ENGR 372L: Heat Transfer

Fall 2020 Computer Programming Assignment (worth 30% of the lab grade). No late work accepted. Email the script, hand in the below, and demonstrate in class. Due: 2:00 PM, Wednesday, October 21st

A) User Interface Requirements: Write a MATLAB program using Gauss-Seidel iteration to compute the temperature distribution in the 2D, SS plate with the B.C.'s shown. Allow the user to input the values of k, h_0, and the convergence criteria (be sure to tell the user the required units). Use a grid spacing of 1 mm in both directions. For each run allow the user to request the temperature of any specific nodes (this can be one at a time, but don't make the user re-run the program to get another node). For every run your program should output to the screen: the temperatures along the tips (6 values) and the bases (6 values) of the fin, the two values of q' (see parts ii. and iv. below), and the number of iterations. Be sure to give the user the opportunity to try different k and h_0 values without having to restart the program.

You must hand in hard copies of the below:

B) Every different nodal equation that you use. Be explicit. Include a diagram showing the numbering of your nodes, the groups of nodes with the same equation, and derivations when necessary. Provide an answer to the question: How many distinct nodal equations are there? Explain/show your answer.

C) Flow chart and explanation of the logic of your program, showing every step and computation.

D) Explicit run instructions/manual, including a node numbering system for the user. I should be able to give these instructions to anyone, even if they are unfamiliar with MATLAB, and they should be able to run your program. (Required, even if your program doesn't run.)

E) Values of the five temperatures for the nodes along the vertical tip for a convergence criteria of 0.01 C, k=1 W/mK, h_0=1 W/m^{2}K.

F) Determine the following:

i. For k=1 W/mK, h_0=1 W/m^{2}K, how many iterations are required for convergence criteria of 1 C, 0.1 C, 0.01 C, 0.001 C, 0.0001 C, and 0.00001 C?

ii. Determine an accurate value of the total heat transfer rate per unit width through the left wall surface for the following conditions:
k=10 W/mK, h_0=1 W/m^{2}K
k=1 W/mK, h_0=1 W/m^{2}K
k=0.1 W/mK, h_0=1 W/m^{2}K
k=10 W/mK, h_0=10 W/m^{2}K
k=1 W/mK, h_0=10 W/m^{2}K
k=0.1 W/mK, h_0=10 W/m^{2}K

iii. What temperature convergence criteria is required to get an accuracy of 0.1% for the q' for part ii) for k=1 W/mK, h_0=1 W/m^{2}K? (Do this by manually rerunning the program with different convergent criteria.) Explain why the percent accuracy of q' is different from the percent accuracy of the temperatures. Be quantitative.

iv. Determine an accurate value of the heat transfer rate per unit width of the total convecting surfaces for the six cases of part ii). Compare with your results from part ii). Explain.

A-D is 65 points.
E is 10 points.
F is 25 points.