Computational Heat & Fluid Flow (ME605)

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Assignment 2

Notes:

- For each problem, please provide: (i) the grid details (with a neat sketch) and discretization steps, (ii) the boundary condition implementation details, (iii) a well-documented code, (iv) the required output (plots/any other such means).
- If you are using one generalized code for problem-solving, please make sure the documenta tion/annotation in the code is clear, and be sure to point it out in your write-up.

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1. Consider an insulated rod whose ends are maintained at constant temperatures of 100 ˚C and 500 ˚C respectively. There are no sources. Determine the steady-state temperature distribution in the rod. 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.

   The analytical solution for this case is given by:

$$T = 800x + 100$$

2. A large plate of thickness L = 2 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 100 ˚C and 200 ˚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. Compare the numerical result with the analytical solution.

   The analytical solution for this case is given by:

$$T = \left[\frac{T_B - T_A}{L} + \frac{q}{2k}\left(L - x\right)\right]x + T_A$$

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. You may consider choosing a grid size of 0.03 m (this is just a suggestion and you may opt for different grid size). Compare the results with the analytical solution by

considering two different formulations for estimating interfacial thermal conductivity (arithmetic and harmonic mean). There are no sources.

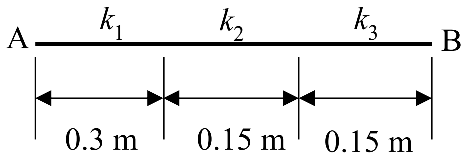

Fig. 1 Composite slab