Test 1 Reflection
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MET 440 Heat Transfer
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Learning Objectives

Test 1 focused on the following course objectives:

- Define different modes of heat transfer
- Discuss the basic laws of conduction, convection, and radiation
- Apply the concept of the thermal circuit to solve one-dimensional heat conduction problems
- Solve simple convection heat transfer problems

Test 1 only had two problems to solve, but both problems addressed each of the above objectives in some way. Both required calculations based on heat transfer through conduction and convection, both required the use of a thermal circuit to understand the overall system, and both defined the different modes of heat transfer using different equations to find the answer.

Grading

Problem 1

This was the more complex problem of the two on the test. It required finding the resistances of several types of material using both conduction and convection techniques and different shape factors.

My attempt at this problem was not the correct methodology. Initially, I focused on finding the individual resistances of each piece of the solar panel and including all of that information into a single R_{total} but after running into complications with the air layer and the shape of the pipes, I abandoned this strategy and instead tried to solve it using a conservation of heat and energy technique which treated the entire block as somewhat homogeneous. Because the panel was insulated, I assumed that all heat absorbed by the glass would then be transferred, eventually, to the water in the pipes below. By taking this route, and adjusting the overall heat absorbed via the area of the pipes, I was able to come up with an answer which seemed plausible, though it also seemed far too simple when applied to such a complex system.

My answer for the first part of the question regarding how much heat energy a single tube absorbs was about two thirds of the given value in the solution. I neglected to properly calculate how the energy would be split between the ambient air above the panel and what would be absorbed into the system. Though the heat conservation approach was not a bad one, neglecting the loss to the air and the overall resistances of the system led to a major difference in the final answer.

For the second part of the problem regarding the temperature of the air layer within the panel, the temperature I calculated was far higher than the solution, nearly double. I treated that air layer as stagnant since it was encased in the panel and would therefore not produce a conductive effect with the glass or the silver slab. Air that is not moving does have k values in the back of the book, and using the approximate temperature of the system, I applied that coefficient to the overall energy absorbed by the panel and got a very high answer relative to the actual solution. This was compounded by my strategy of using all but 10% of the energy supplied by the sun from the beginning of my attempt. Had I treated the air layer as convective heat transfer instead of conductive, my answer would have been a lot closer to the given result. It also would have simplified my initial attempts to find the resistances of the layers as a

convective heat transfer coefficient was given in the problem statement. I assumed that was either given in error or given as a distraction since the air was stagnant. Doing so made the problem much more difficult.

For part c, my process matches that used on the test solutions document. Because my temperature and heat energy values were much different, my answer was also much higher than the one given. Had my previous steps been correct, this portion would have given the correct answer.

Similarly, part d used the correct process, but achieved a very different answer. The energy values on the given results achieved an efficiency of greater than 100%, while my own answer was 90%. Based on my previous experiences with engineered systems, neither of these answers is reasonable, but because of the peculiar design of this solar panel, the description in the given solutions does explain how it is possible in this case.

Problem 2

This problem consisted of a brazing rod being applied to a very hot base metal. The overall layout of this problem is a fin with a given temperature at the tip and at a point one foot away from the tip. It is a relatively simple looking system, but the math behind the fin equations can get quite finicky, and that ultimately ruined my chances.

Ultimately, I ran out of time trying to solve this problem. I spent most of my time and effort attempting to understand Problem 1 believing I had a good handle on Problem 2 only to discover that I did not have the algebraic skills easily at hand to solve it.

Looking at the test solutions, I was on the right track, but stumbled when I reached a point where I could not easily isolate the *k* value from any form of the fin equation. By the time I was done reviewing calculus and algebra, I had run out of time to apply them to the equations before the test was due and had to turn in something that was incomplete.

Grade

For Problem 1, based on the provided rubric, I would give myself 55%. The layout of the problem matches what is expected by the rubric, and there is an effective summary and analysis for the answers I found, but the procedure and calculations were woefully incorrect. The point total would be 30.25 points.

For Problem 2, I was unable to even complete the basic steps of the problem, let alone the calculations. I am giving partial credit for the Procedure portion, as it was using the correct approach, but without correct calculations or any summary or analysis, I can only award 35% for a point total of 8.75.

The overall grade would then be 39/80, or 49%.

Discussion

This test turned out to be very difficult for me. Though there are no excuses for my performance, I was hindered by a very hectic stretch of normal life issues that greatly reduced the available time to study and work on the test. We are still in the process of moving my family more than 7 hours away, and for the 5 days this test was available, my desktop computer was packed in a truck and

unavailable to me. On top of that, managing both houses during the move, traveling between them multiple times, and limited access to the internet or even a desk resulted in only a single day to work on the test, while sitting on the floor with a laptop. My normal process for these kinds of assignments is a comfortable desk with multiple monitors and a work surface for sketches and handwriting equations.

Outside of the physical limitations, the test made me realize that my understanding of the material is more limited than I believed it to be. Even without the proper workstation, I should have been able to piece these problems together, especially Problem 2. Going forward, I will be working on more sample problems and making sure I understand all of the material well before the test is assigned. Finding more time for the next test will also be vital for me. I should no longer have the kinds of physical limitations I faced for this exam, and I plan to take full advantage of having access to my normal tools and work spaces from now on.

For this test, I learned many concepts regarding heat transfer, especially though convections. The fin equation and all the applications it has will be useful in my career as there are many practical examples using fins for transferring heat as well as industrial processes which must account for heat loss in processes like brazing and welding. My career thus far has been centered on tool and die and assembly manufacturing processes like injection molding. Heat transfer properties are key to the success of those processes and these concepts will be important if I plan to stay within that field.

I spent a total of about 6 hours on this test, all within the final Sunday of its availability. Unfortunately, I had no other time slot to work on the problems effectively, and even this slot was directly after an 8-hour drive after a short night of sleep, in a house with no furniture. Most of those circumstances have been listed already, and I take full responsibility for not finding more time to work on the assignment. For future tests, I will be setting aside more time and more appropriate places to work on the material. I underestimated the difficulty I would have on this test and therefore did not plan accordingly. My performance on the test has more than convinced me that I need to focus more in order to fully understand this material.