SIMUTECH CHT PROJECT

Assignment 5

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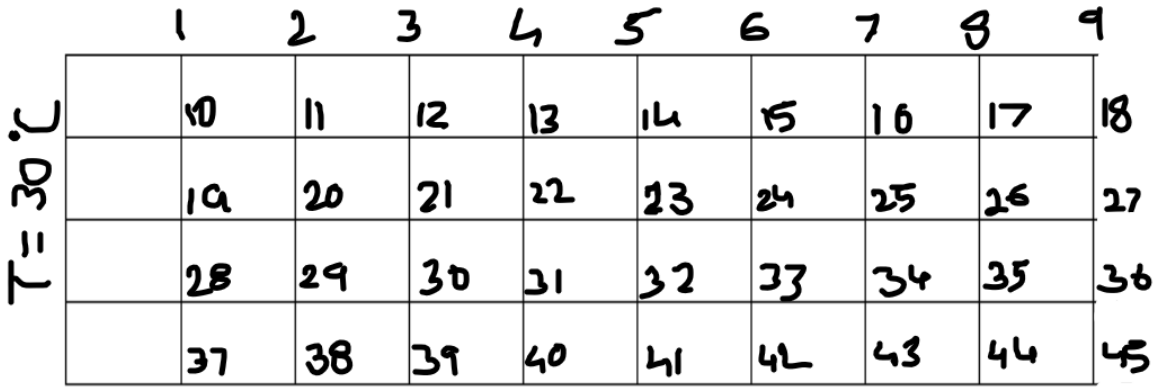
Theory

Equation for steady state heat conduction:

$$\partial Q_{cond,left}/\partial t + \partial Q_{cond,right}/\partial t + \partial Q_{cond,top}/\partial t + \partial Q_{cond,bottom}/\partial t + \partial E_{gen,element}/\partial t = \Delta E/\Delta t = \rho V_{element} c_p \partial T/\partial t$$

Applying this equation to different nodes of the following temperature grid (10×5) nodes:

(Temperature for 5 left nodes is already given to be 303K)



For Top node:

$$\partial T_{i,j}/\partial t = h\Delta x(T_\infty - T_{i,j}) + k\Delta x(T_{i+1,j} - T_{i,j})/\Delta y + k\Delta y(T_{i,j-1} - T_{i,j})/2\Delta x + k\Delta y(T_{i,j+1} - T_{i,j})/2\Delta x$$

Similarly for bottom node:

$$\partial T_{i,j}/\partial t = h\Delta x(T_\infty - T_{i,j}) + k\Delta x(T_{i-1,j} - T_{i,j})/\Delta y + k\Delta y(T_{i,j-1} - T_{i,j})/2\Delta x + k\Delta y(T_{i,j+1} - T_{i,j})/2\Delta x$$

For interior node:

$$\partial T_{i,j}/\partial t = (T_{i-1,j} - 2T_{i,j} + T_{i+1,j})/(\Delta x)^2 + (T_{i,j-1} - 2T_{i,j} + T_{i,j+1})/(\Delta y)^2$$

For the right node, except for the corner, the insulated boundary can be taken as a mirror and the node becomes an interior node with the left and right node temperatures to be the same. So the equation becomes:

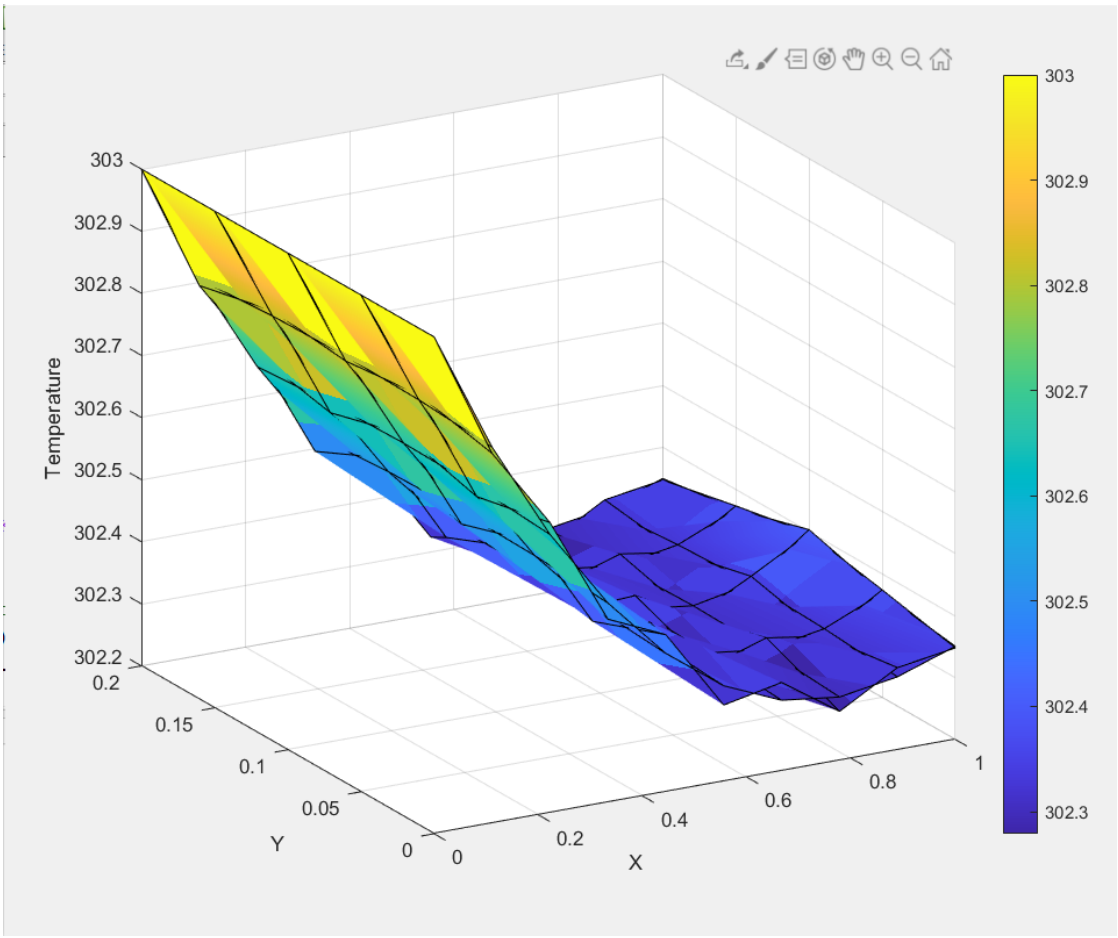
$$\partial T_{i,j}/\partial t = (2T_{i-1,j} - 2T_{i,j})/(\Delta x)^2 + (T_{i,j-1} - 2T_{i,j} + T_{i,j+1})/(\Delta y)^2$$

