



### COURSE OUTLINE

1. **Course:** ASPH 403, Stellar Structure and Evolution - Winter 2021

Lecture 01: MWF 11:00 - 11:50 - Online

| Instructor      | Email             | Phone        | Office | Hours                 |
|-----------------|-------------------|--------------|--------|-----------------------|
| Dr. Jeroen Stil | jstil@ucalgary.ca | 403 220-8015 | SB 519 | Wednesdays, 3pm - 4pm |

ASPH 403 deals with the internal structure of stars, and the evolution of that structure. Key concepts for this course are physical principles that establish equilibrium in a sphere of gas with mass of order 2000 billion billion kg, and how fast conditions change if equilibrium is disturbed. We apply physics of a plasma with a density 20 times that of solid steel and a temperature of 15 million K. As a result, this course is more theoretical than preceding ASPH courses, and it introduces a multitude of concepts that are required to understand how stars work. Some of the challenges of this course are associated with these concepts and applications of thermodynamics, hydrodynamics, quantum mechanics and nuclear physics that will be introduced in this course.

**Online Delivery Details:**

This course is being offered online in real-time via scheduled meeting times, you are required to be online at the same time.

To help ensure Zoom sessions are private, do not share the Zoom link or password with others, or on any social media platforms. Zoom links and passwords are only intended for students registered in the course. Zoom recordings and materials presented in Zoom, including any teaching materials, must not be shared, distributed or published without the instructor’s permission.

This course has a registrar scheduled, synchronous final exam. The writing time is 2 hours + 50% buffer time.

The lectures in the course will be taught synchronously. This means that students will be able to ask questions during the lectures. Lectures will be recorded in Zoom and links to the recordings will be posted in D2L. Notes written during the lectures will be scanned and posted on D2L. There will be no for-credit activities during the lectures.

**Course Site:**

D2L: ASPH 403 L01-(Winter 2021)-Stellar Structure and Evolution

**Note:** Students must use their U of C account for all course correspondence.

2. **Requisites:**

See section [3.5.C](#) in the Faculty of Science section of the online Calendar.

**Prerequisite(s):**

Astrophysics 213 or 305; Physics 229 or 325; Physics 341; and Mathematics 375 or 376.

3. **Grading:**

The University policy on grading and related matters is described in [F.1](#) and [F.2](#) of the online University Calendar.

In determining the overall grade in the course the following weights will be used:

|   | Component(s)              | Weighting % |
|---|---------------------------|-------------|
| Assignments   | To be announced by email. | 25          |
| Term project initial report                             | Due January 31 at 23:59   | 7.5         |
| Term project interim report                             | Due February 22 at 23:59  | 7.5         |
| Term project final report                               | Due March 21 at 23:59     | 15          |
| Midterm, Take-home exam, due February 12, 2021 at 23:59 |                           | 15          |
| Final Exam, Synchronous scheduled by the Registrar      |                           | 30          |

**Take-home exams will be made available by the instructor in D2L at least 24 hours before the due date of the exam.**

Each piece of work (reports, assignments, quizzes, midterm exam(s) or final examination) submitted by the student will be assigned a grade. The student's grade for each component listed above will be combined with the indicated weights to produce an overall percentage for the course, which will be used to determine the course letter grade.

The conversion between a percentage grade and letter grade is as follows.

|                           | A+   | A    | A-   | B+  | B   | B-   | C+   | C   | C-  | D+   | D    |
|---------------------------|------|------|------|-----|-----|------|------|-----|-----|------|------|
| <b>Minimum % Required</b> | 93 % | 90 % | 85 % | 80% | 75% | 70 % | 65 % | 60% | 55% | 50 % | 45 % |

The posted boundaries are **strict minimum thresholds** for the assignment of a letter grade, with no rounding applied. For example, a 84.99% average for the course will result in a B+ grade.

This course will have a final exam that will be scheduled by the Registrar. [The Final Examination Schedule](#) will be published by the Registrar's Office approximately one month after the start of the term. The final exam for this course will be designed to be completed within 2 hours.

The final exam will be administered using an on-line platform. Per section [G.5](#) of the online Academic Calendar, timed final exams administered using an on-line platform, such as D2L, will be available on the platform. **Due to the scheduling of the final exams, the additional time will be added to the end of the registrar scheduled synchronous exam to support students. This way, your exam schedule accurately reflects the start time of the exam for any synchronous exams. E.g. If a synchronous exam is designed for 2 hours and the final exam is scheduled from 9-11am in your student centre, the additional time will be added to the end time of the synchronous exam. This means that if the exam has a 1 hour buffer time, a synchronous exam would start at 9 am and finish at 12pm. - updated April 6, 2021**

The overall assignment grade will be calculated as the average grade of all assignments, with equal weight assigned to each assignment.

