

DEPARTMENT OF MECHANICAL ENGINEERING
INDIAN INSTITUTE OF TECHNOLOGY BOMBAY

ME415: Computational Fluid Dynamics & Heat Transfer

Spring 2023

Assignment # 4: 2D Unsteady State Heat Conduction on a Curvilinear Grid

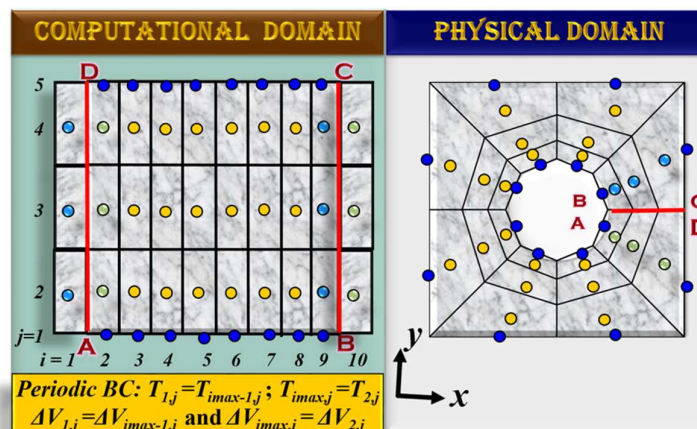
Instructor: Prof. Atul Sharma

Deadline for Submission: 4th April.@2 AM (5th April midnight).

VIVA: 5th April 2023 (Wednesday)@F-24@Mechanical-Dept.

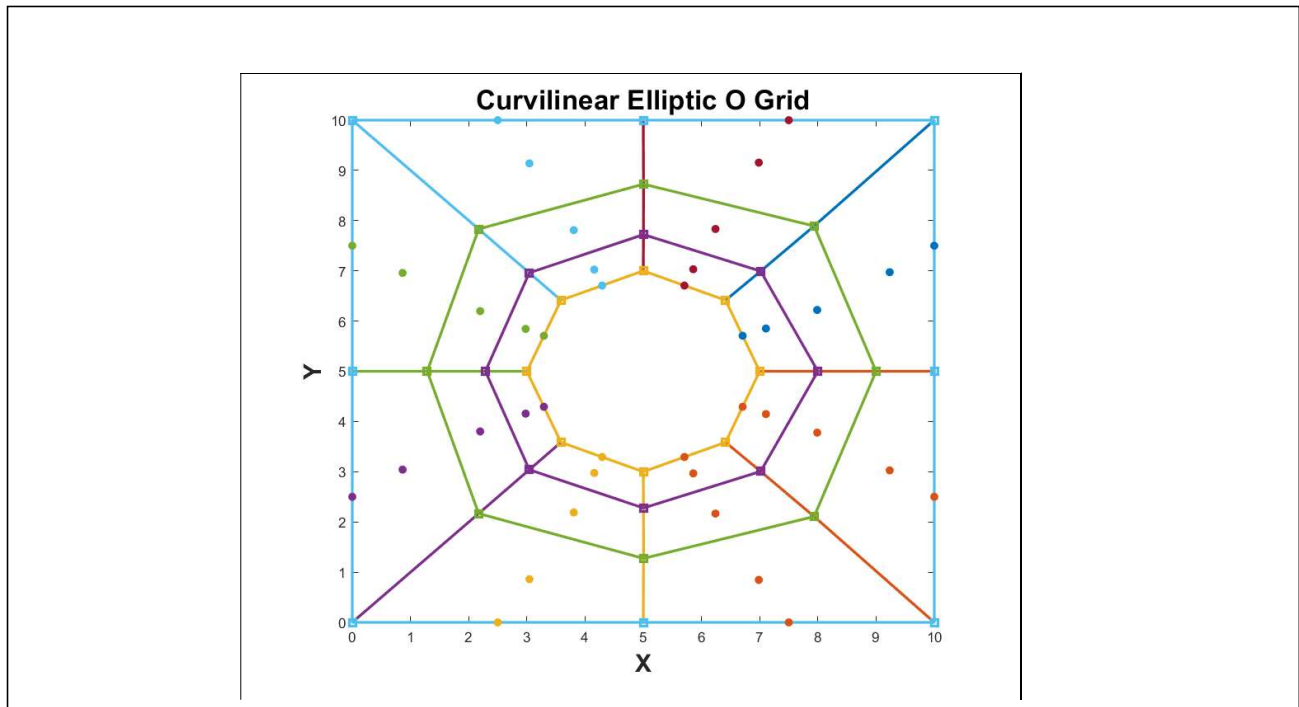
Note: Both problems and answer sheet are provided below. **MATLAB** should be used for programming as well as generating graphical results. The submissions should be ONLINE through Moodle, with a single zipped folder consisting on (a) filled-in answer sheet of this doc file (converted into a pdf file) and/or (b) all the computer programs. The name of the zipped file should be rollnumber_A4-1 and rollnumber_A4-2 for the two submissions.

