ME 24-731
Conduction and Radiation Heat Transfer

Assignment No: 5
Due Date: March 21, 2000
Spring 2000
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1. Consider 2-D unsteady constant-property conduction in a square domain of side L. There is no heat generation. The initial condition is $T(x,y,0) = T_i$, where T_i is a constant. At t=0, the left, right and bottom walls are set to $T = 0$, and the top wall is set at $T = T_1$, where T_1 is a constant. We had done a partial solution for this problem in class. Complete the derivation for obtaining $T(x,y,t)$.

2. Consider a body at an initial temperature T_i plunged into a bath of water at temperature T_∞. The body has a mass m, a surface area A, a volume V, a density ρ and a specific heat C. It transfers heat to the bath through a constant heat transfer coefficient h. T_i is a constant. However, the bath temperature T_∞ is a function of time, and is given by

   $$T_\infty = T_i + At$$

   where A is a constant. Assuming that the body can be analyzed using a lumped capacitance model, use Duhamel's superposition integral to derive an expression for the variation of the body temperature with time.

3. Consider the unsteady counterpart of Problem 4 in Assignment 4. The initial condition is T(x,y,0)=500 K. At t=0, the boundary conditions shown below are applied, and the source term is turned on as well. Assume the density of the body is 1000 kg/m^3 and its specific heat capacity is 1000 J/kg K. Extend your computer program from Assignment 4 to compute the unsteady temperature variation of the body. Perform 10 time steps at a time step Δt= 1000 seconds, using the same 20×20 mesh. At the end of ten time steps, plot the temperature on the vertical and horizontal centerlines. Use the fully implicit scheme.

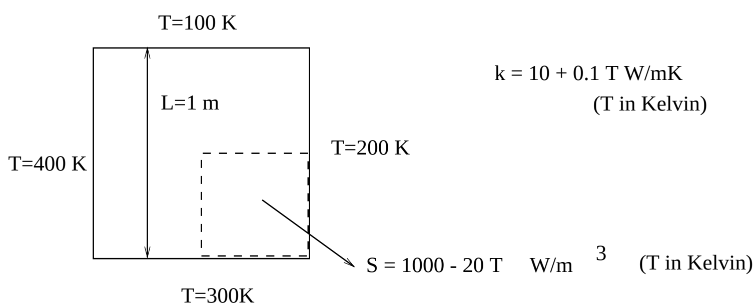

Figure 1: Domain for Problem 3