In principle, weight for the term project will not be transferred to other course components.

#### 4. Missed Components Of Term Work:

The university has suspended the requirement for students to provide evidence for absences. Please do not attend medical clinics for medical notes or Commissioners for Oaths for statutory declarations.

In the event that a student legitimately fails to submit any online assessment on time (e.g. due to illness etc...), please contact the course coordinator, or the course instructor if this course does not have a coordinator to arrange for a re-adjustment of a submission date. Absences not reported within 48 hours will not be accommodated. If an excused absence is approved, then the percentage weight of the legitimately missed assignment could also be pro-rated among the components of the course.

If you miss any component of the course, send an email to the instructor at the earliest possible opportunity in order to work out a suitable accommodation. Missed components of course work receive a zero grade by default.

#### 5. Scheduled Out-of-Class Activities:

There are no scheduled out of class activities for this course.

#### 6. Course Materials:

Required Textbook(s):

Dina Prialnik, *An Introduction to the Theory of Stellar Structure and Evolution, 2nd Edition* Cambridge University Press.

Lecture notes made in class on the document camera will be posted on D2L. These notes are made available as a study aid, and as a supplement to the text book. They are not a replacement for the text book. It is highly recommended to read the set chapters of the text book carefully, with emphasis on understanding key physics. In the lectures, we will emphasize important parts of the theory and discuss key steps in detail, with the expectation that the essential intermediate steps can be learnt from the text book.

Cloud recordings of the lectures will be posted on D2L.

In order to successfully engage in their learning experiences at the University of Calgary, students taking online, remote and blended courses are required to have reliable access to the following technology:

- A computer with a supported operating system, as well as the latest security, and malware updates;
- A current and updated web browser;
- Webcam/Camera (built-in or external);
- Microphone and speaker (built-in or external), or headset with microphone;
- Current antivirus and/or firewall software enabled;
- Stable internet connection.

For more information please refer to the UofC [ELearning](#) online website.

## 7. Examination Policy:

Exams may draw from all components of the course, including assignments, course notes, and set sections of the text book.

The midterm exam will be administered as a "take-home exam". Students will receive the exam 24 hours in advance and they must return their answers through their dropbox in D2L by the due date. Take home exams are open book exams. A formula sheet will not be provided. Students may be asked to discuss a topic related to the course in a few paragraphs as part of the exam. In that case, the marking will be based on the level of insight in the topic displayed in the text provided.

The final exam will be written in a fixed time frame scheduled by the registrar.

**Students should understand that discussing a take home exam with other students is a form of academic misconduct.**

This course contains a great amount of detail from different disciplines in physics. The emphasis is on understanding how physical processes define the constitution of the stellar interior as a function of stellar mass, composition and evolutionary state. For this purpose, an understanding of the physics of these processes is required. The exams may assess this understanding, and your ability to do calculations on specific physical processes.

**All exams are cumulative.**

Students should also read the Calendar, [Section G](#), on Examinations.

## 8. Approved Mandatory And Optional Course Supplemental Fees:

There are no mandatory or optional course supplemental fees for this course

## 9. Writing Across The Curriculum Statement:

For all components of the course, in any written work, the quality of the student's writing (language, spelling, grammar, presentation etc.) can be a factor in the evaluation of the work. See also Section [E.2](#) of the University Calendar.

Grading depends in part on clarity and conciseness of the answers provided. This includes the structure and logic progression of solutions. No points are awarded for unclear or illegible answers. No points will be subtracted for minor grammatical, style, or spelling errors. The term project of this course requires writing reports. The marking of these reports will include style, effective use of figures and references.

## 10. Human Studies Statement:

Students will not participate as subjects or researchers in human studies.

See also [Section E.5](#) of the University Calendar.

## 11. Reappraisal Of Grades:

A student wishing a reappraisal, should first attempt to review the graded work with the Course coordinator/instructor or department offering the course. Students with sufficient academic grounds may request a reappraisal. Non-academic grounds are not relevant for grade reappraisals. Students should be aware that the grade being reappraised may be raised, lowered or remain the same. See [Section I.3](#) of the University Calendar.

