Fall 2019

CE 320-003: Fluid Mechanics

Michel Boufadel

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Course Description
A course that introduces the basics of fluid engineering, including the impact of fluids on structures, and the flow of fluids (mostly water) in constructed pipes and channels.

Text: Hibbeler, Fluid Mechanics, 2nd Edition, Pearson. Students need to purchase the access codes for the electronic version (print copy is not required) of this text from either the NJIT Bookstore or from the Pearson website: http://www.masteringengineering.com. No other sources are acceptable. In order to stay in this course and receive a grade, you have to be registered on the Pearson website.

Additional textbooks
Fundamental of hydraulic engineering systems, 5th edition” By Houghtalen, Akan, and Hwan, Editor is Pearson, 2018.
Hydraulique generale et appliquée, by Carlier, Editor is Eyrolle, 1972.

Prerequisite or Co-requisite: MECH 236 with a grade of C or better. Prerequisite: MECH 235 with a grade of C or better, Math 112 and PHYS111/111A. 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.

“Academic Integrity is the cornerstone of higher education and is central to the ideals of this course and the university. Cheating is strictly prohibited and devalues the degree that you are working on. As a member of the NJIT community, it is your responsibility to protect your educational investment by knowing and following the academic code of integrity policy that is found at: http://www5.njit.edu/policies/sites/policies/files/academic-integrity-code.pdf.

Please note that it is my professional obligation and responsibility to report any academic misconduct to the Dean of Students Office. Any student found in violation of the code by cheating, plagiarizing or using any online software inappropriately will result in disciplinary action. This may include a failing grade of F, and/or suspension or dismissal from the university. If you have any questions about the code of Academic Integrity, please contact the Dean of Students Office at dos@njit.edu.”
Classes
Held weekly in Faculty Memorial Hall 313
Tuesday 2:30 PM-6:30 PM. Attendance is expected. Students may leave after 15 minutes if the
instructor or a substitute has not arrived by that time.

Instructor
Michel C. Boufadel, PhD, PE, P.Hydro., F.ASCE
Office hours (Room 435 Colton) for the course: Monday 2:00-5:00 PM or by appointment.
boufadel@njit.edu

Grading
Weekly quizzes 10%
Mid term exams 40%
Final exam 35%
Homework 10%
Class Participation 5%

90-100=A
80-90=B+
75-80=B
70-75=B-
65-70=C+
60-64=C
50-59=D
< 50=F

Homework Instructions
! Homeworks should be turned in at the beginning of the class on the due date. Late homeworks
will receive a zero grade.
! The questions sheets should be provided in the beginning of the homework solution.
! Only one side of a 8.5x11 sheet must be used.
! Include the information that is given and clearly state any assumption. To receive credit for a
problem, you must show your work.
! No credit will be given if you only write the answer.
! If you think that your answer is not correct (i.e., it does not make sense to you) but you don’t know
what else to do, say so.
! Homeworks should be written as technical reports. The text should be reported first followed by
tables and then figures. The text should present the question and the solution, and point to the
figures and tables. All tables should be numbered, and all figures should be numbered. Tables
should have titles but no captions. Figures should have captions but no titles.
! All axes in graphs should have titles displaying the name of the variable and the units that are
being used in the graph.
! Straight lines should be used to connect between data points in graphs. Use of smooth lines from a
spreadsheet software, such as Excell, will be penalized.
! Printout of columns of numbers from a spreadsheet will be penalized.
! Discussing the problems with your colleagues is permitted but copying is not.
! Documents should be stapled only on the top left.
Exams Instructions

- Quizzes might be given at the beginning of any lecture.
- Bring a **non-programmable calculator** with you to the class, you might need it for a pop quiz.
- Make-up examinations will only be offered with advance permission from the instructor and only under the most extreme circumstances. A typed request and explanation must be provided. But regardless, expect make-up exams to be more difficult.
- To receive credit for a problem, you must show your work. No credit will be given if you only write the answer. If you think that your answer is not correct (i.e., it does not make sense to you) but you don’t know what else to do, say so.

<table>
<thead>
<tr>
<th>Week</th>
<th>Topic</th>
<th>Reading Assignment</th>
<th>Problems</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Introduction (Chapter 1)</td>
<td>3-43 Front &amp; rear inside covers, Appendix A</td>
<td>See masteringengineering assignments (All Weeks)</td>
</tr>
<tr>
<td>2 &amp; 3</td>
<td>Fluid Statics (Chapter 2)</td>
<td>44-74 &amp; 85-90</td>
<td></td>
</tr>
<tr>
<td>4 &amp; 5</td>
<td>Fluid Flow Concepts (Chapter 3) Conservation of Mass (Chapter 4)</td>
<td>136-147 173-213</td>
<td></td>
</tr>
<tr>
<td>6 &amp; 7</td>
<td>Analyzation of Moving Fluids (Chapter 5)</td>
<td>214-257</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>MID Term Exam (Oct. 22)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>Fluid Momentum (Chapter 6)</td>
<td>284-297</td>
<td></td>
</tr>
<tr>
<td>10 &amp; 11</td>
<td>Analysis and Design of Pipe Flow (Chapter 10)(Chapter 14*)</td>
<td>505-543</td>
<td></td>
</tr>
<tr>
<td>12 &amp; 13</td>
<td>Open Channel Flow (Chapter 12)</td>
<td>638-681</td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>Modeling/Similitude (Chapter 8) (including Exam Review)</td>
<td>418-446</td>
<td></td>
</tr>
<tr>
<td><strong>FINAL EXAM</strong></td>
<td></td>
<td></td>
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</tbody>
</table>

