City University
School of Engineering and Mathematical Sciences
ME2111_PRD1_A_2014-15

2D unsteady heat conduction and advection

We want to solve the heat transfer equation on a plate,

$$\frac{\partial T}{\partial t} + u\frac{\partial T}{\partial x} = \propto \frac{\partial^2 T}{\partial x^2} + \beta\frac{\partial^2 T}{\partial y^2}$$

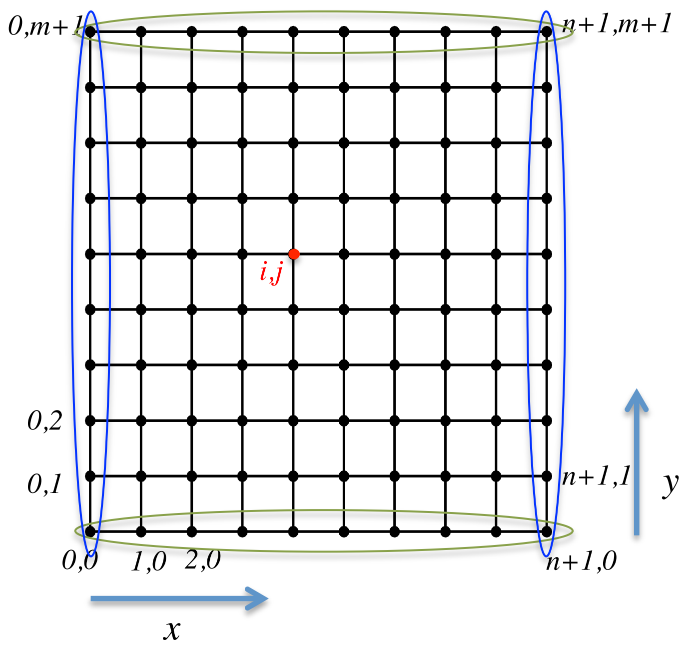
The plate is $2m$ long and $1m$ wide. At initial time the plate has zero temperature.

Convective velocity is given by $u = \frac{y(1-y)}{2}\ m/s$.

The boundary conditions are

$$\begin{cases} \dfrac{\partial T}{\partial y} = 0 & y = 0\ m \\ \dfrac{\partial T}{\partial x} = 0 & x = 2\ m \\ \dfrac{\partial T}{\partial y} = 0 & y = 1\ m \end{cases}$$

At the inlet $x = 0\ m$, temperature changes in time $T = 20\sin\left(\frac{\pi t}{2}\right)$ until 2 seconds and after that temperature stays at $T = 0$.



The thermal diffusivity constant is equal to $\alpha = \beta = 0.05\ m^2/s$ in both directions. The default grid spacing is $\Delta x = \Delta y = \ 0.02\ m$, and the default time step is $\Delta t = 0.02\ s$.

Here you are asked to write a code to solve this problem with implicit central difference Euler scheme. You must use your own linear system solver (iterative solver developed in CW1).

You need to provide a zipped folder that contains all functions necessary for coding in addition to a main script which is the interface that runs the whole simulation (you must load variables in this script and do not ask user to load them). All coding needs to be explained by appropriate comments. Also, you must provide a PDF file, which contains the following results and discussions.

1) Draw the distribution of T on the plate at following times using default setups: $t = 0, 1, 2, 5, 10\ s$. Discuss the results.
2) Discuss the sensitivity of the results at $t = 10\ s$ to grid resolution ($\Delta x = \Delta y = \ 0.1{,}0.02{,}0.01\ m$).
3) Discuss the sensitivity of the results at $t = 10\ s$ to thermal diffusivity ($\alpha = \beta = 0.05, 0.01, m^2/s$.

The total mark is divided into the group report you submit before April 10th at 11 pm and individual oral presentation of your work. The details of the groups and the time schedule for presentations will be given in the class.