

Indian Institute of Technology Kanpur
Department of Mechanical Engineering

ME630A

Instructor: Prof. S. Sarkar

Computer Assignment #4

Due Date: 21.10.2015

Note: Attach a CD containing your computer program to the report. Please submit in time.

1. A rectangular fin 2.0 mm thick and 10 cm long protrudes from a wall. The base is maintained at 250°C, and the ambient temperature is 25°C with $h = 25 \text{ W/m}^2 \text{ K}$. The tip of the fin is losing heat by convection with $h_g = 10 \text{ W/m}^2 \text{ K}$. The width of the fin is 0.5 m. Assuming 1D steady state heat conduction, formulate the problem by the difference method. Solve the final set of linear algebraic equations by TDMA. Obtain the following,

- (i) Calculate the dimensionless fin temperature distribution (Θ vs. X) if the fin material is: (a) Aluminum ($k = 237 \text{ W/mK}$) (b) Stainless steel ($k = 17 \text{ W/mK}$) and (c) Glass ($k = 0.8 \text{ W/mK}$).
- (ii) Compare your results with the analytical solution enclosed with this assignment.
- (iii) Compare graphically the dimensional numerical temperature distributions for aluminum, stainless steel and glass fins, and show the corresponding heat loss computed numerically and analytically in a tabular form.

Analytical Solution of the Fin Temperature Distribution and heat loss

Temperature Distribution

$$\frac{T - T_\infty}{T_0 - T_\infty} = \frac{\cosh m(L - x) + \left(\frac{h_g}{mk}\right) \sinh m(L - x)}{\cosh mL + \left(\frac{h_g}{mk}\right) \sinh mL}$$

Heat Loss

$$q = -kA \left. \frac{dT}{dx} \right|_{x=0} = mkA(T_0 - T_\infty) \frac{\frac{h_g}{mk} + \tanh mL}{1 + \frac{h_g}{mk} \tanh mL}$$

Note: Each figure and table must be captioned and numbered such as Fig.1, Table 1 and so on. Every page of the report must be numbered. The report must have a title page, with name and roll no. Submit the report in a file. The name of the program should be Assn.no-problem no_your surname.file extension (suppose, Assn1-prob2_xyz.for). Write this file name on the top right hand corner of the report.

Your report must show the following in the order in which they are listed below,

- (a) Sketch of the computational domain.
- (b) Problem formulation (governing differential equation, boundary conditions, non-dimensionalisation)
- (c) Discretization (at interior and boundary points)
- (d) Final set of finite-difference equations
- (e) Numerical method of solution
- (f) Grid independence test in a graphical form for each fin material (indicate the number of grid points used to get the final solution)
- (g) Results as indicated in (i), (ii), (iii) above.

Attachments:

- A hard copy of the computer program and output (T vs. X). The output should print the temperature distribution and heat loss with two-decimal digit accuracy, along with clear heading for easy understanding.
- Electronic copy of the computer program on a CD.

Note: Submit full report for either Assignment #4 or Assignment #5.