Physics 299: Introductory Special Topics, Fluid Mechanics Fall 2020

Meeting: Trexler 272 Time: MWF 10:50 – 11:50AM Instructor: Matthew C. Fleenor Office: Trexler 266D email: fleenor@roanoke.edu Office Hours: By appt.

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Required Textbook: *Fluid Mechanics, 3rd Edition*, Cengel & Cimbala, ISBN13: 978-0073380322

Required Prerequisites: Math 118 or 121, Physics 201 or Instructor Permission

Other Required Readings: Provided by Instructor

I. Components of Learning

There are several factors that make a course "good" (by good, I mean a healthy combination of the intellectual and the affective). Good courses are also clear about their essential components. Below is an attempt to be clear about how will I operate within PHYS 299, as well as my expectations of a student who is enrolled in PHYS 299.

Descriptions

Aspiration: Physics is a framework for observing and appreciating the physical universe, in as much as it is a manner of explaining the phenomena within it. Therefore, a few different levels of interpretation exist for the sentence, "I understand physics." My approach in this course is a 'both/and' mentality, where both the conceptual understanding (and dare I say, appreciation) and the analytical problem-solving approach can mutually coexist. Arguably, if you don't have both an interest in the conceptual and the mathematical, then eventually neither will deepen. I will aspire to provide the proper atmosphere and avenues so that neither of these necessary levels of understanding need to be sacrificed. My goal for you is that you will walk away with a deeper understanding in each of these contexts.

Introductory special topics (IST) implies that your learning will be focused in a particular area that may be new to you. Learning how basic and fundamental physical principles fit within the context of fluid interactions can be enlightening, enriching, and invigorating. There are many concepts introduced within a basic physics course (like 201) that remain segregated or compartmentalized from other topics. Our IST series intends to integrate some of these topics so you get a real-world view of how physics "works" to reveal understanding.

Expected Learning Objectives: Successful students will

1.. demonstrate a proficiency with the use of units and estimation;

2. display a working knowledge between the various kinematic quantities and their graphical representation;

3. manipulate Newton's laws of motion in order to show conservation principles (energy and momentum);

4. analyze different contributions of the total energy of a system and comment on how the energy isconserved;

5. determine the hydrostatic forces for several geometries;

6. calculate the stagnation pressure using the Bernoulli equation;

7. apply concept of angular momentum as it relates to fluid energy and stability;

8. demonstrate an understanding of the force balance within buoyancy situations.

Attendance: Although roll will not be taken, daily attendance is expected. Your absence will be noted by the lack of contribution to our discussion and problem-solving interactions in class. Due to the mathematically rigorous nature of the course, you may not miss more than *three* classes without a pre-discussed excuse. Late arrivals greater than 15 minutes will constitute an official absence. *At the third un/excused absence, I will request a meeting with you and send an email to you, your Advisor, and the Registrar alerting them of the situation.*

As is the case for all Roanoke College classes, the time spent on this course will constitute at least 12 hours a week. This includes class, lab, reading, and any homework or writing assignments.

Office Hours: Please take advantage of the office hours prescribed above, or make an appointment with me. Drop-ins are at the total mercy of my daily schedule.

Inquire (NQR**):** I use the NQR environment extensively to place notes, announcements, videos, assignments, *proofs*, *solutions*, links, and other course documents. Please do NOT forget to check NQR before you come to class or if you have a question about previous assignments.

Academic Integrity: I want to foster a mutual respect for the classroom hours that we have together. In light of this, please remember to silence cell phones, electronic devices, laptops, etc. during class and come prepared. Please ask if you want to use these devices for educational purposes in class. Refer to the "Academic Integrity" page on the RC website– http://roanoke.edu/A-Z_Index/Registrar/Policies_and_Information/Academic_Integrity.htm

Included here is an explanation of how violations of the College's academic integrity policy are handled.

Grades: Standard letter grades (A–F) are assigned according to the following scale for this course: "A"(92–100), "B+"(88–91), "B"(83–87), "B–"(80–82), "C+"(78–79), "C"(74–78), "C–"(70-73), "D"(60– 69), "F"(< 60).

