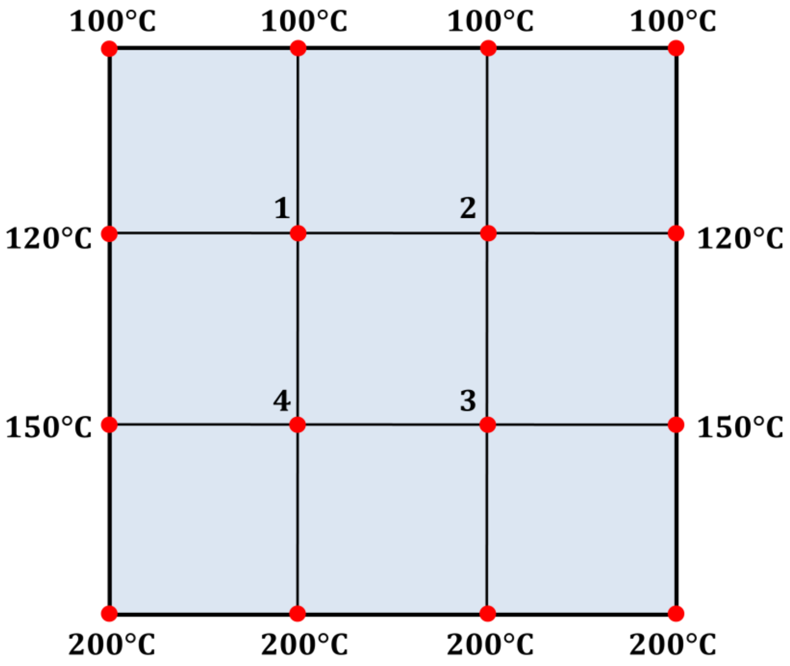
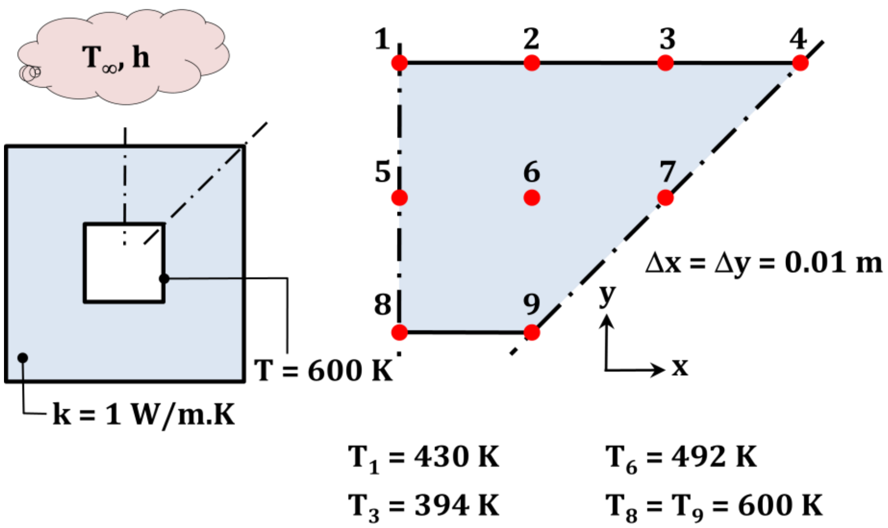
1. Consider steady two-dimensional heat transfer in a long solid body whose cross section is given in the figure. The temperatures at the selected nodes and the thermal conditions on the boundaries are as shown. The thermal conductivity of the body is $k = 180\ W/m\,°C$. Using the finite difference method with a mesh size of $\Delta x = \Delta y = 10$ cm, determine the temperatures at nodes 1, 2, 3, and 4.



2. Consider the square channel shown in the sketch operating under steady state conditions. The inner surface of the channel is at a uniform temperature of 600 K, while the outer surface is exposed to convection with a fluid at 300 K and a convection coefficient of $50\ W/m^2\,°C$. From a symmetrical element of the channel, a two dimensional grid has been constructed and the nodes labeled. The temperatures for nodes 1, 3, 6, 8 and 9 are identified. Determine the temperatures T_2, T_4 and T_7. Also, determine the heat rate per unit length normal to the page from the channel to the outside fluid.

