CE 320 – 003: Fluid Mechanics

(3 credits)

Lectures Mondays and Wednesdays 11:30 AM – 1:35 PM
FMH 403 (Mondays)
TIER 106 (Wednesdays)

Instructor **William Pennock, Ph.D.**
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Office Hours: Monday 1:45–3:15 PM
Wednesday 1:45–3:15 PM

Prerequisite MECH 236 with a grade of C or better (Prerequisites: MECH 235 with a grade of C or better, MATH 112 and PHYS 111/111A).

Required Textbook

R. C. Hibbeler, *Fluid Mechanics*, 3rd Edition, Pearson, ISBN: 9780137839490.
For best results, please read the assigned reading (including example problems) before it is covered in class. For readings labeled "skim", they tend to focus on more theoretical and specialized applications. It is good to be familiar with the existence of these topics, but you are not expected to learn them through this class.

Other Recommended Texts & Reading

1. **E. J. Finnemore & E. Maurer. 2024. *Fluid Mechanics with Civil Engineering Applications,* 11th ed. New York: McGraw Hill, ISBN: 9781264787296**
   This is the textbook I learned from. It is available free online through the library. It is a bit more focused on civil engineering applications than the course text, so it has more specific information of practical interest.
2. **R. A. Granger, *Fluid Mechanics*, Dover, ISBN: 978-0-486-68356-0**
   This is an older textbook that has been published for a fraction of the cost of the course text. It is not out of date and has some great illustrations and problems. It makes a good and affordable companion for this course.

Items Required for this Course

1. **FE Reference Handbook (allowed reference for quizzes and exams)**
2. **Computer to access course resources (may need microphone and webcam)**
3. **HEC-RAS and EPANET software (free to download, available on lab computers)**
4. **Calculator capable of solving cubic functions**

Course Description *(from NJIT's course catalog)*

This course is designed to present the fundamental laws relating to the static and dynamic behavior of fluids. The emphasis is placed on applications dealing with the flow of water and other incompressible fluids. These include flow in pipe systems and natural channels.

Course Objectives (General)
By the end of this course, the student will be able to:

Define fluid properties and statics utilizing the principles developed in previous mechanics courses:

1. Illustrate basic fluid properties and fluid statics.
2. Discuss the design of structures impacted by fluids.

Develop the principles and equations for pressure flow and momentum analysis:

3. Develop the continuity and Bernoulli equations and friction loss equations.
4. Provide distinct and detailed examples of how these equations are utilized in design.

Design water distribution and pressure flow systems (pressure flow, pumps and network analysis):

5. Provide design solutions and examples for pumping and network analysis.
6. Introduce actual engineering design problems.

Illustrate and develop the equations and design principles for open channel flow. Included in this objective is sanitary and storm sewer design and flood control hydraulics (varied flow):

7. Develop the principles of open channel flow and introduce Manning's Equation
8. Provide design principles for sanitary and storm sewer design along with drainage analysis.
9. Introduce the varied flow principles and their application. Discuss the use of software-based solutions such as HEC-RAS.

POLICIES & PROCEDURES

Academic Integrity: It is expected that NJIT's University Code on Academic Integrity will be followed in all matters related to this course. Refer to NJIT's Dean of Students website to become familiar with the Code on Academic Integrity and how to avoid Code violations.

https://www.njit.edu/policies/sites/policies/files/academic-integrity-code.pdf

Communication: All communication by the Instructor will be done through Canvas. It is your responsibility to check e-mail, and the course page on Canvas regularly.

Lectures/Class: Please do your best to be fully present during lectures and avoid distractions for yourself and for your fellow students. If a student must miss a class or an exam, please contact the professor to discuss the issue at least **24 hours prior to** the class or exam. If a

student had a serious medical issue, death in the family, or other excusable emergency absence, the student is required to obtain an excused absence from the Dean of Students prior to asking for a make-up. Make-up quizzes will only be considered after the student has missed two quizzes due to *excused* absences. As with quizzes, make-up exams will only be possible if the absence is excused. **Students within 2% of a letter grade can be promoted up to the next highest grade level or demoted to the next lowest grade level based on their attendance and participation in class** (both during lectures and in online discussions). Attendance will be recorded, and contributions to questions and example problems will be noted.

Handouts: Lecture notes will be made available online and will be substantially similar to the notes presented in class.

Homework: All assignments are individual and are due by 11:59:59 PM on Mondays, unless otherwise specified.

Homework Format: Homework will be submitted online and will be available through Canvas. Although written work will not be requested, it is advisable to record your calculations carefully so that you can document your thought process and request specific help on problems.

