3. Update temperatures T_t, T_u, T_k, and T_v of intersection points t, u, k, and v by employing the interpolation method of Equation (18-28c). Note that the temperatures at vertices (T_i, T_d, T_a, T_b, and T_g) are now the updated values as provided from Step 2 and are not their original values.
4. Steps 1 through 3 are repeated until the temperature distribution along the boundary is converged.

(iv) Once the convergence of the temperature distribution on the boundary has been achieved (i.e., T_i, T_d, T_a, T_b, and T_g), the temperature of the control points on the boundary triangles are updated by utilizing the method described by Equation (18-14).

This step completes the solution algorithm for both the interior and boundary elements. Now the scheme is used to solve the heat conduction equation within the rectangular domain described in Section 3.7. Recall that the domain is a 3.5 ft by 3.5 ft rectangular bar with thermal diffusivity of 0.645 ft^2/hr. In addition to the boundary conditions specified in Section 3.7, which are of Dirichlet type and will be referred to as Case (a), a second set of boundary conditions is specified as Case (b). For this case, the boundary conditions along edges $x = 3.5$ and $y = 3.5$ are specified as inflow heat flux and are given by $q(3.5, y) = -10,000\,\text{Btu/hr ft}^2$ and $q(x, 3.5) = -10,000\,\text{Btu/hr ft}^2$.

T(x,0)=200
T(0,y)=200
T(x,h)=0
T(b,y)=0

Solution begins with triangulation of the domain. For this application, the domain is discretized into 2450 triangles, as shown in Figure 18-6. The time step for the explicit formulation given by (18-18) is selected as ~~0.01~~ hr. The temperature contours for Case (a) are shown in Figures 18-7 and 18-8, which correspond to time levels of 0.1 and 0.4 hrs, respectively.

!!
$\Delta t = 0.001$

The solution is also provided in tabular form in Tables 18-1 and 18-2. These solutions can easily be compared to the solutions provided in Tables 3-7 and 3-8, obtained by a finite difference method. The temperature contours for Case (b) are shown in Figures 18-9 and 18-10 for the time levels of 0.1 and 0.4 hrs, respectively. The temperatures are listed in Tables 18-3 and 18-4 for the corresponding time levels. Note that the values of temperature at the two sides imposed by the heat flux boundary condition increase with time in order to maintain the constant heat flux specified.

An important consideration with regard to the solutions given in Tables 18-3 and 18-4 is as follows. If one evaluates the heat flux based on the computed values of temperature, a value slightly different from that imposed by the boundary condition is obtained! For example, heat flux at point (1.0,3.5) can be calculated according to

$$q = -35\left(\frac{227.4 - 198.99}{3.5 - 3.4}\right) = -9,982\,\text{Btu/hr ft}^2$$

