Study Guide for CM3110
Module 5 Heat Transfer Continued
Morrison Spring 2021

Test subjects in this course are cumulative. Anything on a study guide from a prior exam may be the subject of a current exam.

The Final Exam will cover, in addition to Exam 1-4 material, more complex heat-transfer engineering (heat transfer at fluid-solid boundaries in broader circumstances and with added radiation), unit operations (more complex questions and device design and operation), and radiation heat transfer.

<u>To do well on the test, you should be able to do the following:</u>

Dimensional analysis in heat transfer, conditions at the boundary (complex heat-transfer systems involving <u>natural/free convection</u> and phase change)

1. Compare and contrast forced and natural convection in heat transfer
2. Explain how to determine if the convection present in a heat transfer scenario is free (natural) or forced
3. List two examples of data correlations for Grashof (give the equation; identify symbols)
4. List an example of heat-transfer data correlation for systems with phase change
5. Calculate from data correlations the heat-transfer coefficients discussed above; include the general case as well the simplified cases of air and water

More complex heat-transfer engineering

6. Calculate heat loss through a boundary, evaluating the heat transfer coefficient from data correlations appropriate to the problem (linear driving force model, Newton's law of cooling) <u>with added radiation effects</u>, as appropriate (including knowing when it is appropriate)
7. Calculate the heat flow when there are multiple driving forces for heat flow (for example both natural convection and radiation)
8. (stretch) Explain when a numerical simulator such as COMSOL would be advantageous (and worth the effort) for heat-transfer engineering

Unit Operations (heat transfer dominated)

9. Calculate heat loss $\dot{Q}$ or design double-pipe heat exchangers
10. Calculate heat loss $\dot{Q}$ or design shell-and-tube heat exchangers
11. Explain the utility of heat exchanger effectiveness, ε.
12. Calculate heat loss $\dot{Q}$ or operating conditions using heat exchanger effectiveness
13. Compare and contrast various evaporator designs
14. Explain how mixing (fluid mechanics) issues influence the design of heat-transfer devices such as heat exchangers and evaporators
15. Define *fouling* in regards to heat exchangers or evaporators

16. Calculate the effect of fouling on the overall heat transfer coefficient of a heat exchanger (additional resistance due to fouling)

Radiation heat transfer (including heat shields)

17. Explain how to determine if radiation may be important in a heat transfer scenario
18. Calculate heat transfer coefficients for radiation heat transfer (h_{rad}, linear driving force model)
19. Explain the purpose and functioning of a heat shield
20. List two circumstances where heat shields would provide a desired engineering outcome.
21. Calculate the effect on heat flow of adding heat shields to an apparatus described
22. Calculate the number of heat shields needed to reduce a heat flow to a desired level
23. Compare and contrast radiation heat transfer from a surface to a body and radiation heat transfer between two long and wide plates