Name: _____.

MET 330 Fluid Mechanics
Dr. Orlando Ayala
Spring 2022
Test 1

Take home – Due Tuesday February 15th, 2022, before midnight.

READ FIRST

1. RELAX!!!! DO NOT OVERTHINK THE PROBLEMS!!!! There is nothing hidden. The test was designed for you to pass and get the maximum number of points, while learning at the same time. HINT: THINK BEFORE TRYING TO USE/FIND EQUATIONS (OR EVEN FIND SIMILAR PROBLEMS)

2. The total points on this test are one hundred (100). Ten (10) points are from your HW assignments, and ten (10) other points are based on the basis of technical writing. The other eighty (80) points will come from the problem solutions. For the technical writing I will follow the attached rubric.

3. There are 2 main different parts, each one is worth 80/2 points.

4. What you turn in should be only your own work. You cannot discuss the exam with anyone, except me. Call me, skype me, text me, email me, come to my office, if you have any question.

5. I do not read minds. You should be explicit and organized in your answers. Use drawings/figures. If you make a mistake, do not erase it. Rather use that opportunity to explain why you think it is a mistake and show the way to correct the problem.

6. You have to turn in your test ON TIME and ONLY through BLACKBOARD. You must submit the test solution in only one file, and it has to be a pdf file. You must also submit the excel spreadsheet. For the ePortfolio (which is optional) you are supposed to upload this artifact to your Google drive. I will provide more instructions later.

7. Do not start at the last minute so you can handle anything that could happen. Late tests will not be accepted. Test submitted through email will not be accepted either.

8. Cheating is completely wrong. The ODU Student Honor Pledge reads: "I pledge to support the honor system of Old Dominion University. I will refrain from any form of academic dishonesty or deception, such as cheating or plagiarism." By attending Old Dominion University, you have accepted the responsibility to abide by this code. This is an institutional policy approved by the Board of Visitors. It is important to remind you the following part of the Honor Code:

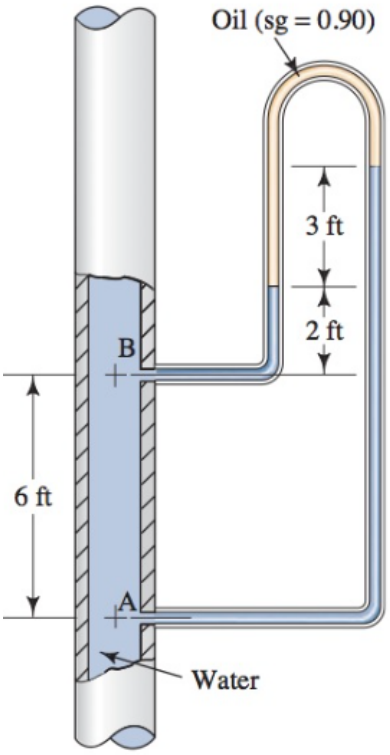
> IX. PROHIBITED CONDUCT
> A. Academic Integrity violations, including:
> 1. *Cheating*: Using unauthorized assistance, materials, study aids, or other information in any academic exercise (Examples of cheating include, but are not limited to, the following: using unapproved resources or assistance to complete an assignment, paper, project, quiz or exam; collaborating in violation of a faculty member's instructions; and submitting the same, or substantially the same, paper to more than one course for academic credit without first obtaining the approval of faculty).

With that said, you are NOT authorized to use any online source of any type, unless is ODU related.

1) For the manometer shown in the figure, the pressure difference between point A and B was calculated and it was found to be 2.7177psi. What would be the deflection in the manometer if instead of using oil with sg=0.90 you use gasoline? What is the minimum height of the manometer so the gasoline does not go into the system?

   Using an excel spreadsheet, run the calculations again. Then determine the deflection for the case of using mercury as the manometric fluid.

   Please, look at the results you got and make comments about them in the "analysis" section of your solution. Why do they make sense?



2) The system shown in the figure was designed to handle a total of 30 gpm of coolant. The owners of the company realized that the coolant needed for Machines #1 and #2 are different to what they had estimated initially. Instead of 20 gpm and 10 gpm, they actually need 30 gpm for each machine exactly. Thus, they need a new pump to deliver the new total flow rate of coolant. The coolant then flows back to the machines as needed, by gravity. The coolant has a specific gravity of 0.92 and a dynamic viscosity of 3.6×10^{-5} lb.s/ft^2. The filter has a resistance coefficient (K) of 1.85 based on the velocity head in the suction line.

