OKLAHOMA STATE UNIVERSITY
SCHOOL OF MECHANICAL & AEROSPACE ENGINEERING
MAE 4273–001 & MAE 4273–01G — EXPERIMENTAL FLUID DYNAMICS
Spring 2015 (3 credit hours)

Lecture: TR 12:30 pm – 1:45 pm; PS 121

Lab: ATRC 058 (times to be determined)

Instructor: Prof. Arvind Santhanakrishnan ("Dr. S")
Assistant Professor
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218 Engineering North
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Office Hours: Tues: 4:30 pm–6:00 pm; Thurs: 4:30 pm–6:00 pm
– For visits after 5 pm, call my office phone so I can let you in.
– E-mail for appointment requests (Tues & Thurs only).

Teaching Assistant: Pritam Mekala
pritam.mekala@okstate.edu

Website: https://oc.okstate.edu/ (OSU D2L)
– Website will be used to post homeworks, solutions, handouts
– A group e-mail list will be used to communicate announcements

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→ TEXTBOOK:

Fox and McDonald's Introduction to Fluid Mechanics, 8th edition, by P. J. Pritchard (2011). ISBN: 9780470547557.

→ COURSE DESCRIPTION:

Experimental study of basic and applied fluid dynamics systems with comparisons to analytical predictions. Fluid dynamics instrumentation, digital data acquisition and processing, design of facilities and experiments, technical report writing and design project with experimental verification.

→ PREREQUISITES:

ENSC 3233 (Fluid Mechanics) & MAE 3113 (Measurements and Instrumentation)

→ COURSE OBJECTIVES:

The major objectives of the course are listed as follows:

1. To enhance the students understanding of fundamental fluid mechanics principles through performing basic experiments with a team that illustrates these principles (MAE program-specific outcome (SO) a, d, i).

2. To provide the student experience designing experiments and performing fluid mechanics measurements with a variety of instrumentation, including advanced modern techniques (SO a, b, c, e, k).
3. To develop the student's ability to handle data (acquisition, analysis, and assessment), with emphasis on assessing the experimental uncertainty (SO a, b).
4. To improve the student's ability to communicate (oral and written) experimental results/conclusions clearly and concisely in a format consistent with industrial, government, and academic environments (SO g).
5. To broaden the student's knowledge of real-world applications of fluid mechanics including active research areas (SO h, j).

→ ACADEMIC DISHONESTY:

- You are encouraged to cooperate among yourselves in discussing the assignments, but the submitted work is expected to result from individual effort. Direct copying of writing, analysis, or computer programs (from present or past students, or from a solution manual) is not acceptable and will not be tolerated.
- Likewise, allowing someone to copy your work is dishonest and punished accordingly.
- **Paraphrasing without giving a reference still counts as plagiarism.**
- All graded material must represent the individual effort of each student.
- All cases of academic dishonesty will be handled in accordance with University policies and regulations. For OSU policies on this matter, please refer to: http://academicintegrity.okstate.edu.
- The first violation will result in a zero grade for that assignment.
- A second violation will result in a grade of F for the course.
- All violations will be reported to the student involved, his or her adviser, the School Head, the Dean of Engineering, and the Office of Student Conduct.

→ GRADING:

The course grade will be weighted for the undergraduate and graduates sections as follows:

	Undergraduate	**Graduate**
Quizzes & Homework*	20 %	10 %
Lab Reports	40 %	35 %
Design Project	40 %	40 %
Review Paper	0%	15 %
Total	**100 %**	**100 %**

There is **NO TOLERANCE** *for academic misconduct!*

* The lowest score will be dropped from your homework/quiz grade.

The actual letter grades will be determined using the following scale:

Total Score	Grade**
90 % – 100 %	A
80 % – 89 %	B
65 % – 79 %	C
50 % – 64 %	D
< 50 %	**E**

** For both sections of the course, grades will be determined from this scale. Individual assignments will not be curved; letter grade minimums may be lowered at the instructor's discretion.

IMPORTANT:
– Grading of undergraduate reports will be based on the standards expected in a professional technical report.
– Students enrolled in MAE 4273–01G, for graduate credit, will be held to a higher standard with standards consistent with journal articles.
– Since this is in part a team course, partial grading will be based on the instructor's evaluation of individual student contributions to the team, along with feedback from the team and class.

→ OUTCOMES:

The student outcomes will be measured by homework, quizzes, lab reports, design project report & presentations as outlined below. For those enrolled in MAE 4273–01G for graduate credit, a review paper will be additionally included as a part of student grade assessment.

Homework & Quizzes: An unknown number of homeworks and quizzes will be given throughout the semester. They will be based on material discussed in lecture and lab. Homeworks should be submitted in hardcopy *before the beginning of class* on the due date. Late assignments will not be accepted without discussing it with instructor before the due date. Each assignment should be stapled together with the student's name, assignment number, and problem number listed at the top of each page. Quizzes will be given without announcement (aka "pop-quizzes") to encourage class attendance and regular class activity.

