ME 552: MEASUREMENTS IN FLUID MECHANICS & HEAT TRANSFER

Course Instructor

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Office hours

Tuesdays 15:00 – 16:00, Thursday 16:00 – 17:00, or by appointment

Meeting Times & Locations

Lecture: Tuesdays and Thursday 08:30 – 09:50 (Rog 332)
Lab: Friday: 08:00-10:00 (officially)

Class Electronic Site Access

Electronic access to class handouts and other reference material will be through Canvas.

Catalog Description

ME 552 Measurements in Fluid Mechanics and Heat Transfer (4).
Lec/Lab: Course emphasis is on measurement techniques and data analysis methods related to fluid mechanics and heat transfer. Proper experimental methods, and data and uncertainty analyses related to thermal and fluids measurements are discussed. Local and spatial mapping of fluid and thermal fields are highlighted.

Course Outcomes

Upon successfully completing this course, a student should be able to
1. Design an experiment pertinent to the thermal and fluid sciences
2. Perform measurements using typical instruments in fluid mechanics and heat transfer and digital data acquisition systems
3. Analyze and interpret data recorded from global and local measurements
4. Apply uncertainty analysis during the design, measurement, and analysis stages of an experiment.

Prerequisites

ME331 (undergraduate fluid mechanics), ME332 (undergraduate heat transfer), and a basic instrumentation class such as ME451

Textbook

No prescribed textbook. Course material will be posted on Canvas or provided in class.

References

The textbooks from the prerequisite classes will be useful as references for data analysis. Other reference textbooks are listed below
1. Fluid Mechanics Measurements, Second edition, Goldstein, R. J., editor, Taylor and Francis, 1996.
2. Theory and Design for Mechanical Measurements, Fourth edition, Figliola, R. S., and Beasley, D. E., John Wiley and Sons, 2006
3. Thermal and Flow Measurements, First Edition, Lee, T-W, Taylor and Francis, 2008.

4. Particle Image Velocimetry- A Practical Guide, Rael, M., Willert, C. E., Wereley, S.T., Kompenhans, J., Second Edition, Springer, 2007
5. A Gallery of Fluid Motion, Eds. Samimy, M., Bruer, K. S., Leal, L. G., and Steen, P.H., Cambridge University Press, 2003.
6. Hot-wire Anemometry- Principles and Signal Analysis, Bruun, H. H., Oxford University Press, 1995.
7. Multimedia Fluid Mechanics, Second Edition DVD, Ed. Homsy, G. M., Cambridge University Press, 2008. This DVD can be checked out for 2 weeks at a time by students registered for the course.
8. Guide to Expression of Uncertainty in Measurement, International Organization for Standardization, First Edition, 1995.
9. NIST online uncertainty guide, http://physics.nist.gov/cuu/ Uncertainty/index.html

Learning Assessment

Student learning will be assessed by the activities listed in Table 1, each of which is described below.

Table 1. Assessment of student learning

Activity	**Percentage of Grade**	**Course Outcome Assessed**
Term Project Part 1: Literature search and proposal	5 (group)	1
Term Project Part 2: Experimental design and uncertainty analysis	10 (group)	1, 4
Term Project Part 3: Flow calibration	5 (group)	2,3
Term Project Part 4: Final report and presentation	20 (group)	2,3, 4
Lab 1- pressure and flow calibration	10 (individual)	2, 3, 4
Lab 2- hot wire anemometry	10 (individual)	2, 3, 4
Lab 3- flame speed measurement	10 (groups of two)	2,3,4
Data acquisition hands-one activity	0 (but must be completed to pass the course)	1,2
Exam	30 (individual)	1, 2, 3, 4

Lab Logistics and Guidelines: Since there are ~30 students in the class, each group for data collection will consist of a maximum of 4 members. Each group will be given a 2 or 3 hour block of time to collect data. Groups will need to coordinate laboratory usage.

Patience and care needs to be exercised in the conduct of the laboratory experiments! The experiments will be performed using instrumentation that is being used for several research projects. Please follow all instructions in the lab handouts as well as those

provided by the instructors in handling of equipment.