   You are hired to redesign for now only the pumped system, but we do not know what the best pipe size would be for this new flow rate. Here it is what you need to do:

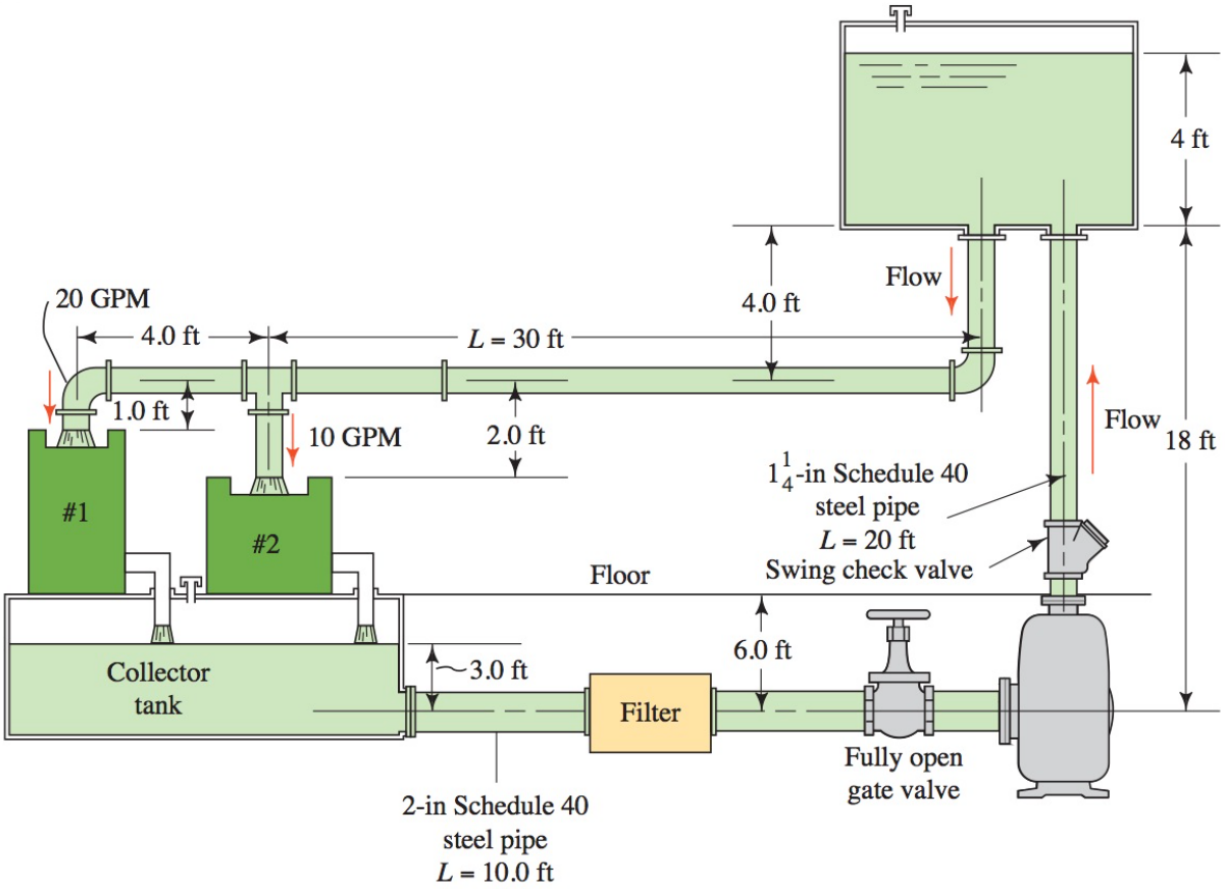
   a. Pick a commercial steel pipe Schedule 40 that will give you a mean flow velocity of about 3m/s with the new total flow rate (do not forget there are two machines in the upper system and one pipe in the pumped system).
   b. With the selected pipe, compute the pump head and the power delivered by the pump to the coolant. Also, compute the pressure at the inlet of the pump.
   c. Using an excel spreadsheet, run the calculations again.
   d. Using an excel spreadsheet, run the calculations again using different steel pipe Schedule 40 sizes. Pick two pipe sizes smaller than the one you selected on part a, and two pipe sizes larger than the one you selected on part a. Keep in mind that the fluid velocity will change for every pipe size while the flow rate is the same for all cases.
   e. For each of the pipe sizes, estimate the cost of installation using the pipe cost list below and consider than labor, transportation, and pump costs ammount for about 40% of the pipe cost. Include a 15% extra for unforseen costs. Make a table of the installation costs in excel.

