University of Dhaka
Department of Nuclear Engineering
3rd Year 2nd Semester B.Sc. (Engg.) 2023
Course Code: NE-3204
MATLAB+LabVIEW
Assignment, Submission Date: September 17, 2023

Time: N/a Full Marks: 30

Answer all questions

1. Solve the following generic diffusion equation on the dummy variable ξ,

$$\frac{\partial \xi}{\partial t} + \frac{\partial^2 \xi}{\partial x^2}(x, y) + \frac{\partial^2 \xi}{\partial y^2}(x, y) = 0,$$

in a 2D Cartesian coordinate system using FDM for

(a) steady-state and **(10)**

(b) transient. **(20)**

If it isn't obvious enough, drop the temporal term for steady-state. Both the steady-state and the transient cases should produce the same solution (after you've run the transient simulation for 'some time', that is).

See Fig. (1) for domain definition.

Use forward differencing in time and central differencing in space,

$$\frac{\partial \xi}{\partial t} = \frac{\Xi_{i,j}^{n+1} - \Xi_{i,j}^{n}}{\Delta t},$$
$$\frac{\partial^2 \xi}{\partial x^2} = \frac{\Xi_{i+1,j}^{n} - 2\Xi_{i,j}^{n} + \Xi_{i-1,j}^{n}}{(\Delta x)^2},$$
$$\frac{\partial^2 \xi}{\partial y^2} = \frac{\Xi_{i,j+1}^{n} - 2\Xi_{i,j}^{n} + \Xi_{i,j-1}^{n}}{(\Delta y)^2},$$

and solve for $\Xi_{i,j}^{n+1}$.

I am setting a Dirichlet boundary condition. Heed the indexing paradigm for discretization; see Fig. (2).

Write iterative solvers based on: (i) Jacobi, (ii) Gauss–Seidel, and (iii) SOR. Compare your solver solutions and make comments.

Set your convergence criterion based on absolute or relative error (or Euclidean/ℓ_2 norm or anything else).

You are advised to present your results in contour/colormap plots.

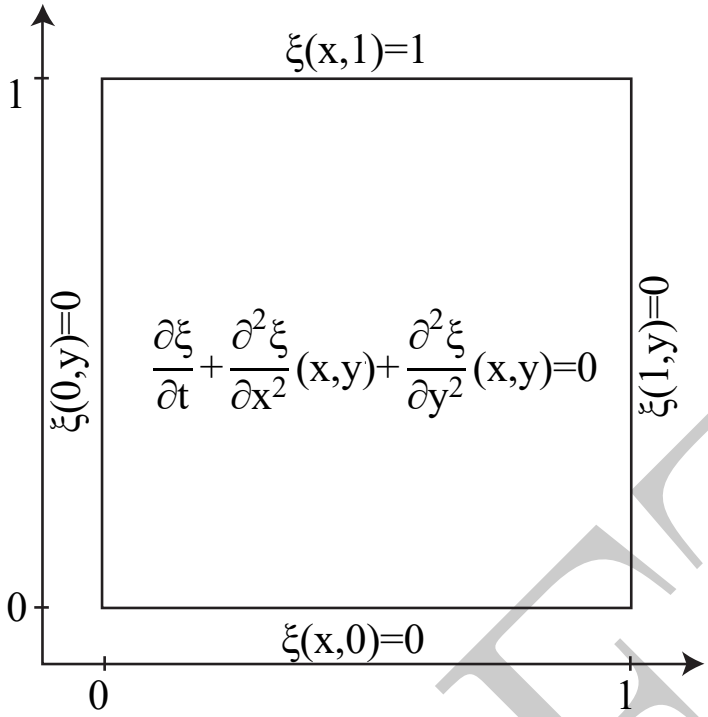

Figure 1: The problem domain with Dirichlet BC.

