Name: BITS ID:

BITS Pilani, Pilani campus, Second semester, 2022-2023

ME G515 Computational Fluid Dynamics- Mid-semester examination

Open book: only TB2, class slides, and handwritten class notes are permitted

Date: 16/03/2023, Duration: 90 min, Max. marks: 30.

State your assumptions clearly and assume any missing data

Common data for all questions: Consider one-dimensional, steady and unsteady heat conduction in a slab along its length, L= 10 cm and across its constant cross section (A_{cs}= 1 m^2). The left (x=0) and right (x=L) sides are at 100 ^oC. The heat generation rate, q_v= 1000-T W/m^3; where T is in ^oC. Based on this common data, attend all the questions below.

Q1. Write the governing equation for the given problem in the conservation form when the process is at steady state. Introduce each terms in this equation. Examine the nature of this governing equation using Fletcher's Eigen value based procedure. Comment on your results. [4 marks]

Q2. Propose a uniform grid for the Q1 problem such that there is one interior and two boundary nodes, draw a neat schematic diagram of it and mark its salient features. Discretize the governing equation using FVM for (i) interior, and (ii) boundary nodes. Also, construct a table of coefficients for each case. Further, calculate the steady state temperature distribution using TDMA. Estimate the heat flux at the right end (x=L). [8 marks]

Q3. Looking at the Q1 problem, comment on the possibility for applying a symmetry boundary condition. If it is possible, demonstrate it, and propose a uniform grid to solve the new problem. Discretize the governing equation using FVM for the boundary node where the symmetry condition is applied. Also, construct a table of coefficients for this node. [6 marks]

Q4.Write the governing equation in the conservation form when the process is at unsteady state. Introduce each terms in this equation. Examine the nature of this governing equation using Fletcher's Eigen value based procedure. Comment on your results. [4 marks]

Q5. Propose a uniform grid for the Q4 problem such that there is one interior and two boundary nodes, draw a neat schematic diagram of it and mark its salient features. Assume an initial condition of T= 0 ^oC for all x. Discretize the governing equation using explicit scheme in FVM for (i) interior, and (ii) boundary nodes. Construct a table of coefficients for each case. Comment on the solution procedure for this problem and its stability. [8 marks]