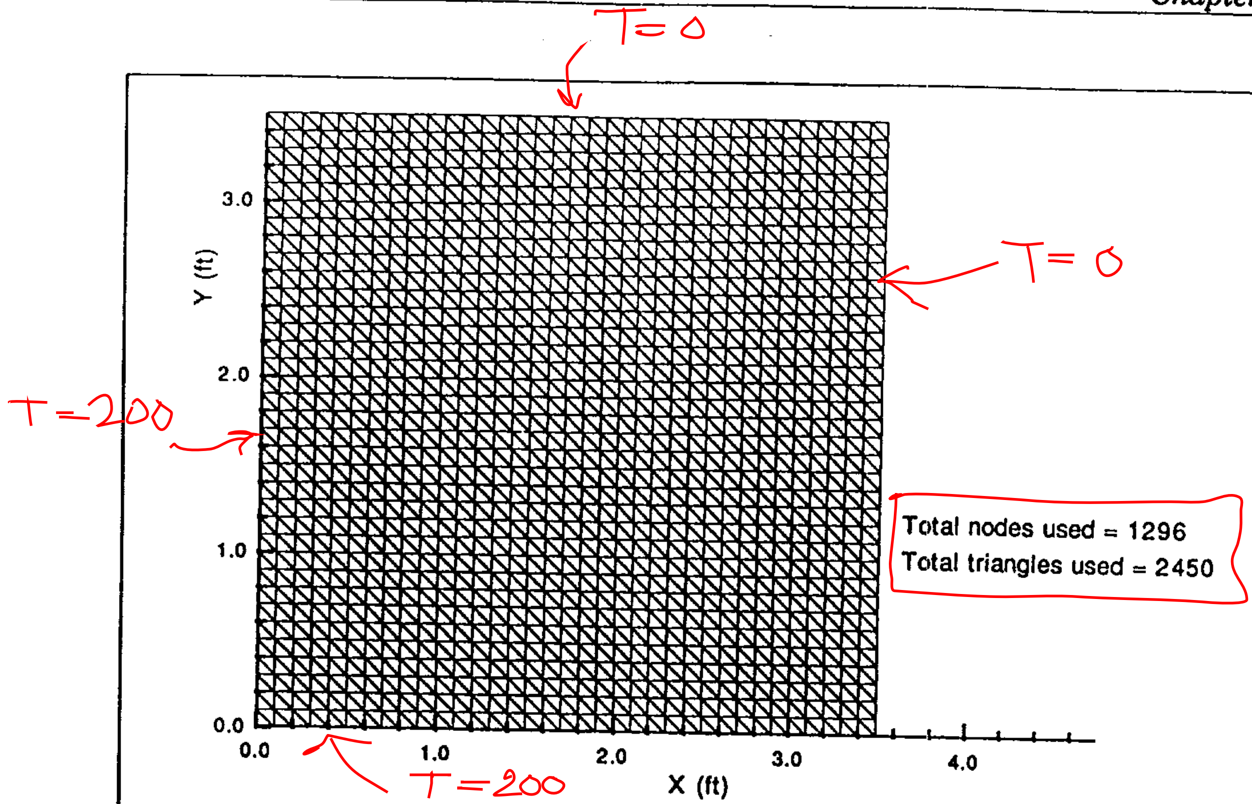

Figure 18-6. The domain of solution and the triangular grid system.

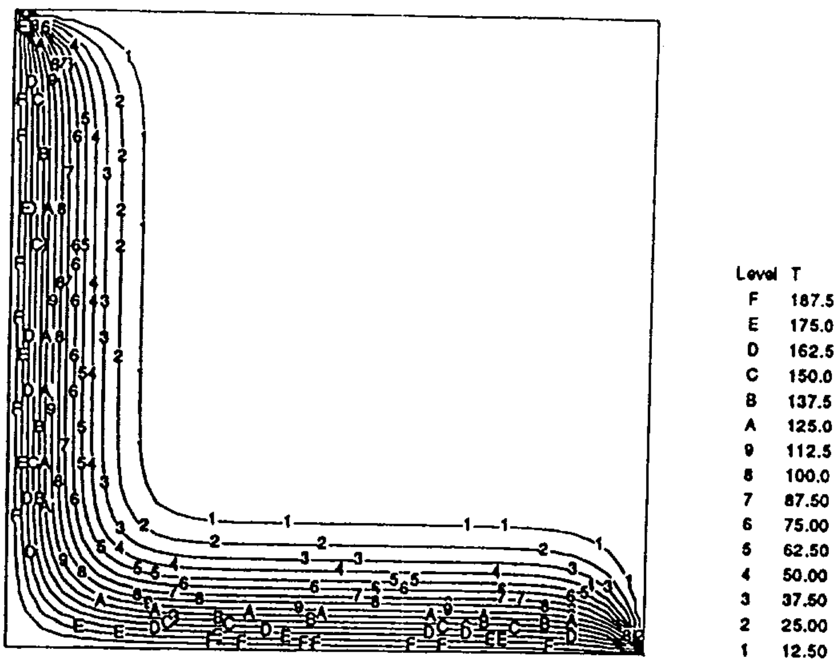

Figure 18-7. Temperature contours at time level of 0.1 hr for Case (a).