Lab Reports: Attendance is required for ALL labs, and the TA will monitor this closely to report to the instructor. Most labs will meet every week for ∼3 hours, and you will work in groups of 5-6 students as a part of each exercise. The experiments will not be completely defined and structured, and it will be up to the groups to devise their own detailed approaches and to the individuals to interpret the results. *Lab reports are required to be submitted individually, and can only be submitted if the student participated in the lab.* Late reports will NOT be accepted, or given *any* credit without making prior arrangements. If a student is absent during a class period when a lab report is due, they must make prior arrangements with classmates to submit the report before the deadline. A missed lab must be made up by performing the experiments with another group. *Only one opportunity will be given for a student with a previously excused conflict/absence for a lab makeup session, under the sole discretion of the instructor.* Students will need to discuss such an absence as early as possible (2 weeks prior at the least) with the instructor to obtain permission beforehand.

Design Project & Presentation: A substantial portion of the course grade will involve working on a hands-on design and experimentation project on topics in fluid mechanics that will be provided by the instructor early in the semester. You will work in teams consisting of 5-6 students under the guidance of

the instructor and course TA. Both the topics and group members will be decided by the instructor and discussed prior to the 2nd week of classes. The design project and presentation grade will be determined through a group project proposal document, group project proposal presentation, group 2nd round update presentation, final group project report and final group project presentation. As a part of this project, your group will be required to:

- Conduct literature review on the topic and turn in a proposal document for design of the experimental setup, metrics that will be characterized, and rationale for planned measurements along with list of planned experiments
- Present the project proposal to the class and revise the design of the project based on class & instructor feedback
- Build the experimental setup, conduct experiments, and perform data analysis.
- Present a 2nd round follow-up update of the project progress to the class
- Write a final report due before the beginning time of the final exam date.
- Present the final project results to the class during the allotted final exam time

Every member of the team is required to participate in the oral presentations and will be graded *individually* based on group and class feedback. In addition, each group will be required to delineate individual roles of team members at the beginning, and present the group organization/individual responsibilities in both the design proposal report and presentation. Every document and presentation turned in by the team will have to delineate individual contributions clearly, and those portions will be used to grade the effort of each team member separately.

Review Paper: This is *only* applicable and required for those students that are enrolled in MAE 4273–01G for graduate credit. This portion of the course work requires the students to engage in an in-depth literature review of a selected topic that is of current interest in fluid mechanics research. The student performance will be evaluated through a journal-quality paper that discusses the literature review motivation, purpose, scope, methods used by researchers, discussion of research results, author's interpretation and future directions–in detail. Several topics in fluid mechanics will be suggested by the instructor within the 2nd week of classes. Students interested in a subject outside of the instructor-recommended subjects will have to get approval from the instructor prior to the deadline to select a topic.

The following are **mandatory requirements for the review paper**:

- Please follow these formatting requirements for **all text** in the body of the paper: **A4 paper size: 8.27 in x 11.69 in; Times New Roman: 12-point size; double-line spacing; 0.75 inch margins for top, bottom, left, and right; gutter 0 inch; Header and footer: 0.5 inch from edge**.
- Figures with their captions should be inserted at the end of the paper (after your references).
- Other formatting details should follow that of a technical journal article (see *Technical Writing A-Z* and http://www.writing.engr.psu.edu/ for specific details).
- The paper length should be between 6 and 8 pages of text.

- Topic should be of current interest in fluid mechanics research. If you are interested in a research topic outside of instructor-recommended areas, consult the following sources for years 2010-2014 to identify areas of active fluids research: (a) articles from the *Annual Review of Fluid Mechanics* or (b) American Physical Society–Division of Fluid Dynamics meeting program abstracts online.
- At least 80% of your citations must be from peer-reviewed journal papers, and at least 50% must be from fluid physics or fluids engineering journals.
- You should have cited and discussed between 10 and 20 journal articles in your review
- No more than 10% of your citations can be from technical books (must have ISBN available).
- The total number of MS theses and/or PhD dissertations used in citations cannot exceed 3.
- No more than 10% of your citations can be from archived conference publications (papers must have been presented at a national/international conference and the PDF copy must be available online).
- At least 60% of all citations in your paper will have to be from articles published after 2002.
- At least 20% of all citations used in the paper will have to be from articles published before 1993.
- Any citations from websites, online manuals/encyclopedias, popular reading books, blogs, etc. cannot be used in the paper in any manner whatsoever.
- Short abstracts, draft papers and presentations cannot be used for sources for any reason.

→ ATTENDANCE POLICY:

- Attendance is expected at all class and lab meetings. Students are responsible for all course material, announcements, schedule changes, etc., given during lecture.
- Quizzes will be given without announcement to encourage regular attendance and promptness.
- Exceptions may be made at the instructor's discretion IF *advanced notice* is given to the instructor.
- If a student is absent during a class period when an assignment is due, they must turn the assignment in early or make prior arrangements with classmates to submit the homework and/or the lab report on the time. Late submissions may result in no credit.
- Missed labs must be made up by performing the experiments with another group. Only one opportunity will be given for a student with a previously excused conflict/absence for lab makeup session, under the sole discretion of the instructor.
- The final design project presentation must not be missed by any team member. Students that are absent during *any* of the design project presentations will not be given *any* credit toward that portion of the course grading. No opportunity will be provided for makeup of the final design presentation.