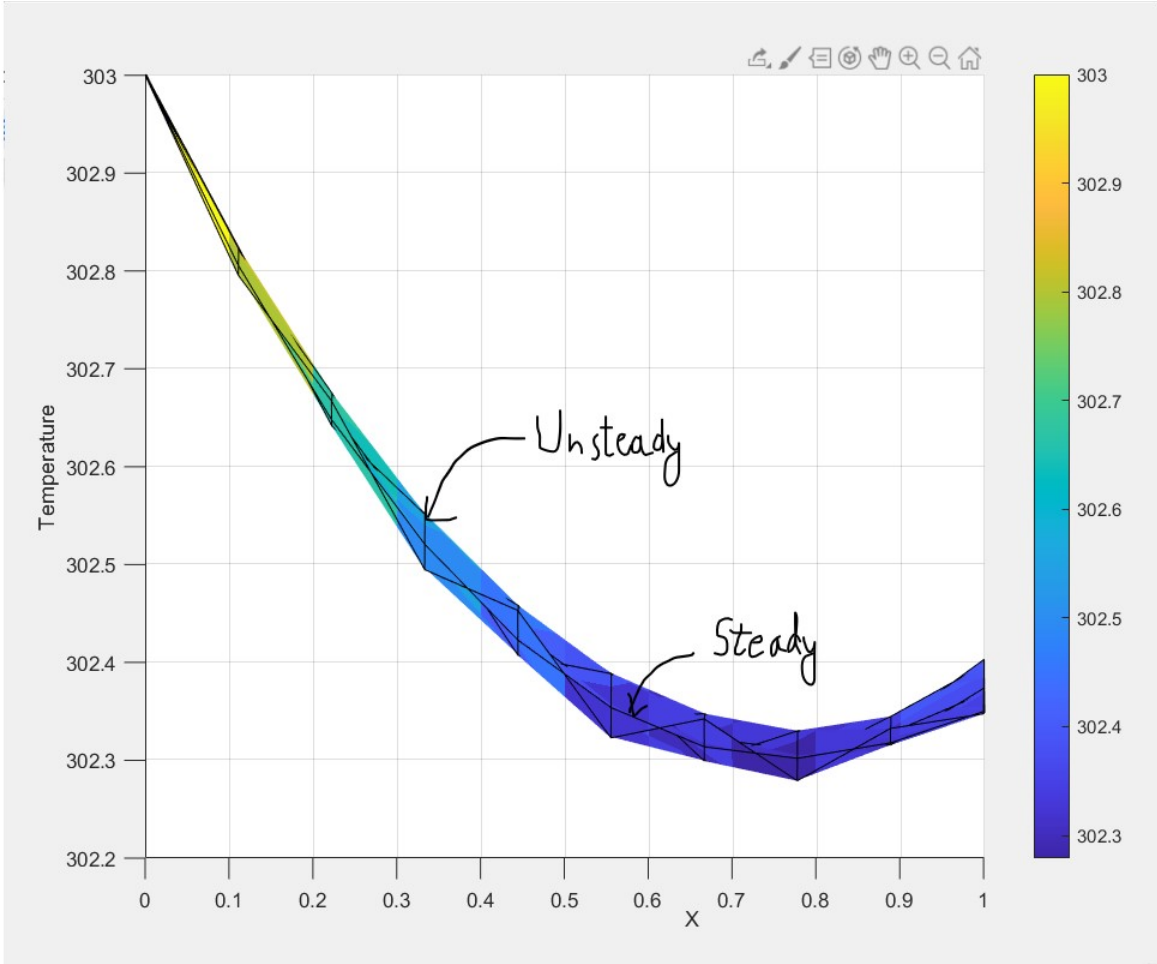
For the right top and bottom corners:

$$\partial T_{i,j}/\partial t = (h\Delta x(T_{\infty} - T_{i,j}) + k\Delta x(T_{i+1,j} - T_{i,j})/\Delta y + k\Delta y(T_{i,j-1} - T_{i,j})/\Delta x)/2$$

Result

2D Temperature plot:




303
302.9
302.8
302.7
302.6
302.5
302.4
302.3
302.2
Temperature
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
X
Unsteady
Steady
303
302.9
302.8
302.7
302.6
302.5
302.4
302.3