

We recognize and acknowledge that McMaster University meets and learns on the traditional territories of the Mississauga and Haudenosaunee nations, and within the lands protected by the "[Dish With One Spoon](#)" wampum, an agreement amongst all allied Nations to peaceably share and care for the resources around the Great Lakes.

ASTRON 2E03 - Planetary Astronomy

2022 Winter Term

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Course Description

This course emphasizes the use physics and mathematics to understand planets in our solar system and others. It also applies key ideas in geophysical and planetary sciences to understand important components of planets such as their internal structure, atmospheres, and heating and cooling processes. Observations and experiments of many kinds, in addition to theoretical models that are used to explain them are discussed. The course begins by exploring key concepts in dynamics that allows us to understand the orbital properties of planetary systems and their stability. After studying heating and cooling processes of a planet, we apply these to the topic of planetary atmospheres; from that of Earth like planets, to the giant planets and ice giants in our solar system. We will discuss the interiors of these various types of planets that turn out to have a number of exotic properties that test the limits of current physical models. We will apply these concepts to the search for and characterization of the more than 4000 exoplanets, most of which are SuperEarths with no counterparts in our solar system. These discoveries have led to the developmet of radically new ideas in how planets form including planetary migration – which will be the final topic of the course.

Prerequisite(s): One of [ARTSSCI 2D06 A/B](#), [PHYSICS 1A03](#), [1C03](#), [1D03](#); and one of [ARTSSCI 1D06 A/B](#), [MATH 1A03](#), [1LS3](#), [1X03](#), [1ZA3](#); or [ISCI 1A24 A/B](#)



Course and Learning Objectives

Learning Objectives

By the end of this course, students will have gained an understanding of the physical processes that give rise to the dynamics and properties of planets and small bodies in our solar system, from the Earth to the giant planet, Jupiter. They will learn how to apply a few basic physical principles to determine important properties of planets - such as the greenhouse effect for atmospheres, planetary structure and orbital dynamics. They will also learn important interdisciplinary ideas from astrophysics and Earth and planetary sciences that are essential for understanding planets, such as the carbon cycle that links oceans and atmospheres. Moving beyond our solar system, they will learn about the latest observational discoveries and our current theories about exoplanetary systems and their formation. Throughout, students will be trained in how observations, experiments, and the latest space craft missions are used to build testable physical models. They will gain an understanding of how these basic ideas are being applied to exoplanetary systems; how exoplanets are found and the new theoretical models that have been developed to understand how they are formed.

Class Activities:

The course is organized as follows:

- 3 classroom-based lectures per week
- In class, TopHat active learning
- 4 assignments
- 1 in-class midterm test
- Final exam

Materials & Fees

Required Materials/ Resources

- There is no suitable textbook at this level that covers the material. Class notes, [Top Hat](#) questions, and slides/videos, will form the basis of the material.
- [Top Hat](#): Active learning platform, to be used in all lectures.
- **Course Website:** [Avenue to Learn](#)



Course Delivery: We are planning for a full return to in-person classes in the winter term 2022. In case this needs to change, I remind you about procedures for virtual classes.

To follow and participate in virtual classes it is expected that you have reliable access to the following:

- A computer that meets performance requirements [found here](#).
- An internet connection that is fast enough to stream video.
- Computer accessories that enable class participation, such as a microphone, speakers and webcam when needed.

If you think that you will not be able to meet these requirements, please contact uts@mcmaster.ca as soon as you can. Please visit the [Technology Resources for Students page](#) for detailed requirements. If you use assistive technology or believe that our platforms might be a barrier to participating, please contact [Student Accessibility Services](#), sas@mcmaster.ca, for support.

