Reg. No.										

MANIPAL INSTITUTE OF TECHNOLOGY
MANIPAL
(A constituent unit of MAHE, Manipal)

II SEMESTER M.TECH. (AUTOMOBILE ENGINEERING)
END SEMESTER EXAMINATIONS, APR-MAY 2019
SUBJECT: COMPUTATIONAL FLUID DYNAMICS [AAE 5233]
REVISED CREDIT SYSTEM
(04/05/2019)

Time: 3 Hours | MAX. MARKS: 50

Instructions to Candidates:
- Answer **ALL** the questions.
- Missing data may be suitable assumed.

1A. For the one-dimensional heat conduction is given by **04**

$$\frac{d}{dx}\left(k.\frac{dT}{dx}\right) + S = 0,$$

Where K = thermal conductivity and T is the temperature and S the heat generated, obtain the discretization equation by Finite Volume technique in the standard form, $a_P T_P = a_E T_E + a_W T_W + S_u$

1B. Derive the Navier-Stokes equation in non-conservative form for a 3-D fluid flow subjected to normal and shear stresses as well as pressure forces **06**

2A. Explain three the properties of numerical schemes in while using Control Volume Approach. **03**

2B. Explain the difference between collocated and staggered grid arrangement **02**

2C. With a neat flow diagram explain the SIMPLE algorithm of Patankar-Spalding **05**

3A. Using finite difference numerical scheme and TDMA method to solve for the distribution of ϕ with the data given below. **06**

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

$\Delta x = 2.0,\ h' = 0.01$ boundary conditions: $T|_{x=0} = 200\,^{o}C \ and \ T|_{x=10} = 100\,^{o}C$

3B. With a neat sketch, explain the solution capsule for ADI method **02**

3C. Explain the four basic rules of control volume formulations. **02**

4. Use the simple implicit finite difference approximation to solve for the temperature **10**

distribution of a long thin rod with a length of 10cm after t = 0.2s and the following values: At t = 0 the temperature of the rod is zero and the boundary conditions are fixed for all the times at T(0)=100°C and T(10)= 50°C.value of k = 0.835cm2/s. the governing equation is given as,

$$k\frac{\partial^2 T}{\partial x^2} = \frac{\partial T}{\partial t}$$

$$\Delta x = 2cm, \Delta t = 0.1s$$

5. A property ϕ is transported by means of convection and diffusion through the one dimensional domain sketched below. The governing equation is **10**

$$\frac{d(\rho u\phi)}{dx} = \frac{d}{dx}\left(\Gamma\frac{d\phi}{dx}\right)$$

The boundary conditions are

$\phi_0 = 1.0$ at x = 0 and $\phi_L = 0$ at x = L.

Using five equally spaced cells and the UDS calculate the distribution of ϕ when u = 0.2 m/s. Consider $\rho = 1.5$, L = 0.5m, Γ = 0.1