Late Homework: Late assignments will automatically be deducted 10% per day they are late and will not be accepted after 72 hours.

Homework Solutions: Solutions to requested problems will be completed in class.

Exams: Exams will be given in person during class time. Both the midterm and the final exam are cumulative. Quizzes will be given on a weekly basis at the end of Wednesday classes. The two lowest quiz grades will be dropped. In addition to a calculator, students are expected to have the *FE Reference Handbook* as a resource for quizzes and exams.

Calculation of Course Grade: A weighted average grade will be calculated as follows:

Homework		15%
In-Class Quizzes	25%	
Projects		10%
Midterm Exam		25%
Final Exam		25%

The <u>minimum</u> requirements for final letter grades are as follows:

A = 90.0%, B+ = 85.0%, B = 80.0%, C+ = 70.0%, C = 60.0%, D = 50.0%, F < 50.0%

Grades are scaled up at the end of the semester to account for performance of the class as a whole.

Instructor Commitment: You can expect the instructor to be courteous, punctual, organized, and prepared for lecture and other class activities; to answer questions clearly; to be available during

office hours or to notify you beforehand if office hours are moved; to provide a suitable guest lecturer or pre-recorded lecture when they are traveling or unavailable; and to grade uniformly and consistently.

AI statement: The use of artificial intelligence (AI) is permitted in this course only when explicitly stated in assignments. If students use AI for any course-related work, they must cite it according to the guidelines provided on the **NJIT Library AI Citation page**. If you have any questions about AI use in this course, please contact the course instructor before submitting any assignments. In cases where AI use is not allowed, students are expected to complete work without AI assistance to develop their skills in this subject area.

Students with Documented Disabilities: NJIT is committed to providing students with documented disabilities equal access to programs and activities. If you have, or believe that you may have, a physical, medical, psychological, or learning disability that may require accommodations, please contact the Coordinator of Student Disability Services located in the Center for Counseling and Psychological Services, in Campbell Hall, Room 205, (973) 596-3414. Further information on disability services related to the self-identification, documentation and accommodation processes can be found on the webpage at: (http://www.njit.edu/counseling/services/disabilities.php)

Course Schedule:

Week	Lecture	Topic	Reading	Finnemore
1	9/3	Introduction		1.1–1.5
2	9/8	Fluid Properties	1.1–1.6, 1.9–1.10	2.1–2.9
	9/10	Viscosity	1.7–1.8	2.11–2.13
3	9/15	Pressure	2.1–2.6	3.1–3.5
	9/17	Buoyancy & Stability	2.11–2.12	3.9
4	9/22	Hydrostatic Forces	2.7	3.6
	9/24	Hydrostatic Forces	2.8, 2.10 (2.9, 2.13 skim)	3.7–3.8
5	9/29	Kinematics	3.1–3.4 (3.5, 7.1-7.13 skim)	4.1–4.4, 4.8, 4.11
	10/1	Flow Rates	4.1, 4.2	4.5
6	10/6	Conservation of Mass	4.3, 4.4	4.6–4.7

	10/8	The Euler and Bernoulli Equations	5.1, 5.2	5.1–5.4
7	10/13	Applying Bernoulli's Equation	5.3	5.8–5.10
	10/15	Using Grade Lines	5.4	5.11–5.15
8	10/20	The Energy Equation	5.5	5.5–5.6
	10/22	**Midterm Exam**	**Up to and including 5.4**	
9	10/27	The Linear Momentum Equation	6.1	6.1–6.3
	10/29	Applying the Linear Momentum Equation	6.2 (6.3–6.5, 14.1–14.9 skim)	6.4–6.5
10	11/3	Major Losses	10.1	7.1–7.12
	11/5	Major Losses (Part 2)	10.1	7.13–7.20
11	11/10 (last day to withdraw)	Minor Losses	10.2, 10.3	7.21–7.24
	11/12	Minor Losses (Part 2)	10.5	7.25–7.28
12	11/17	Pipe Networks	10.4	7.29–7.34
	11/19	Introduction to Open Channel Flow	12.1–12.3	8.1–8.12
13	11/24	Rises, Bumps, & Sluice Gates	12.4, 12.5	8.13
	11/26 (Friday schedule)	**No Lecture, Happy Thanksgiving!**		
14	12/1	Hydraulic Jumps & Weirs	12.8, 12.9	8.18–8.20
	12/3	Steady Uniform Channel Flow	12.6	8.21–8.24
15	12/8	Gradually Varied Flow	12.7	8.14–8.17
	12/10	Dimensional Analysis & Similitude	8.1–8.5	7.2
Exam Period		Final Exam	See NJIT website for date	

Withdrawals: In order to ensure consistency and fairness in application of the NJIT policy on withdrawals, student requests for withdrawals after the deadline will not be permitted unless extenuating circumstances (e.g., major family emergency or substantial medical difficulty) are documented. The course Professors and the Dean of Students are the principal points of contact for students considering withdrawals.

