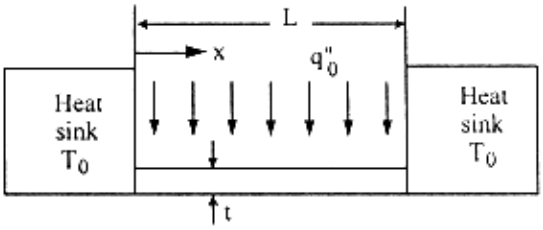
1 Prove that the heat flux is constant for one-dimensional steady-state condition without heat source in a Cartesian coordinate system. (10%)

2. A thin flat plate of length L, thickness t, and width W >> L is thermally joined to two large heat sinks that are maintained at a temperature T_0. The bottom of the plate is well insulated, while the net heat flux to the top surface of the plate is known to have a uniform value of q''_0.



(a) Derive the differential equation that determines the steady-state temperature distribution T(x) in the plate. (13%)

(b) Solve the foregoing equation for the temperature distribution , and obtain an expression for the rate of heat transfer from the plate to the sink. (12%)

3. The truncated hollow cone shown in Fig. 3 is used in laser-cooling applications and is constructed of copper with a thickness of 0.5 mm. Calculate the thermal resistance for one-dimensional heat flow. What would be the heat transfer for a temperature difference of 300℃? (12 %)

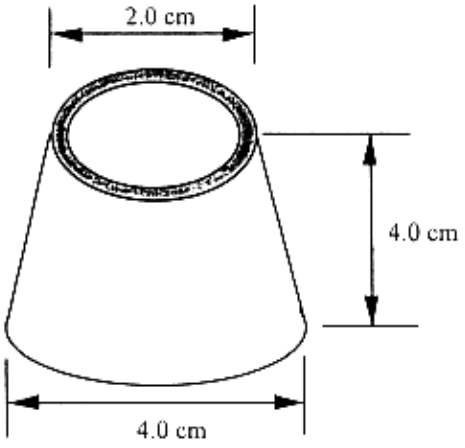


Fig. 3

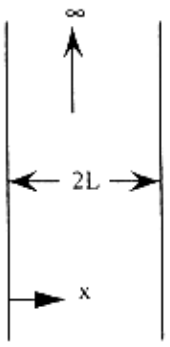


Fig. 4

4. Consider a 1-D transient problem, shown in Fig. 4.

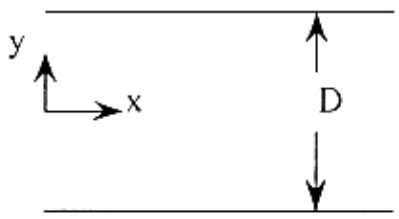
$t = 0, \quad 0 \le x \le 2L\ 0, \quad T = T_i; \quad t > 0, \quad x = 0, T = T_1, \quad x = 2L, T = T_1$

Find the temperature solution with the separation-of-variable method. (16%)

5. Consider heat transfer of a laminar tube flow of a parallel plate duct (fully-developed).

(a) Derive the expression of velocity distribution. (12%)

(b) Derive the expression of Nu (= hD/k) for the case of constant wall heat flux. (13%)



6. Answer the following questions. (12%)

(1) What are the differences between heat transfer and thermodynamics?

(2) What is the Boussineq approximation?