Course Overview and Assessment

Topics:

Week	Lecture Topics	Assignments
1 - (Jan. 10-14)	<ul style="list-style-type: none"> • Overview: Solar System and Exo Planets 	
2 - (Jan. 17-21)	<ul style="list-style-type: none"> • Gravity, Angular Momentum, and Energy 	
3 - (Jan. 24-28)	<ul style="list-style-type: none"> • Planetary Dynamics A: Resonances 	Assign 1
4 - (Jan.31-Feb 4)	<ul style="list-style-type: none"> • Planetary Dynamics B: Three Bodies 	Assign 1 – hand in
5 - (Feb.7-11)	<ul style="list-style-type: none"> • Planetary Dynamics C: Tides 	Assign 2
6 – (Feb 14-18)	<ul style="list-style-type: none"> • Heating and Cooling A: Radiative Heating by Stars 	Assign 2 – hand in;
Feb. 21-25	Midterm Recess	
7 - (Feb.28-Mar4)	<ul style="list-style-type: none"> • Heating and Cooling B: Greenhouse effect 	
8- (Mar 7-11)	<ul style="list-style-type: none"> • Planetary Atmospheres: Terrestrial to Gas Giants • Midterm. March 9. 	
9- (Mar. 14-18)	<ul style="list-style-type: none"> • Planetary Interiors A: Terrestrial Planets 	Assign 3
10 – (Mar.21-25)	<ul style="list-style-type: none"> • Planetary Interiors B: Giant Planets 	Assign 3- hand in



11- (Mar.28- Apr.1)	<ul style="list-style-type: none"> Exoplanets A: Observational Discovery Methods 	Assign 4
12-(Apr.4-9)	<ul style="list-style-type: none"> Exoplanets B: Formation Theories 	Assign 4 – hand-in
13 – Apr. 12	<ul style="list-style-type: none"> Review of course (last class) 	

Evaluation

- **Midterm and Final Exam:** There will be a one hour, in class midterm – see the schedule. The final written exam will be 2.5 hours in length. It will mirror the style of the midterm.
- **Assignments:** There are 4 assignments, each worth the same fraction of the total assignment mark. It is very important that you complete all of them – since this is the primary way that you will be learning the course material.
- **Class participation and expectations:** I will use TopHat as an active learning platform. Each lecture will have a number of questions of varying kinds. For each question, you will receive an equal proportion of a mark for attempting the question, and for getting the correct answer. This will provide feedback and in class exercise in every lecture, to help build your problem solving skills and knowledge.
- **Course-specific regulations regarding missed work, extensions, late penalties:** For SAS students, extensions will apply to hand in work at a later point. For all students, there is a late penalty for work handed in late. Please always try to hand in work, even if late. It is most important to do the example problems, because that's the only real way to learn the material. Normally, we will deduct 5% of the assignment mark for each day that it is late.

Grade Component	Percent of total
Final Examination	40%
Mid Term	20%
Daily TopHat in class questions/participation	10%
Assignments: 4	30%

Requests for Relief for Missed Academic Term Work

[McMaster Student Absence Form \(MSAF\)](#): In the event of an absence for medical or other reasons, students should review and follow the Academic Regulation in the Undergraduate Calendar “Requests for Relief for Missed Academic Term Work”.

MSAF Course Specific Information

- MSAF midterm: Final exam will be worth more of your mark (ie 60%); MSAF Assignments: Assignment total mark will be carried by assignments handed in.

Academic Accommodation of Students with Disabilities

Students with disabilities who require academic accommodation must contact [Student Accessibility Services \(SAS\)](#) at 905-525-9140 ext. 28652 or sas@mcmaster.ca to make arrangements with a Program Coordinator. For further information, consult McMaster University's [Academic Accommodation of Students with Disabilities](#) policy.

Academic Accommodation for Religious, Indigenous Or Spiritual Observances (Riso)

Students requiring academic accommodation based on religious, indigenous or spiritual observances should follow the procedures set out in the [RISO](#) policy. Students should submit their request to their Faculty Office **normally within 10 working days** of the beginning of term in which they anticipate a need for accommodation or to the Registrar's Office prior to their examinations. Students should also contact their instructors as soon as possible to make alternative arrangements for classes, assignments, and tests.

