Seat No: _____ **Enrollment No: _____**

PARUL UNIVERSITY

FACULTY OF ENGINEERING & TECHNOLOGY

M.Tech. Winter 2019-20 Examination

Semester: 2 **Date: 16/12/2019**
Subject Code: 03210151 **Time: 02:00 pm to 04:30 pm**
Subject Name: Computational Fluid Dynamics **Total Marks: 60**

Instructions:
1. All questions are compulsory.
2. Figures to the right indicate full marks.
3. Make suitable assumptions wherever necessary.

Q.1 **A)** Derive and explain the physical meaning of divergence of velocity field. **(05)**
B) Define Neumann, Dirichlet's Boundary Conditions, Essential and natural boundary conditions. **(05)**
C) Explain the need of turbulence model in dealing with CFD problem. Briefly explain the difference between Laminar and Turbulent flow **(05)**

Q.2 **Answer the following questions**. (Attempt any three) (Each five mark) **(15)**
A) Finite volume discretization equation for scalar variable $\emptyset$ is obtained as:

$$-5\emptyset_P = -3\emptyset_E - 2\emptyset_W + 5$$

Is the above discretization expected to yield a physically unrealistic solution? Justify with reasoning.
B) A two-dimensional small-disturbance velocity potential equation for compressible flows is given as, $(1 - M_\infty^2)\frac{\partial^2\emptyset}{\partial x^2} + \frac{\partial^2\emptyset}{\partial y^2} = 0$
i. Examine whether this equation is parabolic, elliptic, or hyperbolic?
ii. Justify your inference from pure physical arguments.
C) Differentiate between FVM, FDM and FEM
D) i. Turbulent flow has wide range of time scale and length scale activities, explain.
ii. Explain the model of energy cascading in turbulent flow.

Q.3 **A)** Solve one dimensional steady state heat transfer problem $\frac{d^2T}{dx^2} + 100 = 0$ subjected to boundary condition at $x = 0$ $T = 0$ and at $x = 10$ $T = 0$ with the help of least square method point collocation method and Galerkin's method. **(07)**

B) Discretize one dimensional steady state heat conduction equation with source term $\frac{d}{dx}\left(k\frac{dT}{dx}\right) + S = 0$ by Finite Element Method, take three elements. **(08)**

OR

B) Discretize one dimensional convection-diffusion equation using Central differencing scheme. And explain drawback of Central differencing scheme. **(08)**

Q.4 **A)** Explain the following **(07)**
i. Grid independence test
ii. Conservativeness
iii. Boundedness
iv. Transportiveness

OR

A) Explain the $k - \varepsilon$ model for turbulent flow modeling. **(07)**
B) Write down the following: **(08)**
i. **Continuity equation in**
1. Differential conservation form
2. Integral conservation form
3. Vector form

ii. **Momentum equation in**
1. Differential form
2. Integral form
3. Vector form

iii. **Transport equation in**
1. Differential form
2. Integral form