Pipe nominal size (in)	Cost per 6 ft
½	$12.95
¾	$17.95
1	$23.95
1 ¼	$28.95
1 ½	$33.95
2	$46.95
2 ½	$71.95
3	$92.95

f. For each of the pipe sizes, estimate the cost to maintain the system operating for 2 years knowing that the electricity cost is about $730 per kW constantly used during those 2 years. Make a table of the operation costs in excel.

g. Add both costs (operation and installation) and plot on the same graph the cost of installation, the cost of operation, and total cost as a function of nomical pipe diameter.

h. Please, look at the results you got and make comments about them in the "analysis" section of your solution. Why do they make sense? What do you think is the best pipe size to use in this system?



Problem solution rubric

	Exceeds Standard	Meets Standard	Approaches Standard	Needs Attention
	4	3	2	1
	10 points	7 points	4 points	0 points
1. Purpose **5%**	The purpose of the section to be answered is clearly identified and stated.	The purpose of the section to be answered is identified, but is stated in a somewhat unclear manner.	The purpose of the section to be answered is partially identified, and is stated in a somewhat unclear manner.	The purpose of the section to be answered is erroneous or irrelevant.
2. Drawings & Diagrams **10%**	Clear and accurate diagrams are included and make the section easier to understand. Diagrams are labeled neatly and accurately.	Diagrams are included and are labeled neatly and accurately.	Diagrams are included and are labeled.	Needed diagrams are missing OR are missing important labels.
3. Sources **5%**	Several reputable background sources were used and cited correctly.	A few reputable background sources are used and cited correctly.	A few background sources are used and cited correctly, but some are not reputable sources.	Background sources are cited incorrectly.
4. Design considerations (assumptions, safety, cost, etc) **10%**	Design is carried out with applicable assumptions and full attention to safety and cost, etc.	Design is generally carried out with assumptions and attention to safety, cost, etc.	Design is carried out with some assumptions and some attention to safety, cost, etc.	Assumptions, safety and cost were ignored in the design.
5. Data and variables **5%**	All data and variables are clearly described with all relevant details.	All data and variables are clearly described with most relevant details.	Most data and variables are clearly described with most relevant details.	Data and variables are not described OR the majority lack sufficient detail.
6. Procedure **25%**	Procedure is described in clear steps. The step description is in a complete and easy to understand short paragraph.	Procedure is described in clear steps but the step description is not in a complete short paragraph.	Procedure is described in clear steps. The step description is in a complete short paragraph but it is difficult to understand.	Procedure is not described in clear steps at all.
7. Calculations **20%**	All calculations are shown and the results are correct and labeled appropriately. The units of all values are shown.	Some calculations are shown and the results are correct and labeled appropriately.	Some calculations are shown and the results labeled appropriately.	No calculations are shown OR results are inaccurate or mislabeled.
8. Summary **5%**	Summary describes the design, the relevant information and some future implications.	Summary describes the design and some relevant information.	Summary describes the design.	No summary is written.
9. Materials **5%**	All materials used in the design are clearly and accurately described.	Almost all materials used in the design are clearly and accurately described.	Most of the materials used in the design are clearly and accurately described.	Many materials are described inaccurately OR are not described at all.
10. Analysis **10%**	The design is discussed and analyzed. Argumentative predictions are made about what might happen in case of change in the operation and how the design could be change.	The design is discussed and analyzed. Argumentative predictions are made about what might happen in case of change in the operation.	The design is discussed and analyzed. No argumentative predictions are made about what might happen in case of change in the operation and how the design could be change.	The design is not discussed and analyzed.