MARQUETTE
UNIVERSITY

COLLEGE OF ENGINEERING

Advanced Fluid Dynamics

MEEN 204 **Course Outline** **Spring Semester 2003**

Lecturer: Joseph Majdalani, Ph.D.

Section No.: 1001.

Lecture Times: 4:00 -5:15 p.m., T-Th.

Lecture Location: EN128.

Course Call No.: 16403.

Office Hours: 2:00-3:00 p.m., MWF, Haggerty Hall, Rm. 251.

Contacts: (1) email: maji@mu.edu; (2) office: 288-6877.

Teaching Assistant: None.

Textbook: White, F. M., *Viscous Fluid Flow*, McGraw-Hill Book Company Inc., New York, 1991, pp. 135-136.

References:

1. Potter, M. C., and Foss, J. F., *Fluid Mechanics*, Great Lakes Press Inc., Okemos, 1982, pp. 368-369.
2. Sherman, F. S., *Viscous Flow*, McGraw-Hill, Inc., New York, 1990.
3. Schlichting, H., *Boundary-Layer Theory*, 7th ed., McGraw-Hill Book Company Inc., New York, 1979.
4. Gradshtein, I. S., and Ryzhik, I. M., *Table of Integrals, Series, and Products*, 5th ed., edited by J. Alan, Academic Press, Boston, 1994, pp. 1084-1096.
5. Abramowitz, M., and Stegun, I. A., *Handbook of Mathematical Functions*, National Bureau of Standards, New York, 1964.
6. Lagerstrom, P. A., *Theory of Laminar Flows*, Section B, edited by F. K. Moore, Princeton University Press, Princeton, NJ, 1964.

Prerequisites: Differential Equations (*MATH 083*) and Mechanics of Fluids (*ENME 151*).

Scope: The main purpose of this course is not so much to cover "advanced" material (the topics covered do not in fact appear terribly advanced) as it is to help students develop a mastery of the underlying principles and the ability to solve, quickly and efficiently, a variety of real fluid mechanics problems from basic principles. The lectures present and illustrate the fundamental principles, methods and modeling approximations that form the basis of fluid dynamics. The problems and tutorials help the students gain deeper physical insight and to develop, by practice and trial, the mindset of an effective problem solver in fluid dynamics.

Objectives: By the end of the course students are expected to

- Better understand the concepts of mass conservation, momentum and energy equations;
- Learn how to apply the Navier-Stokes equation to model viscous flows;
- Improve their understanding of similarity and dimensional analysis;
- Better understand the significance, prediction, and control of boundary layers and separation;
- Be introduced to the vorticity theorems and circulation;
- Lean how to model potential flows and corresponding lift, drag, and thrust generation;
- Analyze surface tension flows;
- Better understand the physics of turbulence.

Motivation: Knowledgeable students will be able to read equally profitably from alternative texts, provided they are in the habit of reading broadly and searching out references that satisfy them on the fundamentals.

Homework Problems: Homework problems will be indicated in the course outline for each topic. The homework problems are not to be turned in. Students are responsible for both the assigned problems and tutorials. No problem sets are collected. However, based on repeated experience over many years, you may take our word that your chances of doing well in this course are minimal if you do not independently do at least the assigned problems before the tutorials, and use the tutorials to repair weaknesses and develop new insights. We are ready to help you in every way to master the course material. There is, however, a profound difference between being taught and learning at the graduate level.

Grading and Exams: There will be two one-hour exams during the term, announced well in advance. There will be a two-hour final exam.

Exams will probe for mastery of the underlying material and for skill in modeling problems in the simplest possible realistic terms.

You can gain extra credit by turning in, at the conclusion of the final exam, a notebook in which you have reworked and amplified your lecture notes in cohesive, clearly reasoned form. This is not mandatory, and that your grade will not suffer if you do not do it: grades will be assigned before the notebooks are examined, and only upward adjustments will be made thereafter. However, thinking through and rewriting the lecture notes in consultation with a text, preferably on the same day (or on that same weekend) as the lectures may be one of the most effective forms of study, and well worth the effort.

Grading and Exams: The final grade is based on the best score earned under any one of the four options described below.

Option 1	Option 2	Option 3	Option 4
Homework: 0%.	Homework: 0%.	Notebook: 20%.	Notebook: 20%.
Exam I: 25%.	Best Exam: 25%.	Homework: 0%.	Homework: 0%.
Exam II: 25%.	Final: 75%.	2 Exams: 50%.	Best Exam: 25%.
Final: 50%.		Final: 30%.	Final: 55%.

Contributions to Professional Component:

Engineering Science: 90%.
Engineering Design: 10%.

Relationship of Course to Program Objectives:

This course aims at the partial fulfillment of the following Program Objectives:

1. Develop the creative and critical thinking skills essential in identifying, structuring, and solving complex problems.
2. Firmly ground students in the fundamentals of mathematics, the basic sciences, and the engineering sciences necessary to pursue a successful career in mechanical engineering.
3. Develop graduates who can communicate effectively in written and graphical forms.
4. Provide open-ended challenges for the design of mechanical and thermal systems.
5. Instill an attitude that learning is a lifelong process.