Reg. No.										

Manipal Institute of Technology, Manipal

(A Constituent Institute of Manipal University)

VI SEMESTER B.TECH (AERONAUTICAL/AUTOMOBILE ENGINEERING)

END SEMESTER EXAMINATIONS, JULY 2016

SUBJECT: COMPUTATIONAL AERODYNAMICS [AAE 334]

REVISED CREDIT SYSTEM

Time: 3 Hours MAX. MARKS: 50

Instructions to Candidates:

- Answer **ANY FIVE FULL** questions.
- Missing data may be suitable assumed.

1A. With suitable examples classify linear 2nd order PDEs. **(02)**

1B. Explain the terms consistency, stability and convergence for a numerical method. **(03)**

1C. Check for the stability of 1D Linear Advection Diffusion Equation $\left(\frac{\partial u}{\partial t} + c\frac{\partial u}{\partial x} = 0\right)$ using FTBS scheme. **(05)**

2A. What does Numerical False Diffusion mean? Explain the same with a neat sketch. **(04)**

2B. Explain the need of staggered grid over collocated grid. Discretize the x-momentum equation in 2D based on the staggered grid formulation. **(06)**

3A. Describe the following: **(04)**

I. Initial value problem
II. Boundary value problem
III. Time marching problem
IV. Space marching problem

3B. Apply MacCormack Predictor-Corrector (P-C) scheme for solving ID Linear Advection Diffusion equation $\left(\frac{\partial u}{\partial t} + c\frac{\partial u}{\partial x} = 0\right)$ and, derive the single step equivalent to P-C scheme. **(06)**

4A. What are the common boundary conditions implemented in the discretized equations of finite volume method. **(02)**

4B. Define Peclet Number and its importance while solving the Convective – Diffusion flow equations. **(03)**

4C. Write short note on: **(05)**

I. Use of FTBS and FTFS schemes alternatively in predictor and corrector steps of MacCormack method
II. Speed of propagation of disturbance in an elliptic problem
III. Compatibility condition for a PDE
IV. Importance of CFL number
V. Discretization error.

5A. Check for the order of accuracy of truncation error in Crank- Nicolson Method. **(02)**

5B. Using finite difference numerical scheme and TDMA method, solve for the temperature distribution along the rod, with governing equation: **(08)**

$$\frac{d^2T}{dx^2} + h'(T_a - T) = 0$$

Take h'=0.01, Δx=2, $T_a = 20℃$, $T_{x=0} = 200℃$, $T_{x=10} = 100℃$

6. A property φ is transported by means of convection and diffusion through the one dimensional domain. The governing equation is **(10)**

$$\frac{d(\rho u \varphi)}{dx} = \frac{d}{dx}(\Gamma \frac{d\varphi}{dx})$$

The boundary conditions are $\varphi_0 = 1$ at x = 0 and $\varphi_L = 0$ at x = L. Using five equally spaced cells and the Upwind Differencing Scheme , calculate the distribution of φ when u = 2.5 m/s. Consider ρ = 1kg/m^3, L = 1m, Γ = 0.1kg/m/s.