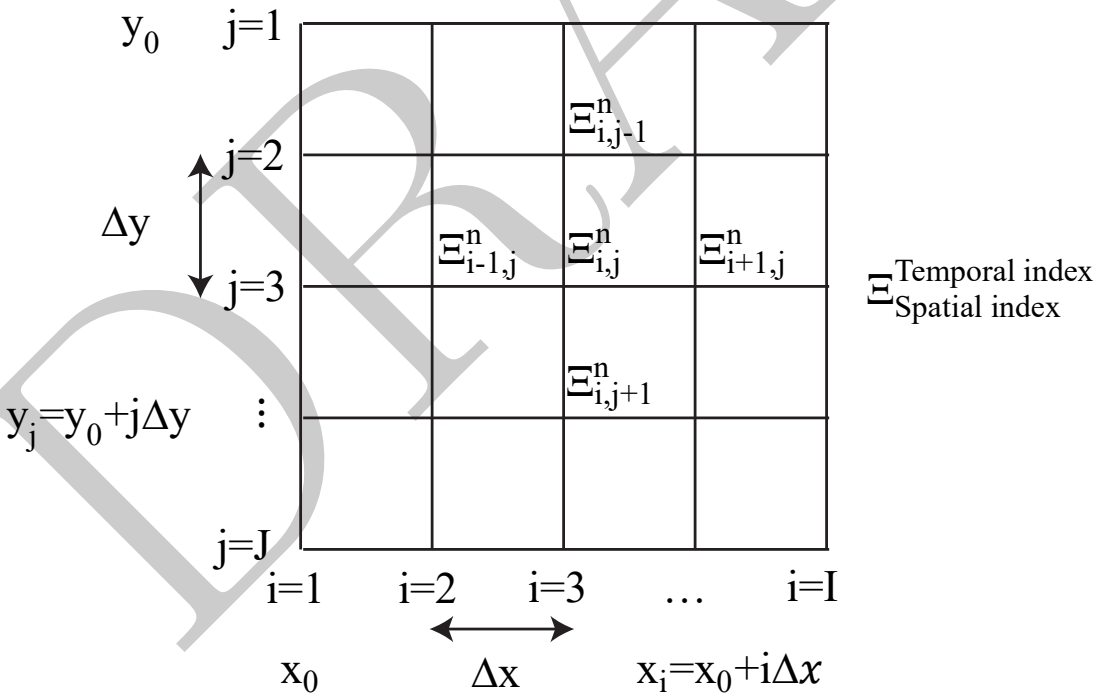

Figure 2: FDM discretized domain. Please be mindful of the indices. For example, notice that I am starting the j index (notwithstanding the domain definition in the previous figure) from the top left as in to keep semblance with the way MATLAB handles matrices.

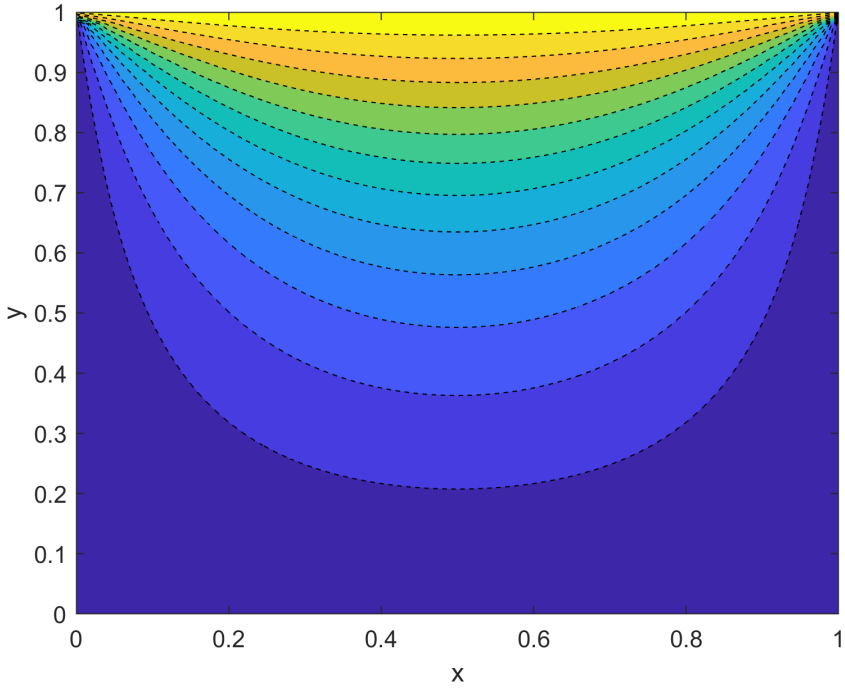

Figure 3: Steady-state solution (should be 1:1; colorbar missing).

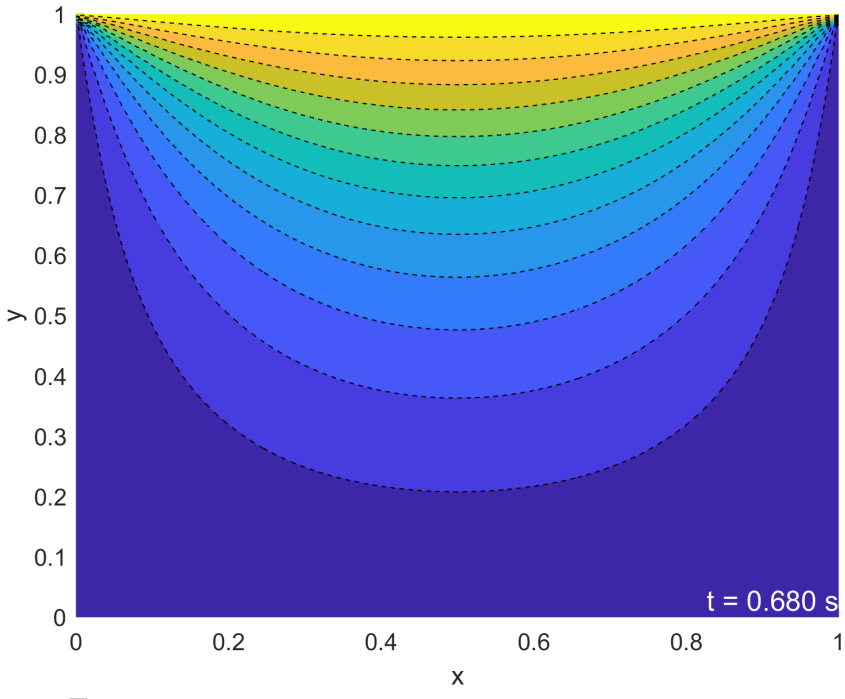

Figure 4: Transient solution (should be 1:1; colorbar missing).