

NEEP 602 -- Engineering Problem Solving II
Homework 4 – Part 2
Due Thursday March 31

10. Triangular Cooling Fin Design (20 points)

The steady-state temperature distribution in a triangular-cross-section cooling fin as shown in the figure is given by the following differential equation, written in terms of nondimensional variables:

$$(1 - \eta) \frac{d^2 \theta}{d\eta^2} + \frac{d\theta}{d\eta} - M^2 \theta = 0$$

in which

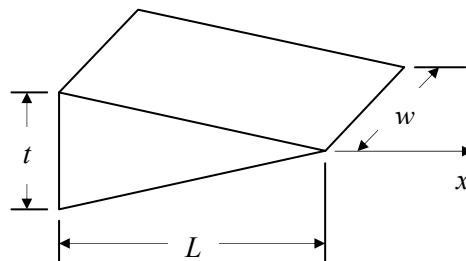
$$\eta = x/L \quad \theta(\eta) = \frac{T(\eta) - T_\infty}{T_b - T_\infty} \quad M^2 = \frac{2hL^2}{kt} \sqrt{1 + \left(\frac{t}{2L}\right)^2}$$

and where T_b is the temperature at the base of the fin, T_∞ is the temperature of the surrounding air, h is the heat transfer coefficient, and k is the thermal conductivity of the fin material. For our case, $t/w \ll 1$.

The boundary conditions are

$$\theta(0) = 1 \quad \text{and} \quad \frac{d\theta}{d\eta}(1) = 0$$

meaning simply that $T(0) = T_b$, the temperature at the base of the fin, and at the end of the fin the temperature gradient is zero, i.e., the heat transfer is negligible there.



If we need to dissipate 52 W to cool an electronic circuit, determine the size and number of cooling fins required. The square circuit board is 75 mm on a side, and the fins should run the length of the board and be spaced so that the distance between them is not less than the thickness t . The maximum base temperature is 40 C and the ambient temperature is 20 C. The fins are aluminum with a thermal conductivity of 200 W/m-K. For the heat transfer coefficient, use 350 W/m²-K. After solving for the temperature distribution in a fin, we can calculate the total heat dissipated by integrating the heat flux along the length of the fin. The local heat flux out of a differential element is $Q = h(T - T_\infty)dA_{surface}$. Due to packaging constraints, the length of the fins L cannot exceed 25mm. You may use either Excel or Matlab. Write a brief (approximately half page) discussion of your results.