Mid semester examination: Part A Type: Open source
Time: 1 hr $\Rightarrow$ Additional permissible time (Including time for email and uploading): 10 minutes Total points: 60
Starting time: 4.30 PM Final submission time: 5.40 PM
Weightage of the examination: 10 % Date: February 19, 2022

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MEC015P1E
Computational Fluid Dynamics and Heat Transfer

- Exchange any idea or material with anyone including class mates, impersonation, plagiarism and any other sort of malpractices are strictly prohibited.
- Usual nomenclature followed in the lectures is applicable.
- Suitable assumption/s can be made if you feel the data is missing, but appropriately mention those in the answer booklet/scripts.
- There is only one question.

1. (60 points) Consider a plane slab which is finite in horizontal axial direction x, and infinitely long along vertical direction y and also along direction z which is perpendicular to both the x and y axes. The volumetric heat generation rate is q which is uniform and constant. A heat flux of q_{wL} is going out from the left end of the slab at $x = 0$ and its right end at $x = b$ is maintained at constant temperature T_R. Now, the need is to determine the steady state axial temperature distribution using the finite volume method (FVM).

   Consider that $q = 4 \times 10^5$ w/m^3, $q_{wL} = 10^4$ w/m^2, thermal conductivity $k = 10$ W m^{-1} °C^{-1}, density $\rho = 2000$ kg/m^3, specific heat $c = 1000$ W kg^{-1} °C^{-1}, $b = 0.1$ m and $T_R = 20$ °C.

   (a) Write down the governing equation and boundary conditions.

   (b) Write down the discretised algebraic equations and obtain the mathematical expressions for the coefficient and source terms for the interior and boundary control volumes.

   (c) Tabulate the grid generation data with proper units taking 11 control volumes where the nodes are equally spaced.

   (d) Tabulate the data for the coefficient matrix and source vector with proper units taking 11 control volumes where the nodes are equally spaced.

   (e) To perform the grid independent tests for spacial coordinates, obtain the temperature profile taking first 06 and then 11, 21 and 31 control volumes with equally spaced nodes, and plot and superimpose all the temperature profiles obtained with different no. of control volumes, in a single diagram.

   (f) Determine the heat flux q_R at $x = b$.

   (g) From temperature distribution you have obtained and plotted, estimate the location where the temperature is the highest and also estimate its magnitude.

Important instructions:

1. Derivation of mathematical formulations carried out in the lectures is not expected.
2. Scan the answer scripts, make a single pdf file keeping all the pages in portrait form and name the file as <WriteUp.pdf>.
3. Initiate the name of the main (computer program) executable file with <Main>.
4. It is advisable to put all the output results file in <ResultsFolder >and keep the pdf of the plot in this folder.
5. Keep everything into the main folder with a name <EntryNumber-MSA-CFDHT-NameStudent>. Compress the folder into zip file.
6. Please do email the zipped file to <cfdht.2022@gmail.com> within the stipulated time as mentioned earlier in the question paper.

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