- Term Work:** The student should present their rationale as effectively and as fully as possible to the Course coordinator/instructor within **ten business days** of either being notified about the mark, or of the item's return to the class. If the student is not satisfied with the outcome, the student shall submit the Reappraisal of Graded Term work form to the department in which the course is offered within 2 business days of

receiving the decision from the instructor. The Department will arrange for a reappraisal of the work within the next ten business days. The reappraisal will only be considered if the student provides a detailed rationale that outlines where and for what reason an error is suspected. See sections [I.1](#) and [I.2](#) of the University Calendar

- b. **Final Exam:** The student shall submit the request to Enrolment Services. See [Section I.3](#) of the University Calendar.

## 12. Other Important Information For Students:

- a. **Mental Health** The University of Calgary recognizes the pivotal role that student mental health plays in physical health, social connectedness and academic success, and aspires to create a caring and supportive campus community where individuals can freely talk about mental health and receive supports when needed. We encourage you to explore the mental health resources available throughout the university community, such as counselling, self-help resources, peer support or skills-building available through the SU Wellness Centre (Room 370, MacEwan Student Centre, [Mental Health Services Website](#)) and the Campus Mental Health Strategy website ([Mental Health](#)).
- b. **SU Wellness Services:** For more information, see [www.ucalgary.ca/wellnesscentre](http://www.ucalgary.ca/wellnesscentre) or call [403-210-9355](tel:403-210-9355).
- c. **Sexual Violence:** The Sexual Violence Support Advocate, Carla Bertsch, can provide confidential support and information regarding sexual violence to all members of the university community. Carla can be reached by email ([syasa@ucalgary.ca](mailto:syasa@ucalgary.ca)) or phone at [403-220-2208](tel:403-220-2208). The complete University of Calgary policy on sexual violence can be viewed at (<https://www.ucalgary.ca/policies/files/policies/sexual-violence-policy.pdf>)
- d. **Misconduct:** Academic integrity is the foundation of the development and acquisition of knowledge and is based on values of honesty, trust, responsibility, and respect. We expect members of our community to act with integrity. Research integrity, ethics, and principles of conduct are key to academic integrity. Members of our campus community are required to abide by our institutional [Code of Conduct](#) and promote academic integrity in upholding the University of Calgary's reputation of excellence. Some examples of academic misconduct include but are not limited to: posting course material to online platforms or file sharing without the course instructor's consent; submitting or presenting work as if it were the student's own work; submitting or presenting work in one course which has also been submitted in another course without the instructor's permission; borrowing experimental values from others without the instructor's approval; falsification/fabrication of experimental values in a report. Please read the following to inform yourself more on academic integrity:

[Student Handbook on Academic Integrity](#)  
[Student Academic Misconduct Policy](#) and [Procedure](#)  
[Research Integrity Policy](#)

Additional information is available on the [Student Success Centre Academic Integrity page](#)

- e. **Academic Accommodation Policy:** Students needing an accommodation because of a disability or medical condition should contact Student Accessibility Services in accordance with the procedure for accommodations for students with disabilities available at [procedure-for-accommodations-for-students-with-disabilities.pdf](#).

Students needing an accommodation in relation to their coursework or to fulfill requirements for a graduate degree, based on a protected ground other than disability, should communicate this need, preferably in writing, to the Associate Head of the Department of Physics & Astronomy, Dr. David Feder by email [phas.ahugrd@ucalgary.ca](mailto:phas.ahugrd@ucalgary.ca) or phone 403-220-8127. Religious accommodation requests relating to class, test or exam scheduling or absences must be submitted no later than **14 days** prior to the date in question. See [Section E.4](#) of the University Calendar.

- f. **Freedom of Information and Privacy:** This course is conducted in accordance with the Freedom of Information and Protection of Privacy Act (FOIPP). Students should identify themselves on all written work by placing their name on the front page and their ID number on each subsequent page. For more information, see [Legal Services](#) website.
- g. **Student Union Information:** [VP Academic](#), Phone: [403-220-3911](tel:403-220-3911) Email: [suvpaca@ucalgary.ca](mailto:suvpaca@ucalgary.ca). SU Faculty Rep., Phone: [403-220-3913](tel:403-220-3913) Email: [sciencerep@su.ucalgary.ca](mailto:sciencerep@su.ucalgary.ca). [Student Ombudsman](#), Email: [ombuds@ucalgary.ca](mailto:ombuds@ucalgary.ca).
- h. **Surveys:** At the University of Calgary, feedback through the Universal Student Ratings of Instruction ([USRI](#)) survey and the Faculty of Science Teaching Feedback form provides valuable information to help with evaluating instruction, enhancing learning and teaching, and selecting courses. Your responses make a

difference - please participate in these surveys.

