics, Ostlie, D. A, and Carroll, B. W. 1996, 2007, Pearson Addison-Wesley
The Physical Universe, Shu, F. H. 1981, University Science Books

Lecture and Interaction Hour Content

There is a course website available through OWL (owl.uwo.ca). Course lectures, supplementary reading, problem sets, and other assignments will be posted there.

Students should check OWL on a regular basis for news and updates. This is the primary method by which information will be disseminated to all students in the class. Students are responsible for checking OWL on a regular basis.

If students need assistance, they can seek support on the OWL Help page. Alternatively, they can contact the Western Technology Services Helpdesk. They can be contacted by phone at 519-661-3800 or ext. 83800.

4. Learning Outcomes

- Apply the concept of dimensional analysis to estimate the self-gravitational energy and free-fall time of a star
- Understand the criterion for gravitational collapse
- Understand the quantum mechanical origin of degeneracy pressure and be able to estimate the relative importance of degeneracy pressure in a star by calculating the degeneracy parameter
- Understand the origin of the substellar mass limit
- Identify the mechanisms of energy transport within a star and explain the conditions under which each will dominate, including being able to explain the criterion for the onset of convective instability
- Understand the dependence of nuclear binding energy per nucleon versus nucleon number in a nucleus, and how this accounts for nuclear energy generation in the universe
- Understand all steps of the derivation of the Lane-Emden equation for stellar structure, including the applicability of polytropic relations to some stars and white dwarfs. Be able to derive analytic solutions to the Lane-Emden equations where such solutions exist. Know how to use a simple first or second-order numerical integration scheme to find numerical solutions to the Lane-Emden equation, and present them in a written report
- Identify and understand the equations of stellar evolution including equations for energy transport and generation
- Be able to describe the key stages of evolution of both low mass and high mass stars, from the main sequence phase till the end of their life
- Understand the fate of stellar remnants as either a white dwarf, neutron star, or black hole, and the criteria for each outcome

5. Methods of Evaluation

Evaluation will be through problem set assignments, project reports, a presentation, and a multiple-choice online quiz delivered through OWL. For each of the problem set assignments, project reports, and presentation I want you to work in **groups of two** and submit a single joint outcome. The assignments and project report will be uploaded to OWL. There is a 10% penalty per day if submitted past the deadline. The presentation will be via slides presented on Zoom to the rest of the class, on a date chosen for your group, and you will also have to upload the slides to OWL.

The overall course grade will be calculated as listed below:

Evaluation	Weight	Date or Due Date
Assignment 1	15%	Feb 1
Project 1	20%	Feb 26

Assignment 2	15%	Mar 8
Online quiz	10%	Mar 19
Project 2 presentations	20%	Mar 23, 25, 30
Final Project	20%	Apr 12

6. Accommodation and Accessibility

Accommodation Policies
Students with disabilities work with Accessible Education (formerly SSD) which provides recommendations for accommodation based on medical documentation or psychological and cognitive testing. The Academic Accommodation for Students with Disabilities policy can be found at: https://www.uwo.ca/univsec/pdf/academic_policies/appeals/Academic Accommodation_disabilities.pdf

Academic Consideration for Student Absence
Students will have up to two (2) opportunities during the regular academic year to use an on-line portal to self-report an absence during the semester, provided the following conditions are met: the absence is no more than 48 hours in duration, and the assessment for which consideration is being sought is worth 30% or less of the student's final grade. Students are expected to contact their instructors within 24 hours of the end of the period of the self-reported absence, unless noted on the syllabus. Students are not able to use the self-reporting option in the following circumstances:

- for exams scheduled by the Office of the Registrar (e.g., December and April exams)
- absence of a duration greater than 48 hours,
- assessments worth more than 30% of the student's final grade,
- if a student has already used the self-reporting portal twice during the academic year

If the conditions for a Self-Reported Absence are *not* met, students will need to provide a Student Medical Certificate if the absence is medical, or provide appropriate documentation if there are compassionate grounds for the absence in question. Students are encouraged to contact their Faculty academic counselling office to obtain more information about the relevant documentation.