Exam: A comprehensive exam will be administered on Tuesday of week 10.

Professional Courtesy: Group members are required to exercise courtesy to their peers by being cooperative, prepared and punctual to the labs and meetings scheduled outside class. Since you are all graduate students, I will not be imposing team members, nor will I be asking for peer review of team members.

Academic Dishonesty: *The individual work in this class strictly needs to be performed as such*. Copying or plagiarism in the individual sections is considered strictly inappropriate. Students who are determined to be engaging in such activities will be assigned a "0" for the assignment and receive an automatic one letter grade drop. Refer to OSUs academic dishonesty website to realize the different activities that are considered unacceptable, http://oregonstate.edu/admin/stucon/achon.htm.

Students with Disabilities
Accommodations are collaborative efforts between students, faculty and Disability Access Services (DAS). Students with accommodations approved through DAS are responsible for contacting the faculty member in charge of the course prior to or during the first week of the term to discuss accommodations. Students who believe they are eligible for accommodations but who have not yet obtained approval through DAS should contact DAS immediately at 541-737-4098

Topics covered and schedule (subject to change)

All locations are in Rogers 332 unless otherwise noted.

Wk.	Date	Topic	Due Date
1	Tu: Jan. 10 Th: Jan. 12 Fri: Jan. 13	Tu: Postponed (will replace with review for final) Th: Introduction; instrumentation and data acquisition basics; calibration; uncertainty analysis Fri: Data acquisition basics & Uncertainty analysis (complete); group assignment;	
2	Tu: Jan. 17 Th: Jan. 19 Fri: Jan. 20	Tu/Th: Pressure measurement; Flow measurement (external and internal); Introduction to Lab. 1 Fri: Lab 1 – Calibration of flow measurements (*Rogers 334*)	Jan 20th (by 4 pm to Rogers Hall 314) Term Project Part 1 (Literature review and proposed effort)
3	Tu: Jan 24 Th: Jan. 26 Fri: Jan. 27	Tu/Th*:* Temperature and pressure measurements Fri: Development of a DAQ system (*Rogers 334*)	Uncertainty assignment due at start of lab

4	Tu: Jan 31 Th: Feb. 2 Fri: Feb. 3	Tu/Th: Hot wire anemometry lecture & lab overview Fri: Lab 2 - Hot wire anemometry (Rogers 334)	Lab 1 due at start of lab.
5	Tu: Feb. 7 Th: Feb. 9 Fri: Feb. 10	Tu/Th: Whole field temperature measurement- Infrared thermometry, Laser Induced Fluorescence Thermometry, Liquid crystal thermometry Fri: Design reviews for term project	Feb. 10th - Term Project Part 2 (Design experiment, plumbing and instrumentation, uncertainty analysis)
6	Tu: Feb. 14 Th: Feb. 16 Fri: Feb. 17	Tu/Th: Visualization and imaging techniques Fri: Lab 3 - Flame speed measurement laboratory	Lab 2 due the start of lab
7	Tu: Feb. 21 Th: Feb. 23 Fri: Feb. 24	Tu/Th: Whole field velocity measurement- PIV Fri: Demonstration of PIV or laser diagnostics	Feb. 24th - Term Project Part 3 (Calibration of system and setting up DAQ)
8	Tu: Feb 28 Th: Mar. 2 Fri: Mar. 3	Tu/Th: Whole field temperature measurement (complete) *(Rog 226*) Fri: Case study for experiment with Dr Fronk	Lab 3 due on March 3rd a 9 am to Rogers 317
9	Tu: Mar. 7 Th: Mar. 9 Fri: Mar. 10	Tu/Th: **TBA** Fri: Laboratory time for term project	
10	Tu: Mar. 14 Th: Mar. 16 Fri: Mar. 17	Tu/Th: Exam Fri: Term project presentation and defense	
Final Week		***No final exam***	Term Project Part 4: Final report Tuesday Mar. 20th at 2 pm