Introduction to Computational Fluid Dynamics: Coursework 1

Due date: see Blackboard

Before the submission deadline, you should submit a pdf file containing all your answers to all the questions in order, together with the source code (such as Matlab `.m`) files that you used to answer the questions. Make your submission on Blackboard. Do not format your pdf file as a report, just answer the questions in order. Your pdf should be a self-contained document and it should not be necessary to look at the Matlab files to mark the coursework (they are provided to give partial credit in case of errors). It is not necessary to provide an abstract/introduction/conclusion *etc.*

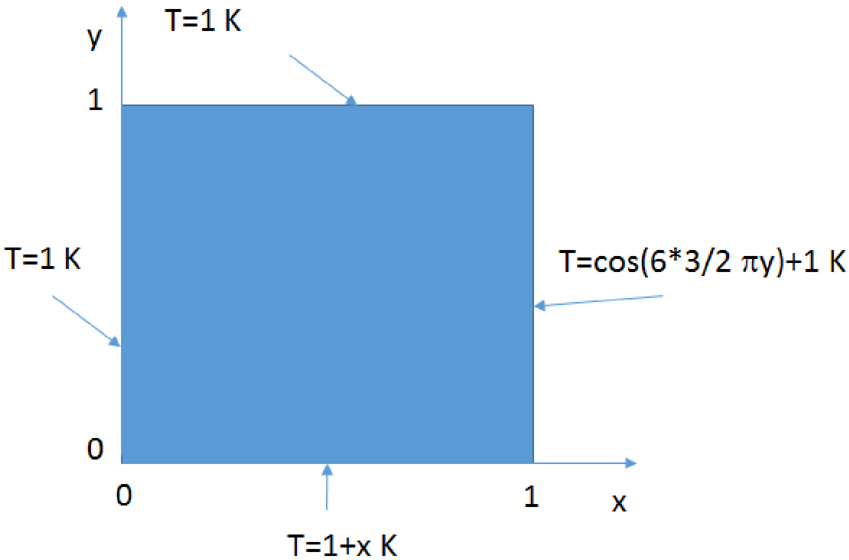
1. The Laplace equation models the heat conduction and is defined as

$$\nabla^2 T = 0 \tag{1}$$

   (a) Discretise equation (1) in one dimension using a centered approximation.

   (b) The domain is a square in the region $0 \leq x \leq 1$, $0 \leq y \leq 1$ what boundary conditions are needed/possible on the edges? Justify your answer.

   (c) Use TWO numerical schemes to discretize your equation and solve the PDE assuming the following boundary conditions $T = 1@x = 0$, $T = cos(6 * \frac{3}{2}\pi y) + 1@x = 1$, $T = 1@y = 1$. $T = (1 + x)@y = 0$. In the domain there is a point at $T = 1.5$ located at $x = 0.5, y = 0.5$ and one $T = 0.5$ located at $x = 0.2, y = 0.2$. Discuss the advantage of one scheme against the other and plot the iso-contours of the two dimensional thermal field in both cases.



(d) Using the same boundary conditions of question c, plot ϵ_{max} versus Δx on a set of log-log axes and comment on the form of the plot. Mesh with Δx=Δy, at least 3 different mesh sizes. Explain how you have decided the minimum Δx=Δy of your computational domain