

MAE 308 - Fluid Mechanics

Department of Mechanical and Aerospace Engineering, NC State University

Fall 2024, Section 002/602/605

(3 units)

Instructor: Prof. Chi-An Yeh
Office: 3154 Engineering Building 3
Email: chian.yeh@ncsu.edu
Office hours: TBA

Time: Monday & Wednesday 1500 – 1615

Classroom: 2213 Engineering Building 3

Grader: TBA

Course Objectives

1. Definitions of fluids: identify the key fluid properties used in the analysis of fluid mechanics, determine the dimensions and units of physical quantities such as viscosity and density.
2. Hydrostatics: calculate hydrostatic pressure distributions and pressure force on a submerged surface, calculate the buoyancy and determine the stability of floating bodies, calculate pressure variation in fluids undergoing rigid-body motion
3. Bernoulli equation: key assumptions, derivation, and application of static, stagnation, dynamic, and total pressures.
4. Lagrangian and Eulerian descriptions: control system/mass and control volume, flow field, material derivative and the Reynolds transport theorem.
5. Conservation laws in integral forms: control volume analyses for mass, linear momentum, angular momentum, and energy.
6. Conservation laws in differential forms: the Navier–Stokes equations, stream function, velocity potential, canonical one-dimensional exact solutions (e.g., Couette and Poiseuille flows).
7. Dimensional analysis: the Buckingham–PI theorem, definitions of Reynolds number, Mach number, drag and lift coefficients
8. Internal flows: fully developed laminar and turbulent flows in a pipe, friction factor, Moody Chart, and head losses.
9. External flows: lift and drag forces on a body, boundary layer theory, and flow separation.

PREREQUISITES

1. MA 242: Calculus III

- vector analysis and vector calculus in cartesian and cylindrical coordinates (Eulerian description), Stokes Theorem, etc.

2. MAE 208: Engineering Dynamics:

- particle kinematics and dynamics (Lagrangian description)

OTHER STRONGLY RECOMMENDED PRE/CO-REQUISITES

1. MAE 201: Engineering Thermodynamics I

- thermodynamic properties, the First Law of Thermodynamics for close systems (control mass analysis) and open systems (control volume analysis)

2. MAE 214: Solid mechanics

- internal force, stress, strain, and strength of structural element under distributed loads. Constitutive behavior of structures/materials

TEXTBOOK

Gerhart, Gerhart, and Hochstein, *‘Munson, Young and Okiishi’s Fundamentals of Fluid Mechanics,’* 9th edition, Wiley, 2016

GRADING

1. Homeworks	25%
2. Mid-term exam 1	20%
3. Mid-term exam 2	25%
4. Final exam 3	30%

Based on the weighted average, the final letter grade will be determined according to:

	A+	A	A-	B+	B	B-	C+	C	C-
highest (%)	100.00	96.99	90.99	85.99	80.99	75.99	71.99	67.99	63.99
lowest (%)	97.00	91.00	86.00	81.00	76.00	72.00	68.00	64.00	61.00
	D+	D	D-	F					
highest (%)	60.99	57.99	55.99	53.99					
lowest (%)	58.00	56.00	54.00	00.00					

Grading policies

1. No late homework will be accepted. The due time of each homework will be clearly stated when assigned.
2. Your homework must be entirely your own work. The instructor highly encourages students to form small study groups for discussions of homework assignments, but the end product must be your own work.

3. There must be no collaboration on exams. Credits will not be given to answers without supporting analyses.
4. Regrading requests for homework and exam need to be submitted within 1 week after the original grade is given. The request needs to be in a written form to identify specific areas of concern and attach it to the original work.
5. No make-up exams will be given. All exams will held in person on the time and dates indicated on the syllabus. It is your responsibility to keep these times free from other engagements as no alternative exam dates are available.
6. No incomplete grades will be given for this course without a verifiable, written doctor's note indicating more than one week's incapacitation.
7. We do not curve final grades except for extreme circumstances.
8. The instructor strictly enforces NC State academic honesty at its highest standard. Neither giving nor receiving unauthorized aid on any exams or homework are allowed. For further details, see <https://policies.ncsu.edu/policy/pol-11-35-01/>.

TENTATIVE COURSE CALENDAR

Sep 2: Labor Day (no classes)

Sep 17: Wellness day (no classes)

Sep 23: Mid-term exam 1

- introduction, definition of fluids, shear and normal stress
- hydrostatics
- Bernoulli equation

Oct 14: Fall break (no classes)

Oct 30: Mid-term exam 2:

- fluid kinematics
- conservation laws in integral form: control volume analysis

Dec 5: Last day of class, last homework due

Dec 11: Final exam (1530 hour) (see <https://studentservices.ncsu.edu/calendars/exam/>)

- conservation laws in differential form: the Navier–Stokes equations
- dimensional analysis and the Buckingham–PI theorem
- viscous pipe flows (internal flows) and boundary layers (external flows)

POLICIES

Attendance

We follow the NC State Attendance Regulations and acknowledge the Excused Absences defined in <https://policies.ncsu.edu/regulation/reg-02-20-03-attendance-regulations/>. We do not handle absence requests sent only to the instructor. All absence requests must be addressed **directly to absence verification officer** (absence-verification@ncsu.edu) with the instructor copied.

Emergencies

In case of emergency, situation beyond one's control, or for other valid reasons, students will be given an opportunity for making up the missed assignments or examinations. Valid excuses include documented illness (including illness of a dependent child), death of an immediate family member, military service obligation, observance of religious holy days, and official university activities. You must notify the instructor in advance when the excused absence is a planned event such as the observance of a religious holy day or an official university activity. Contact the instructor as soon as possible. Proof of valid reason may be required. For make-up assignments, you may be given a different set of assignment problems.

Course Materials

All course materials (course notes, homeworks, exams, syllabus, sample codes, etc.) are the intellectual property of the instructor and/or of NC State. That means that students and others are NOT legally entitled to post these materials on any online tutoring or public websites (e.g., Chegg) or to otherwise disseminate these materials. Distributing any course materials on these platforms constitutes a violation of student conduct (see REG 01.25.03 in POL 11.35.01: <https://policies.ncsu.edu/regulation/reg-01-25-03/>). The University and the instructor have full access to these platforms and will actively monitor the activities on these websites to claim the copyrights of any posted materials and report the violation to the Office of Student Conduct. All course materials are for the use by the students enrolled in this semester's class ONLY.

Changes to the syllabus

In light of COVID-19, the instructor reserves the right to modify the syllabus to accommodate any unseen events. In such a case, changes will be made in a way that does not negatively affect student grading and instructions. All changes will be clearly communicated with students. In any events where NCSU policy or Wake County guidelines are changed to affect course instructions, we will follow their guidelines and make appropriate modifications.

Questions and office hours

You should always feel free to ask questions during classes. You are encouraged to take advantage of the office hours. If you need help outside of those hours, please email me with '[MAE 308]' added to your email title for faster responses.

Online class evaluation

Online class evaluations (ClassEval) will be available for students to complete during the last week of class. Students will receive an email directing them to ClassEval to complete their evaluations. Evaluations are absolutely anonymous: instructors will never know what a particular student responded. For more information about ClassEval, see <https://oirp.ncsu.edu/surveys/classeval>.

Respect your training and honor codes

The training and expectation you get at NC State Engineering are by standard and quality no different from those you would from medical or law schools. Respect that.