Syllabus Information: The dates and topics of the syllabus are subject to change with consultation with the students.

Copyright: All course content (including this syllabus, lecture materials, homework assignments, and exams) is protected content. Students should not make copies of any course materials or distribute these materials in the public domain, including sites such as Chegg, CourseHero, etc.

Class Recordings: Class sessions may be recorded by the instructor. These recordings shall only be used as an educational resource and are not to be distributed or used outside of this class. Information on how to access recorded lectures will be made available by your instructor. Any recordings that contain identifiable information about students will not be used beyond this semester.

Course Objectives Matrix – CE 320 – 003

Strategies and Actions	Course Student Learning Outcomes	ABET Student Outcomes (1-7)	Program Educational Objectives	Assessment Methods/Metrics
Course Objective 1: Define fluid properties and statics utilizing the principles developed in previous mechanics courses.				
Lectures	Illustrate basic fluid properties and fluid statics.	1	1	Weekly homework, quizzes, and exams
Lectures, discussions	Discuss the design of structures impacted by fluids.	1	1, 2	Weekly homework, quizzes, and exams
Course Objective 2: Develop the principles and equations for pressure flow and momentum analysis.				
Lectures	Develop the continuity and Bernoulli equations and friction loss equations.	1	1	Weekly homework, quizzes, and exams
Lectures, discussions	Provide distinct and detailed examples of how these equations are utilized in design.	1, 2	1, 2	Weekly homework, quizzes, exams, and project
Course Objective 3: Design water distribution and pressure flow systems (pressure flow, pumps and network analysis).				
Lectures, software demonstration	Provide design solutions and examples for pumping and network analysis.	2	1	Design problems, project

Lectures	Introduce actual engineering design problems.	2	1, 2	Design problems
Course Objective 4: Illustrate and develop the equations and design principles for open channel flow. Included in this objective is sanitary and storm sewer design and flood control hydraulics (varied flow).				
Lectures	Develop the principles of open channel flow and introduce Manning's Equation	1	1	Weekly homework, quizzes, and exams
Lectures	Provide design principles for sanitary and storm sewer design along with drainage analysis.	2	1	Weekly homework, quizzes, and exams
Lectures	Introduce the varied flow principles and their application. Discuss the use of software-based solutions such as HEC-RAS	2, 7	1, 2	Weekly homework, quizzes, and exams

CEE Mission, Program Educational Objectives and Student Outcomes

The mission of the Department of Civil and Environmental Engineering is:

- to educate a diverse student body to be employed in the engineering profession
- to encourage research and scholarships among our faculty and students
- to promote service to the engineering profession and society

Program Educational Objectives

Our **Program Educational Objectives** are reflected in the achievements of our recent alumni:

1. **Engineering Practice:** Alumni will successfully engage in the ethical practice of civil engineering within industry, government, and private practice, working towards safe, practical, resilient and sustainable solutions in a wide array of technical specialties including construction, environmental, geotechnical, structural, transportation, and water resources.
2. **Professional Growth:** Alumni will advance their technical and interpersonal skills through professional growth and development activities such as graduate study in engineering, research and development, professional registration and continuing education; some graduates will transition into other professional fields such as academia, business, and law through further education.
3. **Service:** Alumni will perform service to society and the engineering profession through membership and participation in professional societies, government, educational institutions, civic organizations, charitable giving and other humanitarian endeavors.

Student Outcomes

Our **Student Outcomes** are what students are expected to know and be able to do by the time of their graduation:

1. an ability to identify, formulate and solve complex engineering problems by applying principles of engineering, science and mathematics
2. an ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety and welfare, as well as global, cultural, social, environmental and economic factors
3. an ability to communicate effectively with a range of audiences
4. an ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental and societal contexts
5. an ability to function effectively on a team whose members together provide leadership, create a collaborative environment, establish goals, plan tasks and meet objectives
6. an ability to develop and conduct appropriate experimentation, analyze and interpret data and use engineering judgment to draw conclusion
7. an ability to acquire and apply new knowledge as needed, using appropriate learning strategies

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