SGM

Experimental Methods in Engineering Mechanics – ME 412

Fall semester 2024
Lab / lecture: Wednesdays MED 2 2419 (module 1, weeks 1-5), other locations to be announced
Office hour: Tuesday afternoon, MED 2 2419, typ. 3-5 p.m.

Professor:	John M. Kolinski (john.kolinski@epfl.ch), +41 21 693 0270
Teaching associates:	Chenzhuo Li, Xinyue Wei
Wiki:	**https://wiki.epfl.ch/me412-2024**
Grading:	A lab report will be prepared by each group at the end of the module, for a total of 3 reports; these will be used to calculated your grade. More information on grading can be found below in **Format and Procedures**.

I. Rationale:
Experimental measurement is the cornerstone of all scientific progress. Being able to design, construct apparatus, carry out measurements and interpret data is essential to scientific and engineering endeavors. In the field of mechanics, there are some experimental methods that have proved their utility, including the use of electronics in experiment, and imaging. This class provides a broad introduction to these methods with specific classical examples in three modules. Through these examples, students will develop a foundation for future research and development in applied mechanics.

II. Course Aims and Outcomes:
Aims
At the end of this class, you should be comfortable identifying an experimental method to measure a given mechanical quantity. Furthermore, you will become familiar with the three experiments and the science behind them. You will be required to seek out information in the course of each module, and this should prepare you to face challenging, open-ended experimental problems in engineering or science.

Specific Learning Outcomes:
Students who have taken this class can expect
- to understand enough analog electronics to build simple circuits using passive and active components with minimal assistance from e.g. Google
- to read a manual or data sheet and then successfully use the IC or apparatus
- to understand the basics of imaging and geometric optics
- to understand the construction and essential elements of a microscope
- to use image processing to extract data from digitally recorded images
- to learn about the mechanics of fracture and Brownian motion
- to be familiar with particle tracking and image correlation methods

III. Format and Procedures:
The course structure is unconventional, so please ask questions if you do not understand something. <u>Warning: this is not a lab class where I provide you with a recipe.</u> You will be required to identify problems, and take the appropriate actions to address them, often without substantial input from the teaching staff. Part of the process of science and engineering is collaborative effort to solve open-ended problems. Not all students appreciate this course structure – if you don't think you will like this course structure, I encourage you to consider the other great course offerings at EPFL instead of EMEM.

Each module will be introduced with a preliminary lecture, where the scientific motivation for the measurement and experimental approach are introduced. Some guided laboratory exercises will provide a platform for engagement with the necessary experimental apparatus. Following these preliminary lab exercises, each experimental group will proceed to construct some components of the experiment, calibrate the constructed components, record data and compile the laboratory procedure and results into a report.

Experimental groups will comprise three to four students each, for a total of approximately 10 groups. Groups will prepare a report to be assessed after the module. Contributions to the course wiki should be included in the appendix, and will be assessed with the report. Wiki contributions can only enhance the grade of the report, and will not detract from it.

I will grade the first reports to provide an example of the standards expected in a report, and the two subsequent modules will be graded by other groups, whose assessment I will use in determining the grade. As long as the assessment is not capricious, the peer assessment will be used to determine the grade for the report. The assessment of the other group's report will comprise a portion of your grade for the report on the respective module.

In each module, groups must rotate so that each individual student is working with students they have not worked with in a previous module.

Grading: lab reports form the bulk of the grade, with each module weighted equally. For modules 2 and 3, the grade will consist of 80% of the composite assessment (mine and the evaluation of another group), and 20% of your grade will be based on your group's *assessment* of the peer report. Contributions to the wiki can add up to 5% toward the report grade.