Courses with An On-Line Element

Some courses may use on-line elements (e.g. e-mail, Avenue to Learn (A2L), LearnLink, web pages, capa, Moodle, ThinkingCap, etc.). Students should be aware that, when they access the electronic components of a course using these elements, private information such as first and last names, user names for the McMaster e-mail accounts, and program affiliation may become apparent to all other students in the same course. The available information is dependent on the technology used. Continuation in a course that uses on-line elements will be deemed consent to this disclosure. If you have any questions or concerns about such disclosure, please discuss this with the course instructor.

Online Proctoring

Some courses may use online proctoring software for tests and exams. This software may require students to turn on their video camera, present identification, monitor and record their computer activities, and/or lock/restrict their browser or other applications/software during tests or exams. This software may be required to be installed before the test/exam begins.

Academic Integrity

You are expected to exhibit honesty and use ethical behaviour in all aspects of the learning process. Academic credentials you earn are rooted in principles of honesty and academic integrity.

It is your responsibility to understand what constitutes academic dishonesty.

Academic dishonesty is to knowingly act or fail to act in a way that results or could result in unearned academic credit or advantage. This behaviour can result in serious consequences, e.g. the grade of zero on an assignment, loss of credit with a notation on the transcript (notation reads: “Grade of F assigned for academic dishonesty”), and/or suspension or expulsion from the university. For information on the various types of academic dishonesty please refer to the [Academic Integrity Policy](https://secretariat.mcmaster.ca/university-policies-procedures-guidelines/), located at <https://secretariat.mcmaster.ca/university-policies-procedures-guidelines/>

The following illustrates only three forms of academic dishonesty:

- plagiarism, e.g. the submission of work that is not one’s own or for which other credit has been obtained.
- improper collaboration in group work.
- copying or using unauthorized aids in tests and examinations.

Authenticity / Plagiarism Detection

Some courses may use a web-based service (Turnitin.com) to reveal authenticity and ownership of student submitted work. For courses using such software, students will be expected to submit their work electronically either directly to Turnitin.com or via an online learning platform (e.g. A2L, etc.) using plagiarism detection (a service supported by Turnitin.com) so it can be checked for academic dishonesty.

Students who do not wish their work to be submitted through the plagiarism detection software must inform the Instructor before the assignment is due. No penalty will be assigned to a student who does not submit work to the plagiarism detection software. **All submitted work is subject to normal verification that standards of academic integrity have been upheld** (e.g., on-line search, other software, etc.). For more details about McMaster’s use of Turnitin.com please go to the [McMaster Office of Academic Integrity](#).

Conduct Expectations

As a McMaster student, you have the right to experience, and the responsibility to demonstrate, respectful and dignified interactions within all our living, learning and working communities. These expectations are described in the [Code of Student Rights & Responsibilities \(the “Code”\)](#). All students share the responsibility of maintaining a positive environment for the academic and personal growth of all McMaster community members, **whether in person or online.**

It is essential that students be mindful of their interactions online, as the Code remains in effect in virtual learning environments. The Code applies to any interactions that adversely affect, disrupt, or interfere with reasonable participation in University activities. Student disruptions or behaviours that interfere with university functions on online platforms (e.g. use of Avenue 2 Learn, WebEx or Zoom for delivery), will be taken very seriously and will be investigated. Outcomes may include restriction or removal of the involved students' access to these platforms.

Copyright and Recording

Students are advised that lectures, demonstrations, performances, and any other course material provided by an instructor include copyright protected works. The Copyright Act and copyright law protect every original literary, dramatic, musical and artistic work, **including lectures** by University instructors.

The recording of lectures, tutorials, or other methods of instruction may occur during a course. Recording may be done by either the instructor for the purpose of authorized distribution, or by a student for the purpose of personal study. Students should be aware that their voice and/or image may be recorded by others during the class. Please speak with the instructor if this is a concern for you.

Research Ethics -NA

Extreme Circumstances

The University reserves the right to change the dates and deadlines for any or all courses in extreme circumstances (e.g., severe weather, labour disruptions, etc.). Changes will be communicated through regular McMaster communication channels, such as McMaster Daily News, A2L and/or McMaster email.