Students should also note that individual instructors are not permitted to receive documentation directly from a student, whether in support of an application for consideration on medical grounds, or for other reasons. **All documentation required for absences that are not covered by the Self-Reported Absence Policy must be submitted to the Academic Counselling office of a student's Home Faculty.**

For policy on Academic Consideration for Student Absences - Undergraduate Students in First Entry Programs, see:
https://www.uwo.ca/univsec/pdf/academic_policies/appeals/Academic_Consideration_for_absences.pdf
and for the Student Medical Certificate (SMC), see:

http://www.uwo.ca/univsec/pdf/academic_policies/appeals/medicalform.pdf

Religious Accommodation
Students should consult the University's list of recognized religious holidays, and should give reasonable notice in writing, prior to the holiday, to the Instructor and an Academic Counsellor if their course requirements will be affected by a religious observance. Additional information is given in the Western Multicultural Calendar:
https://multiculturalcalendar.com/ecal/index.php?s=c-univwo

You may also be eligible to write the Special Exam if you are in a "Multiple Exam Situation" (see http://www.registrar.uwo.ca/examinations/exam_schedule.html).

7. Equity, Diversity, and Inclusion

The principles of EDI are very meaningful to me and I will try to foster an atmosphere of respect and inclusion, where all voices can be heard. All class members should treat others with professional respect and equal consideration in both written and spoken communication. We should work to provide an environment that encourages the free expression and exchange of ideas. I encourage all of you to read the recent report of the President's Anti-racism Working Group, available at https://president.uwo.ca/pdf/arwg-final-report-to-president-shepard-fnl.pdf.

8. Academic Policies

The website for Registrarial Services is http://www.registrar.uwo.ca.

In accordance with policy, http://www.uwo.ca/its/identity/activatenonstudent.html, the centrally administered e-mail account provided to students will be considered the individual's official university e-mail address. It is the responsibility of the account holder to ensure that e-mail received from the University at his/her official university address is attended to in a timely manner.

Participants in this course are not permitted to record any online sessions, except where recording is an approved accommodation, or the participant has the prior written permission of the instructor.

Scholastic offences are taken seriously and students are directed to read the appropriate policy, specifically, the definition of what constitutes a Scholastic Offence, at the following Web site: http://www.uwo.ca/univsec/pdf/academic_policies/appeals/scholastic_discipline_undergrad.pdf.

All required papers may be subject to submission for textual similarity review to the commercial plagiarism detection software under license to the University for the detection of plagiarism. All papers submitted for such checking will be included as source documents in the reference database for the purpose of detecting plagiarism of papers subsequently submitted to the system. Use of the service is subject to the licensing agreement, currently between The University of Western Ontario and Turnitin.com (http://www.turnitin.com).

Completion of this course will require you to have a reliable internet connection and a device that meets the system requirements for Zoom. Information about the system requirements are available at the following link:
https://support.zoom.us/hc/en-us

* Please note that Zoom servers are located outside Canada. If you would prefer to use only your first name or a nickname to login to Zoom, please provide this information to the instructor in advance of the test or examination.

9. Support Services

Please visit the Science & Basic Medical Sciences Academic Counselling webpage for information on add/drop courses, academic considerations for absences, appeals, exam conflicts, and many other academic related matters: https://www.uwo.ca/sci/counselling/

Please contact the course instructor if you require lecture or printed material in an alternate format or if any other arrangements can make this course more accessible to you. You may also wish to contact Student Accessibility Services (SAS) at (519) 661-2147 if you have any questions regarding accommodations.

Western University is committed to a thriving campus as we deliver our courses in the mixed model of both virtual and face-to-face formats. We encourage you to check out the Digital Student Experience website to manage your academics and well-being: https://www.uwo.ca/se/digital/.

Learning-skills counsellors at the Student Development Centre (http://www.sdc.uwo.ca) are ready to help you improve your learning skills. They offer presentations on strategies for improving time management, multiple-choice exam preparation/writing, textbook reading, and more. Individual support is offered throughout the Fall/Winter terms in the drop-in Learning Help Centre, and year-round through individual counselling.

Students who are in emotional/mental distress should refer to Mental Health@Western (http://www.health.uwo.ca/mental_health) for a complete list of options about how to obtain help.

Additional student-run support services are offered by the USC, http://westernusc.ca/services.