ABET SYLLABUS - MECH322 Fluid Mechanics

2019 Catalog Data: Credit: (4-0-0) Two Lecture Hours, Each Lecture 2 hours and 5 minutes.

Prerequisites: MECH-320 Thermodynamics

Terms offered: Summer, Fall, Winter, Spring

Course Description: This is the first course in Fluid Mechanics that involves the study of fluid flow in ducts and over objects. The course introduces the fundamental aspects of fluid motion, fluid properties, flow regimes, pressure variations, fluid kinematics, and methods of flow description and analysis. Present the conservation laws in their differential and integral forms and their use in analyzing and solving fluid flow problems. In addition, the concept of using similitude and dimensional analysis for organizing test data and for planning experiments is introduced. The effects of fluid friction on pressure and velocity distributions are also discussed. The effects of compressibility (variable density) on fluid flows are also included.

Textbook: Fundamentals of Fluid Mechanics, 8th edition by **Munson, Young and Okiishi.**

Supplementary Reference: Fluid Mechanics 8th Ed. Author: F. M. White ISBN: 9780073309200
Publisher: McGraw-Hill

Introduction to Fluid Mechanics, 6th Edition
Author: Robert W. Fox, Alan T. McDonald, Philip J. Pritchard
ISBN: 978-0-471-20231-8
Publisher: John Wiley & Sons

Course Coordinator(s): Dr. Susanta K. Das, Room 2-213 MC, Tel. 762-9916, sdas@kettering.edu

Course Learning Objectives:

Upon completion of this course the student will be able to:

1. Determine pressure distribution in fluids at rest and calculate hydrostatic forces (magnitude and line of action) acting on plane and curved surfaces [1,2,3,6,7]. *Primary Goal.*
2. Apply the control volume concept to describe fluid flow through the application of conservation of mass, momentum, and energy [1,2,3,4,5,7]. *Primary Goal.*
3. Apply the governing differential equations (mass, momentum, energy) to analyze fluid flows [1,3,7]. *Primary Goal.*
4. Plan and understand experiments, as well as understand and correlate data through the use of similitude and dimensional analysis [1,2,6,7]. *Primary Goal.*
5. Determine correct solution units through structured dimensional analysis of problem statement. [1,2,6,7]. *Primary Goal.*
6. Determine the velocity and acceleration of the fluid for steady and unsteady flows [1,7]. *Primary Goal.*

7. Apply the basic principles to the flow of viscous incompressible fluids in pipes, multiple pipe systems, and ducts, to determine friction losses and for pump selection [1,7]. *Primary Goal.*
8. Team class project – design, critical thinking and application of knowledge learned in the course study [1,2,3,4,5,6,7]. *Primary Goal.*
9. Draw streamlines in each flow and determine pressure variations along and normal to a streamline [1,2,7]. *Secondary Goal.*
10. Study the effect of compressibility on steady, isentropic, one-dimensional flow of an ideal gas in a varying cross-sectional area duct [1,7]. *Secondary Goal.*

Prerequisites by Topic:
(1) Integration and Differentiation. Dot Product and Cross Product of Vectors.
(2) Moment of Inertia and Centroids
(3) Concepts of Control Volume and System
(4) Basic Computer Skills (MS Word and Excel)

Tentative Topics covered in the Course

The following is a ***tentative*** course topic schedule for this class.

Week	Chapters	Content
1	1, 2	➢ **SYLLABUS** ➢ **SUCCESS KEYS** • **UNITS & PARAMETRIC THOUGHT** • Definitions ➢ Introduction & Fluid Properties ➢ Pressure, Viscosity, Shear Force/Drag, & Shear Stress 
2	2/3	➢ **FLUID STATICS** • Law of Hydrostatics and Manometers & Manometry • Pressure & Depth • Pressure: Forces on Submerged Surfaces
3	3/4	➢ BERNOULLI'S EQUATION: DERIVATION & APPLICATIONS ➢ CONSERVATION OF ENERGY
4	4	➢ FLUID KINEMATICS – VELOCITY FIELD ➢ MATERIAL DERIVATIVE ➢ ***LAB: MANOMETERS and PRESSURE***
5	5	➢ **EXAM I (20%)** ➢ **REYNOLDS TRANSPORT THEOREM** ➢ **CONSERVATION OF MASS & CONTINUITY** ➢ **CONSERVATION OF MOMENTUM**
6	5/6	➢ **CONSERVATION OF MOMENTUM** ➢ **CONSERVATION OF ENERGY**
7	6	➢ **CONSERVATION OF MOMENTUM** ➢ **CONSERVATION OF ENERGY** ➢ **ChatGPT AI ASSIGNMENT**
8	7/8	➢ **VISCOUS PIPE FLOW/PUMP SELECTION**
9	8	➢ **VISCOUS PIPE FLOW/PUMP SELECTION**
10	9/11	➢ **LIFT & DRAG: FLOW OVER IMMERSED OBJECTS** ➢ ***EXPOSURE TO COMPUTATIONAL METHODS AND CFD*** ➢ **EXAM II (30%)**
11	11	➢ **FINAL EXAM (30%)– Comprehensive (Chapters 5-11)**