The format for the lab reports should follow the 2-column APS letter format (see https://journals.aps.org/prl/authors for technical formatting guidelines), with a focus on concise explanations, and an intense focus on the results of the experiment. All technical details concerning the lab exercises and contributions to the wiki can be submitted as an appendix, or as a second document. Close attention must be paid to **figure presentation and captioning**, as this is a critical aspect of clearly communicating your results from the experiment. Bullet points describing expectations are as follows:

- Figures should be clear, with legible axis labels and legends.
- Figure captions should be complete and concise – all aspects of the figure should be explained, but excess verbiage is to be avoided.
- Writing style should be focused in concise and clear exposition.
- Rigor in the scientific approach, including hypothesis formulation, hypothesis testing, development of results with data to support the conclusions drawn from the experiment, and contextualization of the result in a brief discussion convey the rigor of the scientific approach to each experiment.

Expectations of group reports for each module:

- The report on the final measurement will follow the format of a PRL paper. Some rough guidelines on this writing style can be found here: https://www.asc.ohio-state.edu/wilkins.5/onepage/prl.html . I would encourage more a focus on the overall spirit of the guidelines (points 1, 2, 8 and 9) are the most important. Having a precise line count is less important, but any text on page 5 is too much text. A supplementary document or appendix including technical details, materials and methods and calibration experiments is allowed, but should only be used to fill in the gaps in the paper.
- The grading breakdown, briefly, is:

Grading Category	% of report grade
PRL format (title, abstract, technical layout, etc.)	5
Figures clear, well-annotated and captioned	30
Clear, concise writing	20
Proper use of any statistical analysis / error quantification	5
Use of scientific method	25
Contribution Statement (CRediT author statement – on google)	15
Experimental "Je ne sais quoi" / wiki / etc.	Up to 5 bonus points
Total	**105 / 100**

IV. Background for the class:
This course assumes a strong background in fluid and solid mechanics, as well as familiarity with electronics and associated apparatus.

V. Course Resources: I encourage you to take good notes during introductory lecture for each module, and maintain a running lab book with figures and illustrations. These will make the preparation of the lab reports much easier.

Selected readings will be provided each week on the wiki

The wiki forms a core component of the class. Here, explanations of a particularly helpful procedure, or extra information that you found useful should be posted. Contributions to the wiki should be carefully documented and presented to increase their utility. Wiki contributions should be included with lab reports in the appendix, and can be counted as additional credit for the lab report.

- An incomplete list of course readings:
  The art of electronics by Horowitz and Hill
  Theory of Elasticity by Landau and Lifshitz
  Fluid Mechanics by Landau and Lifshitz
  Dynamic Fracture Mechanics by L.B. Freund
  …. Selected papers to be posted to the Moodle
  …. Data sheets for pertinent op-amps, etc.

VI. Academic Integrity
As laboratory reports constitute the bulk of the assessment, a high standard for proper citation practice is essential. Any deliberate plagiarism will result in a failing grade for the report. You will not lose credit for proper attribution; on the contrary, proper attribution will enhance the clarity of the report and likely increase your grade.

VII. Students with disabilities
In compliance with the EPFL LEX 2.6.5, I am available to discuss appropriate academic accommodations that may be required for student with disabilities.

IX. Tentative Course Schedule: (*Subject to change*)

Week	Module	Plan for contact hours	Outside of class – readings for lecture
1	I	Intro to course – grading, expectations; intro to module; intro to exercises & background – passives and filters	Reading on Oscilloscopes, review syllabus
2	I	Transistors and amplifiers	Assigned readings
3	I	Wheatstone Bridge & driving circuitry	Assigned readings
4	I	Calibrate samples with 4-wire measurement, debug / calibrate bridge circuit	Assigned readings
5	I	Measurements, report preparation and writing	Work on report

6	II	Intro. To instrumentation & experimental prep – DIC lab	Assigned readings
7	II	Prepare samples for measurement; first measurements	
8	II	Conclude experiments & process data	Assigned readings & software preparation for DIC
9	II	Measurements, report writing	Measurement & Work on report
10	II	Conclude processing & write lab report	Work on report
11	III	Lecture, discussion & exercises – Brownian motion	Prepare reading; evaluate report of alt. group from Mod II
12	III	Experimental set-up & preparation	Assigned readings & software preparation for particle tracking
13	III	Conclude experiments & process data	
14	III	Complete data processing & write reports	