1.	/20
2.	/20
3.	/20
4.	/20
5.	/20

Final Exam

CM3110

Wednesday 16 December 2020

Name:

Rules:

- Closed book, closed notes.
- Two-page 8.5" by 11" study sheet allowed, double sided; you may use a calculator; you may not search the internet or receive help from anyone.
- Please text clarification questions to Dr. Morrison 906-487-9703. I will respond if I am able.
- All work submitted for the exam must be your own.
- Do not discuss the contents of the exam with anyone before midnight Wednesday 16 December 2020.
- ***Please copy the following Honors Pledge onto the first page of your exam submission and sign and date your agreement to it.***

Honor's Pledge:

On my honor, I agree to abide by the rules stated on the exam sheet.

Signature _____

Date _____

Exam Instructions:

i. You may work on the exam for up to three hours and 15 minutes (195 minutes).
ii. Please be neat. Only neat answers will be granted partial credit. Please use a dark pencil or pen so that your work is readable once scanned.
iii. Significant figures always count.
iv. Please box your final answers.
v. Submit your work as a single PDF file; put your name on every page. (Genius Scan is a free app that can create a PDF from photos taken by your phone). If you take photos of your work, insert them into Word or Google Docs and create a PDF.
vi. Submit your exam study sheet as a separate PDF file; put your name on the first page (at a minimum)

1. (20 points max) **Answer one of the following** (If you answer more than one, we will only grade the first one or the one that is circled/boxed.). Please limit your answer to at most 4 sentences.

Answer **one** part ONLY.

- (20 points) What engineering considerations lead to the use of several different designs of <u>evaporators</u>? Briefly describe two different evaporator designs.
- (20 points) What is the data correlation that we use in analyzing flow through <u>packed beds</u>? Give the name of this data correlation and the equation for the data correlation. What engineering quantities does it allow us to calculate?
- (20 points) What is the meaning of the velocity for incipient fluidization in <u>fluidized beds</u>? Give the equation for calculating this quantity. Why is this velocity of engineering interest?

2. (20 points) Water at 25^oC flows steadily in a horizontal copper tube (the inner diameter $= 0.545\ in = 0.01384m$; outer diameter $= 0.625\ in = 0.01588m$).
   a. What is the maximum flow rate such that the flow will still be laminar? Give your answer in gallons per minute.
   b. What is the pressure drop per unit length in the flow when the flow rate is $0.25\ gal/min$? Give your answer in Pa/m.

3. (20 points) For the situation described below, heat transfer is taking place that can be described by Newton's law of cooling, $q = hA\Delta T$. How would you determine a good value for the heat transfer coefficient h in this case? What quantities would need to be <u>measured</u> so that you could complete your calculation? What quantities would you need to <u>look up</u>? Briefly explain your reasoning.
   - *A steel pipe (length $= 15m$) with an extremely hot liquid passing through it loses heat to the environment as it crosses a room in a chemical plant. What is the heat loss per meter of pipe?*

4. (20 points) Two very large vertical parallel plates made of wrought iron are part of the protective sheeting of a reactor. The plate nearest to the reactor is at temperature 590^oC. The second plate, which is $12\ cm$ away and farther from the reactor is at temperature 315^oC. What is the net heat flux from the first plate to the second? Please give your answer in W/m^2.

5. (20 points) Water (25^oC) flowing at $1.4\ kg/s$ enters the inside of a counterflow, double-pipe heat exchanger (overall heat transfer coefficient $= 0.225\ kW/m^2\ K$, area for heat transfer $= 30.6\ m^2$). The outside chamber of the heat exchanger contains a heat-transfer fluid (thermal conductivity $= 0.180\ W/mK$, heat capacity $= 1.97\ kJ/kg\ K$, inlet temperature 75^oC) flowing at $1.85\ kg/s$. For the heat exchanger running at steady state, how much heat is transferred? Please give your answer in kW.