Computational Heat & Fluid Flow (ME605)

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Assignment 2

Notes:

You have to submit a report, and it should comprise of following details for each problem

i) The grid details (with a neat sketch)
ii) Discretization details
iii) Boundary condition implementation details
iv) A well-documented working code
v) Required output (plots/any other means)
vi) Analysis of the results

Penalty: Copying and submitting the code written by someone else will incur a huge penalty

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1. Consider an insulated rod whose ends are maintained at constant temperatures of 200 ˚C and 600 ˚C respectively. There are no sources. Determine the steady-state temperature distribution in the rod using the finite volume method. Thermal conductivity k = 1000 W/m K, cross-section area A is 10×10^{-3} m^2 and the length of the rod is L = 0.5 m. Obtain an analytical solution and compare the numerical results with the analytical solution. Perform analysis with different arrangements of grid spacing (atleast 4) and provide the details in the report.
2. A large plate of thickness L = 4 cm with constant thermal conductivity k = 0.5 W/m K and uniform heat generation q = 1000 kW/m^3. The faces A (left face) and B (right face) are at temperatures of 200 ˚C and 400 ˚C, respectively. Assuming that the dimensions in the y- and z- directions are so large that the temperature gradients are significant in the x-direction only, calculate the steady-state temperature distribution using the finite volume method. Obtain an analytical solution and compare the numerical results with the analytical solution. Perform analysis with different arrangements of grid spacing (atleast 4) and provide the details in the report.
3. Consider a composite slab (1-D), as shown in Fig. 1 whose right end (B) has constant temperature 293 K and left end (A) is exposed to a hot fluid of temperature 1073 K. The

heat transfer coefficient is 25 W/m^2 K. The thermal conductivities are k_1 = 20 W/m K, k_2 = 1.5 W/m K, k_3 = 50 W/m K. Calculate the steady-state temperature distribution inside the slab using the finite volume method. You may consider choosing a grid size of 0.03 m (this is just a suggestion, and you may opt for different grid size). There are no sources. Compare the numerical results with the analytical solution

a) By considering arithmetic mean formulation with different arrangments for grid spacing.
b) By considering harmonic mean formulation with different arrangments for grid spacing.

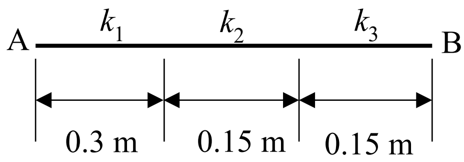

Fig. 1 Composite slab