→ ADDITIONAL REFERENCES/RESOURCES:

Fluid Mechanics (general)

- Kundu, P.K., Cohen, I.M. & Dowling, D.R., Fluid Mechanics, 5th edition, Elsevier, 2012.
- White, FM. Fluid Mechanics, 4th edition. McGraw-Hill, 1998

- White, FM. Viscous Fluid Flow, 3rd edition. McGraw-Hill, 2005.

Fluid Mechanics (experimental)

- Tropea, C., Yarin, A.L. & Foss, J.F. Handbook of Experimental Fluid Mechanics, Springer, 2007.
- Goldstein, R., Fluid Mechanics Measurements, 2nd edition, Taylor & Francis, 1996.
- Fowles, G.R., Introduction to Modern Optics, 2nd edition, Dover Publications, 1989.

Data Processing/Analysis

- Bendat, J.S. & Piersol, A.G. Random Data, 3rd edition, Wiley-Interscience, 2000.
- Gonzalez, R.C. & Woods, R.E., Digital Image Processing, 2nd edition, Prentice Hall, 2002.

Technical Writing

- Young, TM. Technical Writing A-Z, ASME Press, 2005.
- Writing Guidelines for Engineering and Science Students: http://www.writing.engr.psu.edu/

→ SOFTWARE:

The students will be expected to use Microsoft Office™ (Word, Excel & Powerpoint) throughout the course for assignments, reports, and calculations. In addition, the use of MATLAB™ will also be required as a part of this course. The design projects may require the use of CAD software, including but not limited to Solidworks™. The students are required to obtain access to these software either on their personal machines via OSU IT services, or use the computing laboratories available to OSU CEAT students.

→ ABET PROGRAM OUTCOMES:

The Accreditation Board for Engineering and Technology (ABET) accredits your engineering degree. For accreditation, ABET requires graduates from Mechanical and/or Aerospace Engineering programs to demonstrate the following program outcomes. Students are prepared to achieve some, but not all, of these outcomes in MAE 4273, as noted in the Course Objectives. You can learn more about ABET at http://www.abet.org/. The Experimental Fluid Dynamics course contributes to the following MAE ABET program outcomes and program-specific outcomes:

(a) An ability to apply knowledge of mathematics, science and engineering appropriate to the mechanical and aerospace engineering disciplines.

(b) An ability to design and conduct experiments, as well as to analyze and interpret data.

(c) An ability to design a system, component, or process to meet desired needs, within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.

(d) An ability to function on teams, some of which require consideration of multiple disciplines.

(e) An ability to identify, formulate and solve engineering problems.

(f) An understanding of professional and ethical responsibility.

(g) An ability to communicate effectively (written and oral).

(h) The broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context.

(i) A recognition of the need for, and an ability to engage in, life-long learning.

(j) A knowledge of contemporary issues.

(k) An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

→ DISABILITY & DISABILITY-RELATED NEEDS:

Students requiring accommodation for disability-related needs will need to contact OSU Student Disability Services (SDS) to formally initiate documentation review and obtain an Accommodation Letter. OSU SDS contact information can be found online at: http://sds.okstate.edu/

The instructor's policy is to consider all disability-related needs fairly using measures recommended by OSU SDS. **It is the student's responsibility to initiate this process as early as possible**, as accommodations *cannot be applied retroactively* as per OSU SDS policy.

→ ADDITIONAL RESOURCES:

For general information on University regulations, advising, and counseling, see the *OSU Office of Academic Affairs Syllabus Attachment*. It describes academic policies, deadlines, etc., and also lists resources for solving both academic and personal problems.

→ TOPICS:

- Fluids Theory (dimensional analysis, Bernoulli equation, boundary layers, conservation laws applied to experimental methods)
- Experimental Methods (tunnel design, Pitot tubes, flow imaging)
- Technical Communication (written and oral)

→ IMPORTANT DATES**:

Mon, Jan 19	University holiday (no class)
Tue, Jan 20	Last date for non-restrictive add/drop of courses (100% refund)
Fri, Jan 23	Partial refund, restrictive add/drop deadline
Mon, Mar 16– Fri, Mar 20	Spring break (no class)
Fri, Apr 10	W Drop/Withdraw Deadline
Fri, Apr 24	W/F Withdraw Deadline
Fri, Apr 30	Class work ends
Thu, May 7	**Final project reports*** for ALL groups due before 10:00 am**
	Final project presentations* ***for ALL groups from 10:00 am – 11:50 am***
	Review papers for MAE 4273–01G section students due before 5:00 pm

** For more details visit the OSU Office of the Registrar's website: spring 2015 academic calendar

*** Please verify the accurate final exam date and time for MAE 4273 at: spring 2015 final exam schedules