II. Modes of Learning

Rubric

Your grade is determined according to the following distribution:

Exams (3)	60%	Home/Classwork	30%
Participation	5%	Fluid Projects	5%

Descriptions

Exams: All exams are planned (by me) for completion in 1.0 hour, however, you will have up to 1.25 hours to complete each exam. Since the class begins at 10:50 AM, each student has the option to arrive at 10:45 AM and/or stay until 12:00 PM. NOTE: If you have a class that begins at 12:00 PM, it is *your* responsibility to plan for the late arrival into your next class. All exams are not designed to be comprehensive in nature, though most exams will contain some conceptual material from previous exams and/or problems. This *includes* includes the final exam. Make-up exams will only be allowed as a result of a discussion with me **beforehand** or a note related to the emergency (death, hospitalization, misdemeanor, etc.) *signed* by a governing official (medical doctor, parent, law enforcer, etc.).

Quizzes: Weekly quizzes (FRIs) are completed individually or as a small group (my discretion) in class and graded. The quiz will consist of one partial problem from the class discussion, which contain the *more* important concepts and/or phenomena. Typically, the problem will not be numerical in nature.

Problem Sets: Un-/assigned problems (like those in the problem sets) are "**when and where**" you will learn the course material. For better and for worse, there is no way to learn the depth of the material within the one-hour sessions that we will have together. Due to the nature of problem solving, I expect that you will work together *toward* a solution. However, I also expect that you will create an original solution to each assigned problem. Substitutions and simplifications should **NOT** be left to the "reader" (that's me) to figure out. If necessary, words and phrases need to be properly placed so that I can follow your train of thought. Problem sets are your final draft essays and/or compositions that display the fruit of your higher-level critical thinking skills, so you need to view them in that light. These can be completed in electronic format or by-hand (neatly). If you do not follow these guidelines, I will return them to you for completion. I can provide examples of the kind of work that I expect on a final submission for the problem sets.

Participation: What it means to "participate" in Physics 299 should include the following: listening to audio-video lectures, attentive attendance, engagement in question and answer, reflective write-up for two extracurricular lecture or presentations, and responsibility for your own learning (office hours, etc.).

III. Daily Course Outline

In what follows, you will see the plan for working through the course. Each course meeting provides a section of the text, a conceptual topic, and a homework problem to reinforce the topic. Exams (*EXAM #*) are also marked on the course outline, so please refer to it often. If there are deviations from the following outline, I will certainly draw your attention to them.

Week	Date	Chapter	Topics
1	17-Aug 19-Aug 21-Aug	**1: Jargon & Approach**	Introduction & (some) Terminology Dimensions, Units, and Problem-solving
2	24-Aug 26-Aug 28-Aug	**2: Fluid Properties**	Specific Gravity, Vapor Pressure, & Specific Heat Compressibility & Speed of Sound Viscosity & surface tension
3	31-Aug 2-Sep 4-Sep	**3: Fluid Statics**	Pressure, Measurement, & Fluid Statics Hydrostatic Forces: Planar and Curved Surfaces Buoyancy, Stability, & Rigid-body Motion
4	7-Sep 9-Sep 11-Sep		Exam 1 (on FRI)
5	14-Sep 16-Sep 18-Sep	**4: Fluid Kinematics**	Lagrangian & Eulerian Flow Visualization Plotting Fluid Flow Data Vorticity, Rotationality, & Reynolds Transport
6	21-Sep 23-Sep 25-Sep	**5: Energy Equations**	Conservation of Mass &Efficiency Bernoulli Equation Energy Equation & Analysis
7	28-Sep 30-Sep 2-Oct	**6: Momentum Analysis**	Newton's Laws on a Control Volume Linear Momentum Equation Angular Momentum Equation
8	5-Oct 7-Oct 9-Oct		Exam 2 (on FRI)
9	12-Oct 14-Oct 16-Oct	**7: Dimensional Analysis**	Dimensional Homogeneity & Similarity Method of Repeating Variables Modeling & Incomplete Similarity
10	19-Oct 21-Oct 23-Oct	**8: Internal Flow**	Laminar Flow Turbulent Flow Piping Networks & Pumping

11	26-Oct 28-Oct 30-Oct	**9: Differential Analysis**	Continuity Equation Cauchy's Equation Navier-Stokes Equation
12	2-Nov 4-Nov 6-Nov	**11: External Flow**	Friction & Pressure Drag Drag Coefficients Flow & Lift Forces
13	9-Nov 11-Nov 13-Nov	**12: Compressi-ble Flow**	Isentropic Flow Shock & Expansion Waves Duct Flow w Heat Transfer & Friction
14	16-Nov 18-Nov 20-Nov		Exam 3 (8 AM – 12 PM)