- i. **Copyright of Course Materials:** All course materials (including those posted on the course D2L site, a course website, or used in any teaching activity such as (but not limited to) examinations, quizzes, assignments, laboratory manuals, lecture slides or lecture materials and other course notes) are protected by law. These materials are for the sole use of students registered in this course and must not be redistributed. Sharing these materials with anyone else would be a breach of the terms and conditions governing student access to D2L, as well as a violation of the copyright in these materials, and may be pursued as a case of student academic or [non-academic misconduct](#), in addition to any other remedies available at law.

### 1. If you need help.

The challenges that students face taking on-line courses are widely recognized in the university. Adaptations are made as we become aware of the impact of certain aspects of course design. Students who find that this course has an unintended negative impact because of their situation, are encouraged to contact the instructor to explore possible solutions.

Detailed course information will be posted on D2L. Check D2L for important dates like due dates for assignments, midterm information, etc.

**Email to the instructor is strictly for issues related to the organization of the course, or to book an appointment. Questions about course material cannot be effectively answered by email. Do not send scanned notes by email.**

Questions about course material can be asked immediately after class, during office hours, or by appointment in a dedicated Zoom meeting. The instructor will make an effort to stay after lectures until all questions have been answered.

In the on-line course delivery because of the COVID-19 virus, office hours will be held as a town-hall style meeting in zoom. Details to be announced by email. Office hours will not be recorded.

Recordings of Zoom lectures are posted only for the purpose of studying for ASPH 403.

### 2. Assignments.

Assignments are intended to provide hands-on experience with course material and to explore specific parts of the theory by self-study. To achieve these goals, we will do a mix of on-line and written assignments. The on-line assignments will be administered through TopHat. These allow a wider range of practice problems and a faster turnaround time.

The TopHat course identification is **ASPH403W2021**. The join code is **885869**. You must make sure your name and student ID are entered in the correct area, to ensure you receive grades for TopHat assignments.

Written assignments allow for more in-depth considerations and calculations. **Written assignments must be submitted in the designated D2L dropbox by the due date.** Latex/Word typesetting or hand-written solutions are accepted on an equal basis.

Assignments will receive equal weight for the purpose of calculating the over-all assignment grade.

All assignments will be announced by email to ensure optimal integration with the lectures. The due date will be at least 7 days after announcement of the assignment. We expect to do 4 or 5 assignments through the term, depending on course progress and external factors (e.g. the pandemic).

### 3. Term project.

Every student will select a star from a list posted by the instructor on D2L at the start of the term. Students will research their star during the term and write an introductory, interim and final report on their star, using scientific resources on the internet and scientific papers. Students are encouraged to consult with the instructor if they have questions about their star, or their project.

**Introductory report (1 page of text and 1 prescribed figure, due January 31, 2021, 7.5% of course grade):**

The introductory report describes available observational data for the star with one page of text (only) and one additional figure as specified below. The report must be written in prose. A table is not acceptable. The report includes apparent and absolute magnitudes in various filters, variability (if any), spectral type, any binary companions, classification (e.g. delta-Cepheid, Mira variable, W Vir star), population designation (population I or

II), proper motion, radial and tangential velocity, and distance measured by the GAIA space observatory, any radio or X-ray detections, etc. The required figure plots apparent magnitude versus wavelength over the widest possible wavelength range, but at least ultraviolet through optical to infrared (including). The text will be marked on detail, insight and efficacy of the presentation of the available data.

No additional figures allowed. Reserve your own selection of figures for the final report.

**Course Outcomes:**

- Understand the equations that relate pressure, density and temperature in a star in hydrostatic and local thermodynamic equilibrium for chemically homogeneous and inhomogeneous stars.
- Relate the physical state of the gas in the interior of a star to evolutionary time scales and the observed distribution of stars in the Hertzsprung-Russell diagram.
- Quantitatively evaluate the equation of state and physical processes such as nuclear fusion, convection, and radiation transport for plasma in equilibrium ionization under non-degenerate and degenerate conditions.
- Discuss the late stages of stellar evolution as a function of mass, and how these relate to the creation of heavy elements and the dissemination of products of stellar nucleosynthesis into the interstellar medium.
- Describe the main features of the spectra of stars in the spectral sequence OBAFGKM and understand the physical origin of spectral lines.

Electronically Approved - Apr 06 2021 16:55

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**Department Approval**