

ENGPYHS 3SP3
Space Systems Engineering
Undergraduate Studies
Fall 2024
Course Outline

CALENDAR/COURSE DESCRIPTION

A survey of topics required for the development of near-Earth satellite missions from a systems engineering perspective. Topics include introduction to systems engineering, launch and space environments, orbital mechanics, spacecraft dynamics, propulsion and power systems, radio and optical communications, and observational instrumentation. Selected guest lectures from industry experts.

PRE-REQUISITES AND ANTI-REQUISITES

Prerequisite(s): Registration in Level III or above of an Engineering or Honours Physics program.
Antirequisite(s): None.

INSTRUCTOR OFFICE HOURS AND CONTACT INFORMATION

Liam Flannigan
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Office Hours:
Available online via email and appointment.

TEACHING ASSISTANT OFFICE HOURS AND CONTACT INFORMATION

TA 1: Petru Ojebra
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TA 2: Tiancheng Wu
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TA 3: Joyce Xie
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COURSE WEBSITE/ALTERNATE METHODS OF COMMUNICATION

1. Avenue to Learn will host the official course website for course materials, communications, submission of work and grading. <http://avenue.mcmaster.ca/>
2. Lectures will be held in person at PC 155 (the Psychology building). Attendance is recommended as lecture recordings will not be posted.
3. Appointments can be scheduled by sending an email to the instructor to organize a time to meet. Questions are also welcome over email about the course. For mark disputes, please wait until the solutions for the assignment are posted before emailing the instructor or the teaching assistants about marks.

COURSE INTENDED LEARNING OUTCOMES

By the end of this course, students will be able to identify and apply systems engineering concepts to space missions and will understand the multidisciplinary collaboration required to realize a near-earth space mission.

Course concepts include:

- The systems engineering process and project life cycle.
- Requirements definition and flowdown.
- Verification and validation.
- The role of standardization in space systems.
- Space mission design.
- Implementation and applications of remote sensing and astronomy payloads
- Spacecraft systems hierarchy and functional decomposition.
- Effect of the launch and near-earth orbit environments on space system design.
- Orbital mechanics of near-earth orbits.
- Spacecraft communications.

MATERIALS AND FEES

Required Texts:

"NASA systems engineering handbook NASA SP-2016-6105 Rev2" Hirshorn, Steven R., Linda D. Voss, and Linda K. Bromley. National Aeronautics and Space Administration, 2017.

Available free online: <https://www.nasa.gov/conspeaknect/ebooks/nasa-systems-engineering-handbook>

Recommended Additional Texts:

Fortescue, Peter, Graham Swinerd, and John Stark, "Spacecraft systems engineering". John Wiley & Sons, 2011.

Curtis, Howard D. "Orbital mechanics for engineering students." Butterworth-Heinemann, 2013.

Wertz, James Richard, David F. Everett, and Jeffery Puschell. "Space mission engineering: the new SMAD.", 2011.

W. Larson, D. Kirkpatrick, J. Sellers, D. Thomas, D. Verma "Applied Space Systems Engineering", McGraw Hill, 2009.

Other Materials:

The course will use MATLAB for some assignment problems.

COURSE FORMAT AND EXPECTATIONS

The course is organized as follows:

- 1 lecture per week, 3 hours, Wednesday evenings 7pm-10pm in PC 155

Grading is based on the following:

- Homework assignments
- Exam

Since this course is delivered as a single extended lecture each week covering a wide range of topics, attendance is highly encouraged. Lecture notes will be available, but they are designed to complement the lecture and will not always be a complete standalone reference.

COURSE SCHEDULE

The tentative lecture schedule is listed below. This schedule may be modified as the course progresses based on the availability of guest lecturers. Any changes to the schedule will be posted on Avenue to Learn.