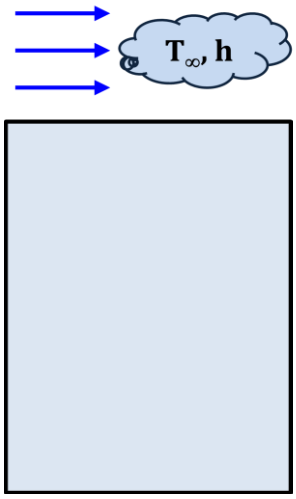


3. A long bar of rectangular cross section is 60 mm by 90 mm on a side and has thermal conductivity of $1\ W/m.°C$. One surface is exposed to a convection process with air at $100°C$ and a convection coefficient of $100\ W/m^2.°C$, while the remaining surfaces are maintained at $50°C$.

   (a) Derive the difference equations for unknown nodes.

   (b) Determine the unknown nodal temperatures using Gauss-Seidel method with relative error of 0.02, with using a grid spacing of 30 mm.

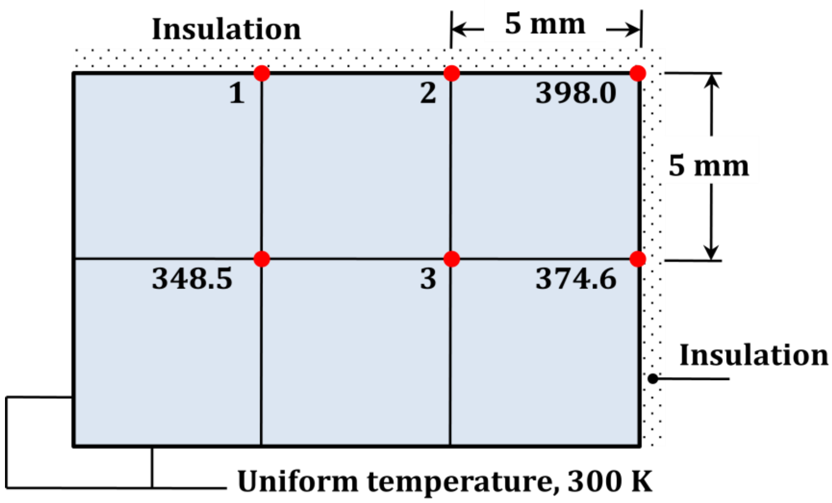
   (c) Determine the heat rate per unit length normal to the page into the bar from the air.



4. Steady-state temperatures (K) at three nodal points of a long rectangular rod are as shown. The rod experiences a uniform volumetric generation rate of $5 * 10^7\ W/m^3$ and has a thermal conductivity of 20 W/m.K. Two of its sides are maintained at a constant temperature of 300 K, while the others are insulated.

   (a) Derive the difference equations for unknown nodes.

   (b) Determine the temperatures at nodes 1, 2, and 3.



5. **Steady-state temperatures at selected nodal points of the symmetrical section of a flow channel are known to be $T_2 = 95.47°C$, $T_3 = 117.3°C$, $T_5 = 79.79°C$, $T_6 = 77.29°C$, $T_8 = 87.28°C$, and $T_{10} = 77.65°C$. The wall experiences uniform volumetric heat generation of $10^6\ W/m^3$ and has a thermal conductivity of $k = 10\ W/m.°C$. The inner and outer surfaces of the channel experience convection with fluid temperatures of $T_{\infty,i} = 50°C$ and $T_{\infty,o} = 25°C$ and convection coefficients of $h_i = 500\ W/m^2.°C$ and $h_o = 250\ W/m^2.°C$.**
   (a) Determine the temperatures at nodes 1, 4, 7, and 9.
   (b) Calculate the heat rate per unit length from the outer surface A to the adjacent fluid.
   (c) Calculate the heat rate per unit length from the inner fluid to surface B.