**Accessibility**
Any student who has a need for accommodation based on the impact of a disability should contact the Instructor privately to discuss the specific situation as soon as possible. Contact Disability Resources and Services to coordinate reasonable accommodations for students with documented disabilities. The NJIT website below provides additional information: [http://www.njit.edu/counseling/services/disabilities.php](http://www.njit.edu/counseling/services/disabilities.php)

**Academic Honesty**
Student’s expected to abide by the NJIT’s Academic Honesty Policy. Any work submitted by a student for academic credit will be the student's own work. You are encouraged to study together and to discuss information and concepts covered in lecture and the sections with other students. You can give "consulting" help to or receive "consulting" help from such students. However, this permissible cooperation should never involve one student having possession of a copy of all or part of work done by someone else. During examinations, you must do your own work. Talking or discussion is not permitted during the examinations, nor may you compare papers, copy from others, or collaborate in any way. Any collaborative behavior during the examinations will result in failure of the exam, and may lead to failure of the course and University disciplinary action.
## Outcomes Course Matrix – CE 320 - Fluid Mechanics

<table>
<thead>
<tr>
<th>Strategies, Actions And Assignments</th>
<th>ABET Student Outcomes (1-7)</th>
<th>Program Educational Objectives</th>
<th>Assessment Measures</th>
</tr>
</thead>
<tbody>
<tr>
<td>Student Learning Outcome 1: Define fluid properties and statics utilizing the principles developed in previous mechanics courses.</td>
<td>1</td>
<td>1</td>
<td>Weekly homework and exams.</td>
</tr>
<tr>
<td>Illustrate basic fluid properties and fluid statics.</td>
<td>1</td>
<td>1</td>
<td>Weekly homework and exams.</td>
</tr>
<tr>
<td>Discuss the design of structures impacted by fluids.</td>
<td>1</td>
<td>1, 2</td>
<td>Weekly homework and exams.</td>
</tr>
<tr>
<td>Student Learning Outcome 2: Develop the principles and equations for pressure flow and momentum analysis.</td>
<td>1</td>
<td>1</td>
<td>Weekly homework and exams.</td>
</tr>
<tr>
<td>Develop the continuity and Bernoulli equations and friction loss equations.</td>
<td>1, 2</td>
<td>1, 2</td>
<td>Weekly homework and exams.</td>
</tr>
<tr>
<td>Provide distinct and detailed examples of how these equations are utilized in design.</td>
<td>1, 2</td>
<td>1, 2</td>
<td>Weekly homework and exams.</td>
</tr>
<tr>
<td>Student Learning Outcome 3: Design water distribution and pressure flow systems (pressure flow, pumps and network analysis).</td>
<td>2</td>
<td>1</td>
<td>Design problems.</td>
</tr>
<tr>
<td>Provide design solutions and examples for pumping and network analysis.</td>
<td>2</td>
<td>1, 2</td>
<td>Design problems.</td>
</tr>
<tr>
<td>Introduce actual engineering design problems.</td>
<td>2</td>
<td>1, 2</td>
<td>Design problems.</td>
</tr>
<tr>
<td>Student Learning Outcome 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).</td>
<td>2, 7</td>
<td>1, 2</td>
<td>Homework and exams.</td>
</tr>
<tr>
<td>Develop the principles of open channel flow and introduce Manning’s Equation.</td>
<td>2, 7</td>
<td>1, 2</td>
<td>Homework and exams.</td>
</tr>
<tr>
<td>Provide design principles for sanitary and storm sewer design along with drainage analysis.</td>
<td>2</td>
<td>1</td>
<td>Homework and exams.</td>
</tr>
<tr>
<td>Introduce the varied flow principles and their application. Discuss the use of software-based solutions such as HEC-2</td>
<td>2</td>
<td>1</td>
<td>Homework and exams.</td>
</tr>
</tbody>
</table>

### 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 scholarship among our faculty and students
- to promote service to the engineering profession and society

Our program educational objectives are reflected in the achievements of our recent alumni:

1 – Engineering Practice: Alumni will successfully engage in the practice of civil engineering within industry, government, and private practice, working toward 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 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 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.

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 and inclusive 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 conclusions
7. an ability to acquire and apply new knowledge as needed, using appropriate learning strategies

Revised: 2/13/18