2021

CMCE 2351 Fluid Mechanics Lab, Course Outline

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CMCE 2351 Fluid Mechanics Lab

Welcome!

Welcome to CMCE 2351L Fluid Mechanics Laboratory. This course is required for the Associates of Applied Science (AAS) in Civil Engineering Technology degree. The prerequisite is the completion of CMCE 1215 with a grade of C or better and a corequisite of CMCE 2351 (Lecture). This course is 0 class hours, 2 lab hours, 0 credits.

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Syllabus

Course Objectives

During the semester, our goal is to accomplish the objectives listed below. You will be assessed (graded) on these objectives. These objectives will enable you to perform the Course Outcomes:

1. **apply** concepts related to static and dynamic fluids,
2. effectively **communicate** ideas and concepts to peers through written work, class discussions, laboratory reports and presentations
3. **recommend** and **critique** design alternatives,
4. **utilize** HEC-RAS design software for steady, open channel flow.

Course Outcomes

Upon successful completion of this course, each student will be able to demonstrate the following relative to fluid mechanics design:

1. Ability to apply knowledge, techniques, skills and modern tools of mathematics, science, engineering, and technology to solve broadly-defined engineering problems appropriate to the discipline (Criterion 3.B1);
2. Ability to design systems, components, or processes meeting specified needs for broadly-defined engineering problems appropriate to the discipline (Criterion 3.B2);
3. Ability to apply written, oral, and graphical communication in broadly-defined technical and non-technical environments; and an ability to identify and use appropriate technical literature (Criterion 3.B3);
4. Ability to conduct standard tests, measurements, and experiments and to analyze and interpret the results to improve processes (Criterion 3.B4);
5. Ability to function effectively as a member as well as a leader on technical teams (Criterion 3.B5); and
6. Employ productivity software to solve technical problems.

Note: Required course outcome criterion as per ABET. ABET accredits the civil engineering and construction engineering technology program.

Class Policies

General: Everyone is expected to be: on time, alert, an active participant, respectful, courteous, and prepared.

All student work is expected to be: neat, legible, stapled or fastened, original, professional, grammatically correct, in pencil, front side only, on engineering paper, and submitted at the beginning of class. Students are to hold onto all graded work until the end of the semester.

Email: All e-mail correspondence to the Professor is to be professional. Unprofessional e-mails will not be answered. Please be sure your name appears in the email. Use the following subject header for all e-mails: “CMCE2351-Subject.”

Assignment: All assignments are due at the beginning of class. **Late assignments will not be eligible for full credit.** Any late submission will be downgraded 20% per missed session.

Laboratories: Laboratories are to be uploaded directly to Blackboard and are due by the date and time posted on Blackboard. **Late laboratories will not be eligible for full credit.** Any late submission will be downgraded 20% per missed session. However, one laboratory extension will be granted and is due one week after the original due date.

Extra Credit: Students may accumulate up to 5 extra credit points towards the final grade at the discretion of the Professor. Proof of attendance or extra work must be submitted to the

Professor. The “Extra Credit” form must be submitted by the last day of class. Note: the 5 point limit applies to a combination of lab and lecture extra credit submissions.

The “Fine Print”: In life there are emergencies, certain events, and other extenuating circumstances that are beyond our control. In the event that a student cannot adhere to the Class Policies the student MUST:

1. Contact the Professor immediately via telephone, e-mail, or in person and inform the Professor of the situation.
2. Meet with the Professor to discuss and document an alternative agreement.

Laboratory Schedule

Week	Laboratory Schedule	Topic	Lab Due Date
1	Introduction	Lab Procedures & Safety	
2	Lab 1	Density	
3	Tutorial 1		Lab 1 **draft** due
4	Lab 2	Specific Gravity & Viscosity	Lab 1 due
5	Lab 3	Pressure Measurement	Lab 2 due
6	Lab 4	Pascal & Archimedes’ Laws	Lab 3 due
7	Lab 5	Center of Pressure	Lab 4 due
8	Lab 6	Stability	Lab 5 due
9	Lab 7	Flow through an Orifice	Lab 6 due
10	Tutorial 4		
11	Lab 8	Impact of a Jet	Lab 7 due

12	Lab 9	Flow Measurement-Weirs	Lab 8 due
13	Tutorial 5		Lab 9 due
14	Lab 10	HEC-RAS	Lab 10 due
15		Review (if Needed)	Submission Deadline

Course Materials

Lab Manuals

Lab Manuals will be provided by Professor:

