Test Reflection – Exam 3

The third exam asked us to solve a one dimensional, time dependent problem both analytically and numerically, using COMSOL, and compare the results. As outlined in class, the steps for solving such a problem included, deciding if the body was semi-infinite or not. If not, computing Biot number (in this case we had to guess an Lc value) and choosing the appropriate equation to solve for the slab length using the given parameters. Since Lc was not known and multiple variables were dependent on Lc, either directly or indirectly, once we knew the correct equation(s), we were to solve for the temperature at the center of the slab using an iteration process and interpolation. Once the central temperature was determined we were to calculate the temperature at the outside surface of the slab at the same given time.

Instead of guessing Lc and plugging numbers in to try, I decided to copy Table 5.1 from the notes into an excel spreadsheet and using the Biot number formula, calculating Lc of each corresponding Biot number, C_1 and ζ_1. Once the spreadsheet was made and values were calculated, it was clear that the Biot number was greater than .1, meaning I would use the one-term approximation formula for a plane wall. This equation is also in the above-mentioned spreadsheet. Reading from the spreadsheet, the answer was between Biot numbers of 6 and 7, and the Lc was between .2349 and .274 so interpolation was required. The interpolation yielded a Lc of 0.511m. This meant that the slab must be 0.511m in width to achieve the 95°C temperature at the center of the slab at t=8hours as given in the problem. The next step was to determine the temperature at the surface of the wall which was calculated as 178.34°C.

In comparison to the solution given, I did utilize the correct equations for both the central temperature of the slab and the outer surface of the slab. My solutions were slightly off from the given solutions. My calculated Lc was 0.511m while the given solution was 0.4944m, yielding a difference of 0.0166. My calculated surface temperature was 178.34°C while the given solution was 177.84°C, yielding a difference of 0.5°C. I believe that the slight discrepancies can be attributed to the fact that I used a different fluid density then the given solution used. The density came from a table in the book which gave a range for density for the given material and I chose a different value than was used in the solution.

In the second problem we were to solve the first problem using COMSOL. I did use the correct geometry and material values (except for the slight difference in density as mentioned above). I had a hard time getting the parametric sweep to function correctly, so I had to run the program multiple times using a different Lc each time until I achieved the correct value. I again came up with values of 0.51m for Lc and approximately 178°C for the surface temperature, matching what I had calculated in the first problem. Once again, my values were slightly off

from those in the given solution but could be explained by the difference in the density value used in calculation.

I can see where being able to determine figures such as these would be beneficial. The exam question is a perfect example. Various materials have different characteristics and thresholds when subjected to high temperatures. These equations, or software, are valuable for an engineer to determine what type of material to use or how thick a given material needs to be to withstand the type of temperatures in a given situation. It is good practice allow for a certain factor of safety which can be built in using these equations. It is also important to be able to pick the correct equation(s) to use for a given scenario, or else you could calculate misleading values. This class has helped me to understand the criteria to take into consideration when determining the correct equations and how to use those equations.

If I continue working where I do, I do not see myself using these types of equations and in-depth analysis of heat transfer, though it is good to know what is out there and how to use it if I ever do come across it. However, I do not know the future has in store for me, and I may wind up in another industry with a different employer and this material may be of value.

Writing	
Purpose	0.50
Drawings	0.60
Sources	0.50
Design Considerations	1.00
Data & Variables	0.50
Procedure	2.00
Calculations	2.00
Summary	0.40
Materials	0.50
Analysis	1.00
TOTAL	9.00
Problem 1	
Correct (T-Tinf)/(Ti-Tinf) Equation	1.00
Iteration Process	1.00
Assume L	1.00
Compute Biot	1.00
C1 and Ze1	1.00
Theta0	1.00
Temp at Surface	1.00
Final Result	1.00
TOTAL	8.00
Problem 2	
Geometry	1.00
Material Properties	1.00
BC	1.00
Initial Conditions	1.00
Iteration	0.80
Temp at surface	1.00
% Error	0.00
Final Result	1.00
TOTAL	6.80