Date/Week	Topic	Readings
Week 1 (Sept 4)	Introduction to Systems Engineering	
Week 2 (Sept 11)	Requirements and System Design	
Week 3 (Sept 18)	Launch Structure/Thermal	
Week 4 (Sept 25)	Product Integration and Satellite Systems	
Week 5 (Oct 2)	The Space Environment	
Week 6 (Oct 9)	Intro to Orbital Mechanics	
Week 7 (Oct 16)	Midterm recess, no lecture.	
Week 8 (Oct 23)	Orbits in 3D	
Week 9 (Oct 30)	Satellite Communications	
Week 10 (Nov 6)	Intro to Spacecraft Dynamics	
Week 11 (Nov 13)	Satellite Attitude Determination and Control Systems	
Week 12 (Nov 20)	Earth Observation / Remote Sensing	
Week 13 (Nov 27)	James Webb Space Telescope / AstroSats	
Week 14 (Dec 4)	No lecture.	

ASSESSMENT

Assessment for this course will be based on regular homework assignments and a final exam. Homework assignments will be handed out at the end of the given week's lecture and due at the beginning of the following week's lecture. The number of assignments will vary depending on guest lecturer scheduling, but the plan is to have at least 9 assignments. Your worst assignment will be dropped for marking purposes, so for example: if we have 9 assignments, only the best 8 will be considered for your final mark.

The final exam will be in person and will cover a subset of topics covered in the course, to be communicated prior to the exam. Date and duration are TBD.

Component	Due Date	Weight
Homework Assignments	Due on Avenue to Learn one week after being posted	65%
Final Exam	TBD	35%
Total		100%

EQUITY, DIVERSITY, AND INCLUSION

Every registered student belongs and is welcome in this course. Diversity of backgrounds and experiences is expected and welcome. You can expect your Instructor to be respectful of this diversity in all aspects of the course, and the same is expected of you.

The Department of Engineering Physics is committed to creating an environment in which students of all genders, cultures, ethnicities, races, sexual orientations, abilities, and socioeconomic backgrounds have equal access to education and are welcomed and treated fairly. If you have any concerns regarding inclusion in our Department, in particular if you or one of your peers is experiencing harassment or discrimination, you are encouraged to contact the Chair, Associate Undergraduate Chair, Academic Advisor or to contact the [Equity and Inclusion Office](#).

PHYSICAL AND MENTAL HEALTH

For a list of McMaster University's resources, please refer to the [Student Wellness Centre](#).

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:

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

COURSES WITH AN ON-LINE ELEMENT

McMaster is committed to an inclusive and respectful community. These principles and expectations extend to online activities including electronic chat groups, video calls and other learning platforms.

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.

CONDUCT EXPECTATIONS

As a McMaster student, you have the right to experience, and the responsibility to demonstrate, respectful and dignified interactions within all of 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.

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.

COURSE POLICY ON MISSED WORK, EXTENSIONS, AND LATE PENALTIES

1. **Assignments submitted after the deadline will receive a mark of 0%.** This is due to assignment solutions being posted regularly after the assignment deadline.
2. A valid MSAF filing will allocate the missed assignment grade to the remaining assignments (counts as your lowest grade homework).

SUBMISSION OF REQUEST FOR RELIEF FOR MISSED ACADEMIC WORK

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”.

1. **Relief for missed academic work worth less than 25% of the final grade resulting from medical or personal situations lasting up to three calendar days:**
 - Use the [McMaster Student Absence Form](#) (MSAF) on-line self-reporting tool. No further documentation is required.
 - Students may submit requests for relief using the MSAF once per term.
 - An automated email will be sent to the course instructor, who will determine the appropriate relief. Students must immediately follow up with their instructors. Failure to do so may negate the opportunity for relief.
 - The MSAF cannot be used to meet a religious obligation or to celebrate an important religious holiday.
 - The MSAF cannot be used for academic work that has already been completed attempted.
 - An MSAF applies only to work that is due within the period for which the MSAF applies, i.e. the 3-day period that is specified in the MSAF; however, all work due in that period can be covered by one MSAF.
 - The MSAF cannot be used to apply for relief for any final examination or its equivalent. See *Petitions for Special Consideration* above.

2. **For medical or personal situations lasting more than three calendar days, and/or for missed academic work worth 25% or more of the final grade, and/or for any request for relief in a term where the MSAF has been used previously in that term:**
- Students must report to their Faculty Office to discuss their situation and will be required to provide appropriate **supporting documentation**.
 - If warranted, the Faculty Office will approve the absence, and the instructor will determine appropriate relief.

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.

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.

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.