Computational Heat & Fluid Flow (ME605)

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Assignment 2

Notes:

- All the problems are required to be solved using finite volume method
- For each problem, please provide: (i) the grid details, (ii) the boundary condition implementation details, (iii) a well-documented code, (iv) the required output (plots/any other such means).
- Items (i) and (ii) above should be written out on a separate sheet and attached before items (iii) and (iv).
- If you are using one generalized code for problem solving, please make sure the documentation/annotation in the code is clear, and be sure to point it out in your write-up.

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1. 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 and discuss the results by considering three different arrangements of grids.

   The analytical solution for this case is given by:

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

2. Consider an annular fin put on a tube (of outer radius $r_1 = 1.25$ cm) as shown in Fig. 1. The fin is made from two materials. The inner material has radius $r_2 = 2.5$ cm and conductivity $k_2 = 200$ W/m K and the outer material extends to radius $r_3 = 3.75$ cm and has conductivity $k_3 = 40$ W/m K. The fin-thickness $t = 1$mm. The tube wall (and hence the fin base) temperature is $T_0 = 200$ ˚C. The fin experiences heat transfer coefficient $h = 20$ W/m^2 K and the ambient temperature is $T_\infty = 25$ ˚C. Assuming conduction to be radial

   a. Using 8 number of grids obtain the temperature distribution in the fin. Explain the results.

b. Obtain results for three different grid arrangements of grids (N =8, 16 and 32). Explain the results.

c. Estimate the heat loss from the fin and effectiveness. Neglect heat loss from the fin tip.

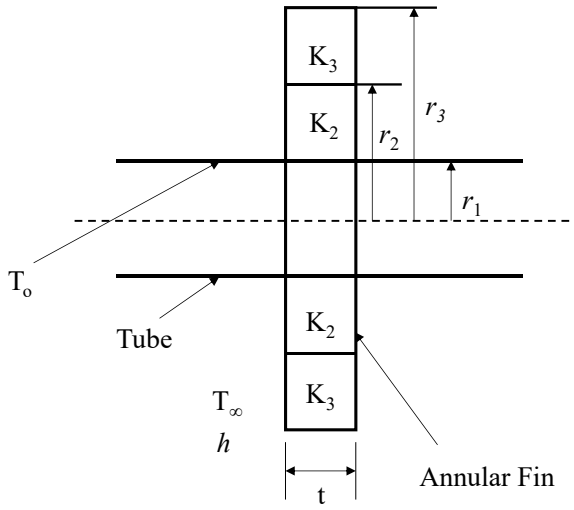

Figure 1 Annular fin of composite material