- H314 (Hydrostatics and Properties of Fluids)
- H4 (Flow Through an Orifice)
- H8 (Impact of a Jet)
- H1Da-b (Set of Weirs for H1D)

Data Sheets

Data Sheets will be provided by the Professor

Weekly Topics and Readings

Week 1: Lab Procedures & Safety

1. **Read**: Fluid Mechanics Laboratory:
    - Guidelines and Fluid Laboratory – Sample Density Lab
2. **Watch**: Oregon Occupational Safety & Health (Oregon OSHA). October 6, 2017. Job Hazard Analysis (JHA) Playlist items listed below. Each video is <2 min.
    - Overview
    - Identifying Hazards
    - Controlling Hazards (Hierarchy of Controls), OSHA Rules, Analysis, JHA, Safety
3. **Additional Resource(s)**: NYCCT Laboratory Safety Training

Week 2: Density (Lab 1)

1. **Read**: Lab Manual H314 (pages 11-12)
2. **Watch** for Method A (Beaker):
    - Hildebrand, Robert. October 6, 2014. "Density of Liquids Video" (~2:30 min.)
3. **Watch** for Method B (Eureka Can, also known as an overflow can):
    - Boyd, Stephen. September 10, 2014. "Activity 3 – Volume of an Irregular Solid using the Overflow Method" (~1:30 min.)
    - Wigand, Brian. September 15, 2015. "How to use an overflow can" (~4:30 min.)
4. **Watch** for Method C (Density Bottle):
    - Adawiyah, Rabiatul. March 13, 2018. "Determine the Density of Fluid Using Density Bottle Method" (~4:30 min.)

Note: The Method B (Eureka Can) demonstrations are for finding the density of an irregular object. The class lab is focused on the density of the fluid, therefore obtaining different information than the videos and the lab manual formulas should be followed.

Week 3: Tutorial 2

Practice problems will be available on blackboard or distributed during class.

Week 4: Specific Gravity & Viscosity (Lab 2)

1. **Read**: Lab Manual H314 (pages 13 and 16)
2. **Watch** for the Specific Gravity portion:
    - Camlab Ltd. August 2, 2016. "How to use a Hydrometer" (~1:30 min.)
    - Lab 1 Method A (Beaker) can be revisited for a refresher on calculating the density of a fluid: Hildebrand, Robert. October 6, 2014. "Density of Liquids Video" (~2:30 min.)
3. **Watch** for the Viscosity portion:
    - Physic Demos. August 20, 2016. "Viscosity Demo: Water and Oil" (~1 min.)
    - Amritacreate. February 7, 2017. "Viscosity – MeitY OLabs" Watch ONLY up to 2:28, to see how terminal velocity is calculated. The class lab is obtaining different information than the video, so use the lab manual formulas and NOT the formulas presented in the video.

Week 5: Pressure Measurement (Lab 3)

1. **Read**: Lab Manual H314 (pages 33-35)
2. **Watch**:
    - Rathnayake, Upaka. February 7, 2017. "Calibration of a Pressure gauge" (~4 min.)
    - ADTW learn. July 3, 2020."Bourdon Tube pressure gauge working animation" (~4 min.)

    - Winters Instruments. December 14, 2011. "What is Hysteresis?" (~1:30 min.)
3. **Additional Resource(s)**: To learn more about other types of gauges, watch:
    - Wika Group. January 2, 2019. "How does a pressure gauge work? | Bourdon tube vs. diaphragm element" (~2:30 min.)
    - Instrumentation Academy. November 17, 2020. "How does a Bourden Tube Pressure Gauge Work – Animation. CType, Helical & Spiral Bourden Gauges" (~3 min.)

Week 6: Pascal & Archimedes Laws (Lab 4)

1. **Read**: Lab Manual H314 (page 21)
2. **Watch**:
    - LightDragon348. November 8, 2013. "The Weight of Water: Water at 4 Degrees Celcius, Volume Capacity and Mass and Surface Area" Watch ONLY up to 3:42 as a refresher on the volume of a cylinder and think about how the concepts in the video can be applied when thinking about the volume of water displaced.

Week 7: Center of Pressure (Lab 5)

1. **Read**: Lab Manual: H314 (pages 30-31) Note: The lab will completed for a fully submerged plane and analyzed using the calculations noted on the data sheet (NOT the integral approach noted in the lab manual) .
2. **Watch**:
    - TecQuipment Ltd. April 3, 2019. "Hydrostatics and Properties of Fluids Experiment H314 – Fluid Mechanics – TecQuipment" See 1:15 for the equipment setup.
    - Shields, Gerarda Mary. August 31, 2020. "Fluid Mechanics Laboratory: Center of Pressure" (~3 min.) Note that this video is setup slightly different but the concepts are the same.

