(Please write your Enrolment number immediately) Enrolment Number :____________________

Mid-Term Examination

B.TECH PROGRAMMES (UNDER THE AEGIS OF USICT)

Seventh Semester, September / October 2024

Paper Code : CADM-401T **Subject :** Computational Fluid Dynamics

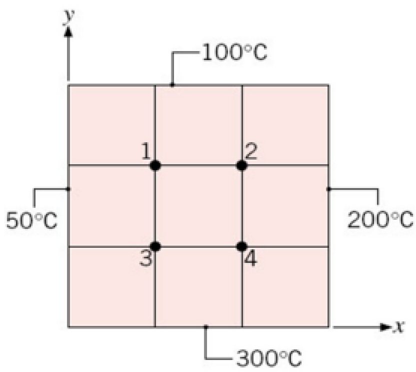
Time : 1:30 Hrs. **Max Marks**: 30

Note: Attempt Q.No. 1, which is compulsory and any two more questions from the remaining

Q1 (i)	Explain round-off and discretization error for a finite difference scheme	2 Marks	CO1
(ii)	Classify following partial differential equations as elliptic, parabolic or hyperbolic (a) $\frac{\partial u}{\partial t} - \frac{\partial^2 u}{\partial x^2} = 0$ (b) $\frac{\partial^2 u}{\partial x^2} - \frac{\partial^2 u}{\partial y^2} = 0$	2 Marks	CO1
(iii)	Mention advantages and disadvantages of implicit and explicit methods.	2 Marks	CO2
(iv)	Write the 3-dimensional continuity equation and momentum equation, in the cartesian coordinate system, for an infinitesimally small fluid element fixed in space.	2 Marks	CO1
(v)	Mention different types of boundary conditions for CFD problems.	2 Marks	CO2

Q.2	Find the order of accuracy of the following finite difference approximations: $\left(\frac{\partial^2 T}{\partial x^2}\right)_i = \frac{2T_i - 5T_{i+1} + 4T_{i+2} - T_{i+3}}{(\Delta x)^2}$	10 M	CO1

Q.3	Consider the following finite difference scheme corresponding to the given partial differential equations. Obtain the condition for the scheme to be stable Partial Differential Equation : $\left(\frac{\partial T}{\partial t}\right) = \alpha\left(\frac{\partial^2 T}{\partial x^2}\right)$ Finite Difference Scheme : $\frac{T_i^{n+1} - T_i^n}{\Delta t} = \alpha \frac{T_{i+1}^n - 2T_i^n + T_{i-1}^n}{(\Delta x)^2}$	10 M	CO2

Q.4	Consider 2-D steady state heat conduction in a square slab governed by the PDE $\frac{\partial^2 T}{\partial x^2} + \frac{\partial^2 T}{\partial y^2} = 0$ Write a general algebraic equation for temperature at any node in terms of temperature of neighbouring nodes using the 'central in space' Finite Difference scheme. For the boundary condition shown in figure, calculate temperature of the four interior nodes. 	10 M	CO2

Mid-Term Examination (Re-Appear)

B.TECH PROGRAMMES (UNDER THE AEGIS OF USICT)

Seventh Semester, November 2024

Paper Code : CADM-401T **Subject :** Computational Fluid Dynamics

Time : 1:30 Hrs. **Max Marks**: 30

Note: Attempt Q.No. 1, which is compulsory and any two more questions from the remaining

Q1 (i)	Explain different types of boundary conditions for solving Partial differential equations.	2 Marks	CO1
(ii)	What are characteristics curve for a partial differential equations	2 Marks	CO1
(iii)	Write the Continuity equation for 2-Dimensional Incompressible steady state flow.?	2 Marks	CO2
(iv)	Discretize one-dimensional transient heat conduction equation using crank nicolson method.	2 Marks	CO1
(v)	What is the significant of 'Courant number' and CFL condition in stability analysis?	2 Marks	CO2

Q.2	Derive the differential Governing equation for fluid motion according to Newton's second law in conservation form.	10 M	CO1

Q.3	Derive a finite difference expression of $O(\Delta x)^4$ for $\left(\frac{\partial^2 T}{\partial x^2}\right)_i$ using a stencil comprising points i -2, i -1, i, i+1, i+2	10 M	CO2

Q.4 (10 M)

Consider the viscous flow of air over a flat plate. At a given station in the flow direction, the variation of the flow velocity, u, in the direction perpendicular to the plate (the y direction) is given by the expression $u = (1-e^{-y/L})$.
Where L= characteristics length 3cm, the units of u metres per seconds. The viscosity coefficient μ is 3.7373X 10^{-5} kg/(m-s). Using the above equation to provide the values of u at discrete grid points equally spaced in the y direction, with Δy=0.1cm. Specifically, it is obtained

y, cm	u(m/s)
0	0
0.1	51.86
0.2	102.02
0.3	150.5

Using discrete values, calculate the shear stress at the wall .a) Using a first order difference (b)Using the second order difference

$$\left(\frac{\partial u}{\partial y}\right) = \frac{-3u_1 + 4u_2 - u_3}{2(\Delta y)}$$