

## MECH 580 A04 – Experimental Techniques and Uncertainty

Summer 2024 (202405)

### Instructor

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### Office Hours

TBA

**Prerequisites:** Undergraduate Statistics Course

### Schedule and Sections

MECH 580    Section: A04    CRN: 30653

### Textbooks, Course Lecture Notes & Online Course Materials

There is no required textbook but the course material is drawn from the following texts and it is strongly recommended that students access these textbooks throughout the course:

1. Thomas Ryan. 2007. Modern Experimental Design. Wiley, ebook Available in the Library.
2. Philip Cash, Tino Stankovic, Maria Storga (eds.) 2016. Experimental Design Research, Approaches, Perspectives and Applications, Springer, ISBN 978-3-319-33781-4 (eBook) Available in the Library.
3. Hugh W. Coleman, W. Glenn Steele. 2018. Experimentation, Validation, and Uncertainty Analysis for Engineers, 4th Edition, Wiley, ISBN: 978-1-119-41770-5

### COURSE LECTURE NOTES

Unless otherwise noted, all course materials supplied to students in this course are intended for use in this course only. These materials are NOT to be re-circulated digitally, whether by email or by uploading or copying to websites, or to others not enrolled in this course. Violation of this policy may in some cases constitute a breach of academic integrity as defined in the UVic Calendar.

### COURSE OBJECTIVES

- Explain the principles behind research design and experimental design toward proving a hypothesis through physical or numerical experimentation.
- Explain the fundamentals of designing, calibrating and validating models (both physical prototypes and numerical/mathematical).

**LEARNING OUTCOMES:** By the completion of MECH 580, students will be able to (under development):

1. Know how to design an experiment that tests a hypothesis or achieves an objective.
2. Understand the principles of model design from conception to development.
3. Know the limitations of their observations and the statistical analyses tools available to treat that data.
4. Be able to compute the uncertainty in their data, models, designs.

<b>Assessment</b>	<b>%</b>
<b>Computational Assignments</b> <ul style="list-style-type: none"> <li>• 4 to 5 Assignments</li> </ul>	50
<b>Test</b> <ul style="list-style-type: none"> <li>• Thursday, June 27th</li> </ul>	25
<b>Project</b> <ul style="list-style-type: none"> <li>• Report: 20% and due end by 11:59 on Thursday, August 1<sup>st</sup>. Students must design an experiment that tests a hypothesis or achieves an objective of their choice. The project must outline the question/objective/prototype and then describe the experimental design, expectations and uncertainty analysis.</li> <li>• Presentation: 5%</li> </ul>	25

### **Tentative Course Topic Schedule**

<b>Module</b>	<b>Topics</b>
1, 2, 3, 4, 5	Introduction: Classical Approaches to Experimental Design Objectives for Experimental Designs; Planned Experimentation versus use of Observational Data; Basic Design Concepts; Steps for the Design of Experiments; Types of Experimental Designs; analysis of Means; Missing Data; Experimental Designs and Six Sigma; Quasi-Experimental Design; Completely Randomized Design. Full Factorial Designs with Two Levels; Fractional factorial Designs with Two-Levels. Designs With More Than Two Levels; Nested Designs; Robust Designs; Split-Unit, Split-Lot, and Related Designs. Response Surface Designs; Repeated Measure Designs; Multiple Responses.
6, 7, 8, 9	Degree of Goodness and Uncertainty Analysis; Model Conception, Calibration, Validation Designing Experiments to Test Mathematical Models; Data Coverage and Confidence; Data Reduction, Dimensional Analysis; Variable Reduction; Monte Carlo Methods and Taylor Series Methods; Validation of Simulations
10, 11, 12	Building on Experimental Design Research and Synthesizing Knowledge in Design Research

### **Notes on Work Completion**

Failure to complete all laboratory requirements will result in a grade of N being awarded for the course. The final grade obtained from the above marking scheme for the purpose of GPA calculation will be based on the percentage-to-grade point conversion table as listed in the current Undergraduate Calendar.

## **General Information**

**Note to Students:** Students who have issues with the conduct of the course should discuss them with the instructor first. If these discussions do not resolve the issue, then students should feel free to contact the Chair of the Department by email or the Assistant to the Chair to set up an appointment.

