Name:

MET 350 Thermal Applications Dr. Orlando Ayala Spring 2025 Test 2

Take home – Due Sunday March 25th, 2025, 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. <u>HINT:</u> 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 problems. Each problem will be 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 CANVAS. You must submit only one file and it has to be a pdf file. 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.

An ideal Rankine steam cycle modified with two closed feedwater heaters and one open feedwater heater is shown below. The power cycle receives 100 kg/s of steam at the high-pressure inlet to the turbine. The feedwater heater exit states for the boiler feedwater and the condensed steam are the normally assumed ideal states. The tables below provide some information for some of the states in the cycle.



Process states and selected data								
State	<i>P</i> , kPa	<i>T,</i> ℃	h, kJ/kg	<i>s,</i> kJ/kg∙K				
1 2 3 4 5	20 620 620 620 5000							
6 7 8 9 10 11	5000 5000 1910 620 140 20	700	3900 3515 3154 2799 2478	7.514 7.514 7.514 7.514 7.514				

Saturation data								
<i>P,</i> kPa	T _{sat} , ℃	v _f , m ³ /kg	<i>h_f,</i> kJ/kg	<i>s_g,</i> kJ/kg∙K				
20 140	60.1 109.3	0.00102	251 458	7.907 7.246				
620 1910 5000	210.1 263.9	0.00110 0.00117 0.00129	676 898 1154	6.748 6.356 5.973				

- 1. After years of operation, the steam trap handling the fraction of mass extracted from the closed feedwater heater operating at 1910 kPa starts to malfunction and gets completely blocked. With the steam trap malfunction the mass fractions for the other feedwater heaters ("*y*" and "*z*") got affected and the operator noted that the fluid at state 3 was saturated liquid. For such case:
 - (a) Determine the fraction of extracted mass "y" and "z" for the open and closed feedwater heater respectively that guarantees the proper operation of the cycle.
 - (b) Determine the cooling water temperature rise in the condenser, in °C, when the cooling water flow rate is 4200 kg/s. Assume Cp = 4.18 kJ/kg·K for cooling water.
 - (c) Determine the rate of heat rejected in the condenser, the produced net power, and the thermal efficiency of the plant.
- 2. All of the sudden, the second steam trap starts to malfunction as well. For such case:
 - (a) Determine the fraction of mass "*y*" extracted for the open feedwater heater that guarantees the proper operation of the cycle.
 - (b) Determine the cooling water temperature rise in the condenser, in °C, when the cooling water flow rate is 4200 kg/s. Assume Cp = 4.18 kJ/kg·K for cooling water.
 - (c) Determine the rate of heat rejected in the condenser, the produced net power, and the thermal efficiency of the plant.

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	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	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	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.