Class Schedule: Two sessions per week with 2 hours and 5 minutes per session.

Course Assessment Metrics

EXAM I:	**20%**
EXAM II:	**30%**
PROJECT/OTHER:	**20%**
FINAL EXAM:	**30%**

Exams: Exams will be held in class, **CLOSED-BOOK, AND CLOSED-NOTES**. Before each exam, you will be provided the **EQUATION BOOKLET** available on Blackboard. You are encouraged to use equation booklet to complete homework problems to familiarize yourself with the booklet. Students finishing early may leave the exam room early; however, students are strongly encouraged to spend the entire exam time reviewing their works.

Quizzes: Quizzes may be administered at the end of the class. Prior notification may not be given. Materials covered up to previous class will be considered in the quiz. The top 3 quizzes will be considered during final course grade calculation for a max of 10% of final exam grade.

Homework: Homework (HW) is a critically important part of this class. Homework problems are meant to reinforce your understanding of the course concepts learned in the classroom but are **not normally collected but can be for special problems**. HW problems are the **FOUNDATION** of lecture problems to showcase the application of engineering fundamental relating to fluid mechanics, to various problem domains.

History has shown that it is impossible to mimic say a "TIGER WOODS by watching a Video of the perfect golf stroke. Rather one MUST practice the execution, i.e., MUST "practice" problem solving, as doing a problem "ONCE" is insufficient preparation for an exam. Improvement of any skill IS NOT possible without *PRACTICE*.

Exams/Quizzes: Questions nearly **ALWAYS** are based upon covered lectured problems, which are **ALWAYS** based upon assigned homework problems.

THOUGHT: *If you do not read the text before doing your homework and/or do not study lecture notes before and after class presentation, then you should expect that these problems will take you much longer than the estimated 30 minutes. It is always a bad strategy to jump into doing homework without reviewing and mastering understanding of lecture power point materials. As such, materials not just provide a solution, but of most importance provide the "process" of "**how**" to "think" about development of the solution "PATH". This is "leaps" and "bounds" above the process of merely writing down an equation.*

Project: Team class project (open project topic related to the course contents) will be done by a student team with 2 or 3 students in a team if assigned.

Subjective: The Subjective grade will reflect instructor's opinion regarding the initiative, leadership, cooperation, organizational ability and judgment demonstrated by the student during the class as well as class attendance.

Attendance: Attendance is weighted in the subjective part of the course grade. Any anticipated absence should be worked out with the instructor ahead of time. No make-up exams will be offered without a written statement from the Department Head or Dean's office. Missing classes will have a significant effect on student's understanding of the course materials and performance on exams.

Course Load: Per academic handbook, a minimum of a 2 for 1 ratio between the numbers of hours spent working on the course and the number of hours spent in class is expected. So, expect to spend 2-3 hours daily focused on Fluid Mechanics homework and reviewing lecture notes.

*Success is **not** based upon time "memorizing" equations as they all given to you. Rather success is based upon understanding "**why**" and "**when**" to apply an equation which is supported by the understanding of the fluid mechanics principals driving the fundamentals.*

*The '**PATH**' to success in Fluid Mechanics or ANY engineering course is paved with the understanding of "**UNITS**" and "**DEFINITIONS**" that drives the **APPLICATION** of fluid mechanics engineering equations as a part of a process.*

The 'PATH' to problem solving success is NOT driven by merely applying arbitrary engineering equations without a knowledge of "what" are the variables, "what" are the units of BOTH the equation and the units, "what" is the expected outcome of the equation, and "when" is it appropriate to apply the equation?