Week 8: Stability (Lab 6)

1. **Read**: Lab Manual H314 (pages 22 – 26)
2. **Watch**:
    - vulcanhammerinfo. May 14, 2020. "Fluid Mechanics Laboratory Video: Buoyancy and Stability". Watch approximately 10:35 to 11:40 for the discussion about how to find the center of gravity. (~1 min.) The rest of the video also contains discussion about the lab concepts so you may want to watch other portions aw well. (Overall video ~30 min.)
3. Additional Resource(s): Some additional concepts to think about
    - Magic Marks. September 10, 2013. "Metacenter Definition | Fluid Mechanics"
    - Casual Navigation. May 17, 2019. "How Stabilizers Reduce A Ship's Roll" (~6 min.)

Week 9: Flow through an Orifice (Lab 7)

1. **Read**: Lab Manual H4 (pages 1-6 and 13-24)
2. **Watch**:
    - TecQuipment Ltd. June 9, 2015. "Teaching Equipment – Fluid Mechanics – Flow through an Orifice" for an overall look at the equipment. (~1:30 min.)
    - Khan, Afrasayab. July 11, 2017. "To Determine the Hydraulic Coefficients (Cc, Cv & Cd) for Small Circular Orifice" for experiment.(~5:30 min.)
    - Lee, Juneseok. September 15, 2020. "Fluid Lab – Orifice" for reference experiment. (~4:30 min.)

Week 10: Tutorial 4

Practice problems will be available on blackboard or distributed during class.

Week 11: Impact of a Jet (Lab 8)

1. **Read**: Lab Manual: H8 (entire manual)
2. **Watch**:
    - TecQuipment Ltd. July 23, 2015. "Teaching Equipment – Fluid Mechanics – Impact of a Jet" (~2 min.)
    - Ong, Paul. October 1, 2019. "CE1101A Hydraulics Experiment: Impact of a Jet" for closeup of different plates (~1 min.)

Week 12: Flow Measurement-Weirs (Lab 9)

1. **Read**: Lab Manual H1Da/b (pages 1-6 and 13-17)
2. **Watch**:
    - Ahmari, Habib. October 13, 2018. "Experiment # 9: Flow Over Weirs" (~5:30 min.)
3. Additional Resource(s):
    - Practical Engineering. February 25, 2019. "What is a Weir?" for additional background information. (~8 min.)
    - Behzadian, Kourosh. November 25, 2020 "Flow Over Weirs Laboratory Experiment" for a walk through of the lab manual. (~14 min.)

Week 13: Tutorial 5

Practice problems will be available on blackboard or distributed during class.

Week 14: HECRAS (Lab 10)

Please follow these steps for the final lab:

1. **Download**: the FREE software can be downloaded from the United States Army Corps of Engineers (https://www.hec.usace.army.mil/software/hec-ras/download.aspx).
    - From the left hand menu, click on the “Download”.
    - Download the latest version of the program available.
2. **Complete**: The Introduction to HEC-RAS Directions (distributed by the Professor).
3. S**ubmit**: the required information for the laboratory report. Make sure to name the project file “YourLastName_YourFirstName.” This will serve as proof that you completed the exercise yourself.
4. Additional Resource(s):
    - Albrook Hydraulics Laboratory. November 17, 2016. “HEC-RAS Tutorials” There are 7 videos that walk through download and installation (~4 min.), an overview (~7:30 min.), and 5 other videos that walk through a problem (~20 – 30 min.)
    - Reference Book: Floodplain Modeling Using HEC-RAS (ISBN-10: 1934493023) but it is strongly encouraged that you check out all of the free resources available online.

Want to explore HEC-RAS more? There are additional resources available from the US Army Corp of Engineers. If you download the “with examples version” of HEC-RAS, there are problems available in the “Application Guide” than you can work through using the data available with the download. Also, check out the “User Manual” for additional support and guidance.

Additionally, there are some training courses available on the Army Corps website. Click “Training Materials” and you will be able to see the courses and material that you can follow along with at your own pace. For example, **#352 – Advanced 1D 2D Unsteady Flow Modeling (July 2019)** has a mix of slides and examples. When you get to 1.6, you will be able to download the material and try on your own. There are also “Webinars and Tutorials” for free videos, which have data files available also.

Week 15: Review (if needed) and Submission Deadline

The last session will be planned based on the class needs.