**Centre for Accessible Learning (CAL)** <https://www.uvic.ca/accessible-learning/index.php>

**Accommodation of Religious Observance (AC1210)** Read it [here](#)

**Discrimination and Harassment Policy (GV0205)** Read it [here](#)

## **Sexualized Violence Prevention and Response at UVic:**

UVic takes sexualized violence seriously, and has raised the bar for what is considered acceptable behaviour. We encourage students to learn more about how the university defines sexualized violence and its overall approach by visiting <https://www.uvic.ca/sexualizedviolence/>. If you or someone you know has been impacted by sexualized violence and needs information, advice, and/or support please contact the sexualized violence resource office in Equity and Human Rights (EQHR). Whether or not you have been directly impacted, if you want to take part in the important prevention work taking place on campus, you can also reach out:

**Where:** Sexualized violence resource office in EQHR; Sedgewick C119

**Phone:** 250.721.8021

**Email:** [svpcordinator@uvic.ca](mailto:svpcordinator@uvic.ca)

**Web:** <https://www.uvic.ca/sexualizedviolence/>

### **Office of the Ombudsperson:**

The Office of the Ombudsperson is an independent and impartial resource to assist with the fair resolution of student issues. A confidential consultation can help you understand your rights and responsibilities. The Ombudsperson can also clarify information, help navigate procedures, assist with problem-solving, facilitate communication, provide feedback on an appeal, investigate and make recommendations.

**Phone:** 250-721-8357

**Email:** [ombuddy@uvic.ca](mailto:ombuddy@uvic.ca)

**Web:** <https://uvicombudsperson.ca/>

**Electronic devices in labs and lectures:** No unauthorized audio or video recording of lectures is permitted.

**Electronic devices in midterms and exams:** Calculators are only permitted for examinations and tests if explicitly authorized and the type of calculator permitted may be restricted. No other electronic devices (e.g. cell phones, pagers, PDA, etc.) may be used during examinations or tests unless explicitly authorized.

### **Faculty of Engineering, University of Victoria Standards for Professional Behavior**

It is the responsibility of all members of the Faculty of Engineering, students, staff, and faculty, to adhere to and promote standards of professional behavior that support an effective learning environment that prepares graduates for careers as professionals...

You are advised to read the Faculty of Engineering document <https://www.uvic.ca/ecs/assets/docs/student-forms/professional-behaviour.pdf> which contains important information regarding conduct in courses, labs, and in the general use of facilities.

### **Graduate Students' Society**

The Graduate Students' Society (GSS) serves all students registered in a Graduate degree program. For information on GSS activities, events and services navigate to <https://gss.uvic.ca/>

### **Grading System**

The University of Victoria follows a percentage grading system in which the instructor will submit grades in percentages. The University will use the following Senate approved standardized grading scale to assign letter grades. Both the percentage mark and the letter grade will be recorded on the academic record and transcripts. Read the policy [here](#)

### **Attendance**

Students are expected to attend all classes in which they are enrolled. An academic unit may require a student to withdraw from a course if the student is registered in another course that occurs at the same time. An Instructor may refuse a student admission to a lecture, laboratory, online course discussion or learning

activity, tutorial or other learning activity set out in the course outline because of lateness, misconduct, inattention or failure to meet the responsibilities of the course set out in the course outline. Students who neglect their academic work may be assigned a final grade of N or debarred from final examinations. Students who do not attend classes must not assume that they have been dropped from the course by an academic unit or an instructor. Courses that are not formally dropped will be given a failing grade, students may be required to withdraw and will be required to pay the tuition fee for the course. Read the policy [here](#).

### **Academic Integrity**

Academic integrity is intellectual honesty and responsibility for academic work that you submit individual or group work. It involves commitment to the values of honesty, trust, and responsibility. It is expected that students will respect these ethical values in all activities related to learning, teaching, research, and service. Therefore, plagiarism and other acts against academic integrity are serious academic offences.

**The responsibility of the institution:** Instructors and academic units have the responsibility to ensure that standards of academic honesty are met. By doing so, the institution recognizes students for their hard work and assures them that other students do not have an unfair advantage through cheating on essays, exams, and projects.

**The responsibility of the student:** Plagiarism sometimes occurs due to a misunderstanding regarding the rules of academic integrity, but it is the responsibility of the student to know them. If you are unsure about the standards for citations or for referencing your sources, ask your instructor. Depending on the severity of the case, penalties include a warning, a failing grade, a record on the student's transcript, or a suspension. It is your responsibility to understand the University's policy on [Academic Integrity](#)

### **Equality**

This course aims to provide equal opportunities and access for all students to enjoy the benefits and privileges of the class and its curriculum and to meet the syllabus requirements. Reasonable and appropriate accommodation will be made available to students with documented disabilities (physical, mental, learning) in order to give them the opportunity to successfully meet the essential requirements of the course. The accommodation will not alter academic standards or learning outcomes, although the student may be allowed to demonstrate knowledge and skills in a different way. It is not necessary for you to reveal your disability and/or confidential medical information to the course instructor. If you believe that you may require accommodation, the course instructor can provide you with information about confidential resources on campus that can assist you in arranging for appropriate accommodation. Alternatively, you may want to contact the Centre for Accessible Learning (formerly the Resource Centre for Students with a Disability) located in the Campus Services Building.

The University of Victoria is committed to promoting, providing, and protecting a positive, and supportive and safe learning and working environment for all its members.