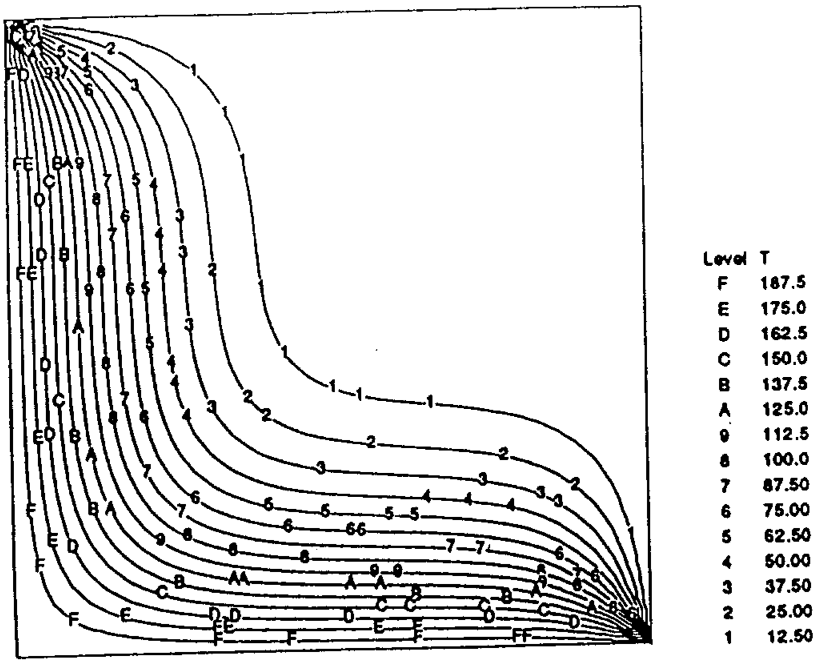

Figure 18-8. Temperature contours at time level of 0.4 hr for Case (a).

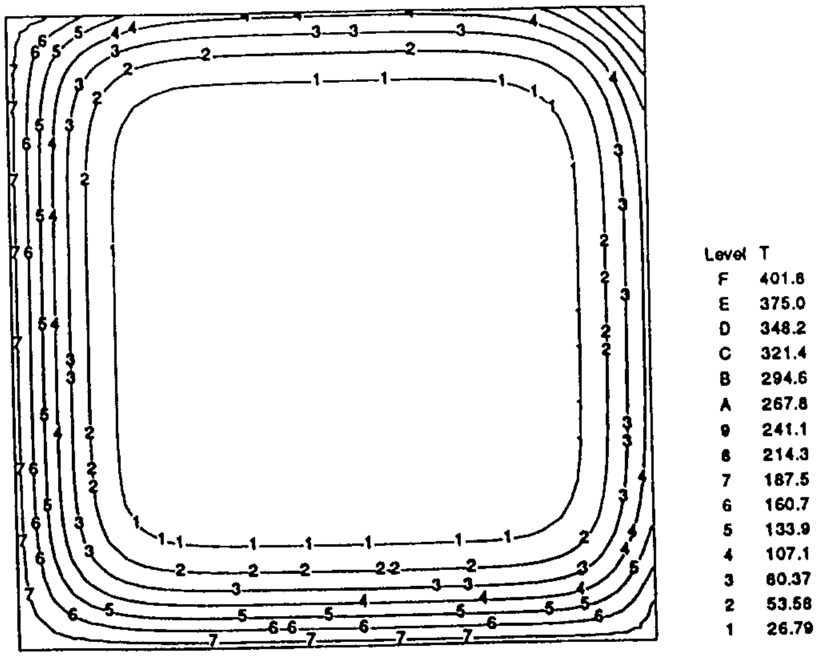

Figure 18-9. Temperature contours at time level 0.1 hr for Case (b).