One cannot solve for the "UNKNOWNS", without understanding known parameters.

Understanding the process of "how" to think about engineering solutions results in a process mindset development that problems and geometry all of a sudden become irrelevant.

"FOLLOW THE PATH"

Course Grade: As a general rule grades are not curved. Consistent performance, however, is often used to address final grade issues. Course letter grade scale breakdown is given below.

Level of performance	100 points scale	4.0 points scale	Letter Grade
Excellent	95 - 100	4.0	A
Excellent (-)	91 - 94	3.8	A-
Good (+)	87 - 90	3.5	B+
Good	84 - 86	3.0	B
Good (-)	81 - 83	2.8	B-
Fair (+)	77 - 80	2.5	C+
Fair	73 - 76	2.0	C
Fair (-)	70 - 72	1.8	C-
Poor (+)	65 - 69	1.5	D+
Poor	60 - 64	1.0	D
Failure	Below 60	0	F

A	These grades are awarded to students whose level of performance in meeting the requirements of the course is outstanding. These students understand the concepts and the principles of the course and are able to apply them creatively to unfamiliar situations, to use correct methods accurately in problem solving, and to communicate their feelings to others effectively.
B	These grades are awarded to students whose level of performance in meeting the requirements of the course is definitely better than average. These students have a good understanding of most or all of the concepts and principles,, generally use correct methods,, and are usually accurate in their thinking.. They do a good, though not superior, job in communicating within the context of the course.
C	These grades are awarded to students whose level of performance is adequate. These students meet the essential requirements of the course and have a basic understanding of course concepts and principles, but have some difficulty applying them correctly. They do a fair job of communicating their ideas.
D	These grades are awarded to students whose level of performance in general is poor but not failing. These students meet minimum course requirements but lack adequate understanding of some concepts and principles and make rather frequent mistakes in applying them. They do a poor job of communicating ideas relating to the course.
F	This grade is issued to students whose level of performance fails to meet even the minimum requirements of the course. These students fail to grasp most of the essential concepts and principles and make frequent mistakes in applying them. Their performance is definitely unsatisfactory.

Class rule: All electronic devices must be turned off during the class except a calculating device.

Academic Assistance: In addition to your professors, academic assistance with class work and writing is available from the Academic Success Center (ASC) at (810) 762-7995 or https://my.kettering.edu/page/academic-success-center-asc

Common Statement on Students with Documented Disabilities:

- The University will make reasonable accommodations for persons with documented disabilities.
- Students need to register with Wellness Center every term they are enrolled in classes.
- To be assured of having services when they are needed, students should contact the Wellness Center during the first week of each term.
- Note that it is the student's responsibility to arrange accommodations with each professor.
- http://www.kettering.edu/studentlife/docs/student_handbook.pdf (page 26)
- http://www.kettering.edu/registrar/docs/2011-12UndergraduateCatalog.pdf (page 46)

Common Statement on Ethics in the University and Academic Integrity

- Kettering University values academic honesty and integrity. Cheating, collusion, misconduct, fabrication, and plagiarism are serious offenses.
- Each student has a responsibility to understand, accept, and comply with the University's standards of academic conduct as set forth in our statement, "Ethics in the University," and "Academic Integrity" as well as policies established by individual professors.
- http://www.kettering.edu/studentlife/docs/student_handbook.pdf (pages 40-42)
- http://www.kettering.edu/registrar/docs/2011-12UndergraduateCatalog.pdf (page 26).

Common Statement on Title IX or Sexual Harassment:

- The University encourages the campus community to "Know Your IX" and take steps to understand individual's rights and responsibilities as they relate to issues of sexual harassment, sexual assault, domestic violence, dating violence, relationship violence, and stalking.

- The University policy and procedures which relate to these rights and responsibilities may be found here:

- Policy and Procedures on Sexual and Gender Based Harassment, Discrimination and Assault can be found at https://my.kettering.edu/search?s=Title+IX+or+Sexual+Harassment

Prepared by: Dr. K. J. Berry, Professor, Department of Mechanical Engineering