- 1. Curvilinear Grid Generation using Elliptic PDE Method:** Consider a square plate of dimension 10 units with a circular hole of 2 units. Develop a computer program to generate an elliptic PDE method based curvilinear grid generation and generate the O-type of grid. Take the number of grid points (vertices of CVs) for grid generation as shown in Slide No. 9.11; and plot the figure for the O-type curvilinear grid.
- 2. Unsteady Heat Conduction in a Square Plate with Circular Hole:** Consider the O-type grid - generated in the previous problem – for 2-D heat conduction in a square plate (density: 7750 kg/m³, specific-heat: 500 J/Kg K & thermal-conductivity: 16.2 W/m-K) with a circular hole. Using the complex geometry formulation and explicit method for unsteady state heat conduction, develop a program for flux-based solution methodology. Using the grid and the code, along with a non-dimensional boundary condition for temperature as unity in the hole and zero at the outer square boundary, plot the steady state temperature distribution in the plate. Take steady-state convergence tolerance as 10^{-6} . The computational as well as physical domain for this problem; and implementation of BC is shown below.



Answer Sheet

Problem # 1: Curvilinear Grid Generation:



Problem # 2: Unsteady Heat Conduction in a Square Plate with Circular Hole:

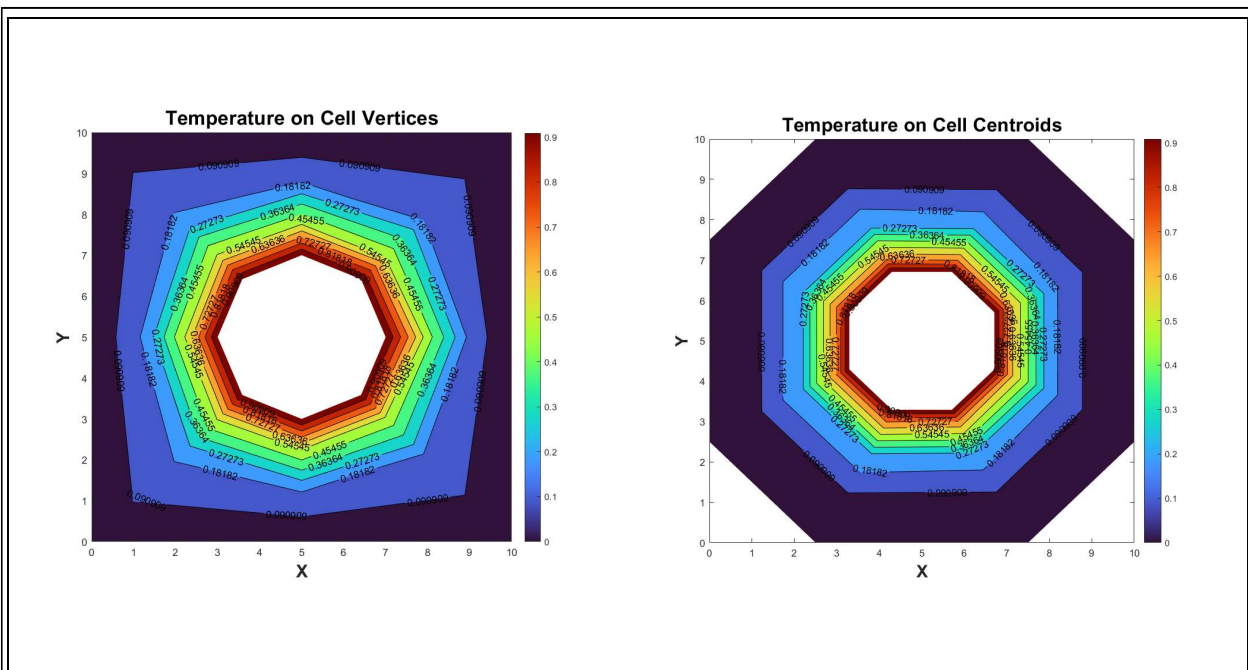


Fig. 4.2: Steady State Temperature Contour on the plate.