**Finite Difference Heat Transfer Analysis Utilizing Gauss-Seidel Iteration in Matlab**

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Wednesday Lab

ENGR 372

Lab Report 3

Code:

B

C

D.) RUN INSTRUCTIONS

1.

2.

E.) Temperature Values of the Six Nodes along the Vertical Surfaces on the Tips of the Two Fins

|  |  |
| --- | --- |
| Convergence Criteria | 0.0001 ºC |
| Thermal Conductivity [k] | 1 W/mK |
| Convection Coefficient [h0] | 1 W/m2K |
| Top Corner of Upper Fin Tip | 347.4547 ºC |
| Center of Upper Fin Tip Temperature | 347.7748 ºC |
| Bottom Corner of Upper Fin Tip Temperature | 347.4543 ºC |
| Top Corner of Lower Fin Tip Temperature | 318.9116 ºC |
| Center of Lower Fin Tip Temperature | 319.2039 ºC |
| Bottom Corner of Lower Fin Tip Temperature | 318.9113 ºC |

F.) i.) For k = 1 W/mK and h0 = 1 W/m2K,

|  |  |
| --- | --- |
| Convergence Criteria | Number of Iterations |
| 1 ºC | 38 |
| 0.1 ºC | 275 |
| 0.01 ºC | 626 |
| 0.001 ºC | 980 |
| 0.0001 ºC | 1337 |
| 0.00001 ºC | 1696 |

ii.)

|  |  |  |
| --- | --- | --- |
| Thermal Conductivity [k] (W/mK) | Convection Coefficient [h0] (W/m2K) | Total Heat Transfer Rate per Unit Width Through Left Wall [q’] (W/m) |
| 10 | 1 |  |
| 1 | 1 |  |
| 0.1 | 1 |  |
| 10 | 10 |  |
| 1 | 10 |  |
| 0.1 | 10 |  |

iii.) Temperature convergence criteria required to get an accuracy of 0.1% for q’ when k=1 and h0=1.

iv.) Accurate value of heat transfer rate per unit width

A) Write 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 1mm 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)

🞎 The temperatures along the bases of the fin (6 values)

🞎 The two values of q’ (see parts ii. and iv.)

🞎 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

*Hand in hard copies of:*

🞎 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 (just show all the ones you did)

🞎 Provide an answer to the question:

🞎 How many distinct nodal equations are there?

🞎 Explain/show your answer.

🞎 C)

🞎 Flow chart

🞎 Explanation of logic

🞎 Show every step and computation –

🞎 D)

🞎 Explicit run instructions/manual

🞎 including a node numbering system for the user

🞎 should be able to give instructions to anyone and they can run it

🞎 E)

🞎 Values of the 6 temperatures for the nodes along the vertical surfaces on the tips of the two fins

🞎 for convergence criteria of 0.01 degrees C; k = 1 W/mK; h0 = 1 W/(m2k)

🞎 F)

🞎 Determine the following

🞎 i.) For k=1 W/mK, h\_0=1 W/(m2K) How many iterations are required for a convergence criteria of:

🞎 1 degrees C

🞎 0.1 degrees C

🞎 0.01 degrees C

🞎 0.001 degrees C

🞎 0.0001 degrees C

🞎 0.00001 degrees 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^2K

🞎 k=1 W/mK, h\_0 = 1 W/m^2K

🞎 k=0.1 W/mK, h\_0 = 1 W/m^2K

🞎 k=10 W/mK, h\_0 = 10 W/m^2K

🞎 k=1 W/mK, h\_0 = 10 W/m^2K

🞎 k=0.1 W/mK, h\_0 = 10 W/m^2K

🞎 iii.) What temperature convergence criteria is required to get an accuracy of 0.1% for the q’ in part 🞎 ii.) for k=1 W/mK, h0 = 1 W/m^2K

🞎 Do this by manually rerunning the program with different convergence 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)

🞎 k=10 W/mK, h\_0 = 1 W/m^2K

🞎 k=1 W/mK, h\_0 = 1 W/m^2K

🞎 k=0.1 W/mK, h\_0 = 1 W/m^2K

🞎 k=10 W/mK, h\_0 = 10 W/m^2K

🞎 k=1 W/mK, h\_0 = 10 W/m^2K

🞎 k=0.1 W/mK, h\_0 = 10 W/m^2K

🞎 Compare with your results from part ii.)

* + Explain