Reg. No.										

MANIPAL INSTITUTE OF TECHNOLOGY
MANIPAL
A Constituent Institution of Manipal University

VII SEMESTER B.TECH. (MECHANICAL ENGINEERING)

END SEMESTER MAKE-UP EXAMINATIONS DEC 2016/JAN 2017

SUBJECT: COMPUTATIONAL FLUID DYNAMICS [MME 441]

REVISED CREDIT SYSTEM
(30/12/2016)

Time: 3 Hours MAX. MARKS: 50

Instructions to Candidates:

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

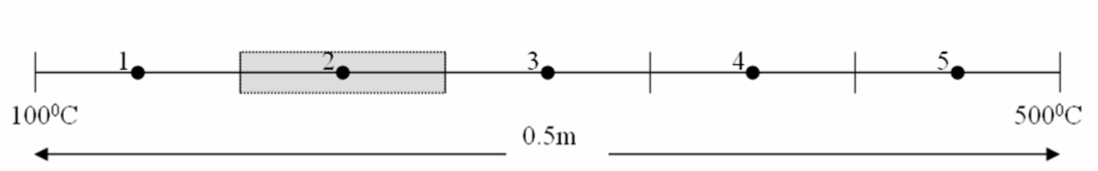
Q.1A Consider the fluid equation **-03-**

$$u\frac{\partial u}{dx} = \mu \frac{\partial^2 u}{\partial y^2}$$

(a) Is this equation in conservative form? If not suggest a conservative form for this equation
(b) Develop a finite difference formulation for this equation using the Finite Volume approach.

Q.1B Derive the **Energy Equation** in the **non**-**conservative** form from first principles. **-07–**

Q.2A Solve for steady state temperature distribution in a one dimensional bar having conductivity k as 1000 w/m.K and a cross sectional area of 10X 10^{-3} m^2, as given below by applying Finite Difference Method using Taylor series approach: Use TDMA for computation of grid temperatures. **-06-**



Q.2B With respect to finite difference discretization schemes of CDS and UDS, compare: **-04-**
(a) Consistency
(b) Boundedness
(c) Transportiveness
(d) Accuracy

Q.3A Explain the meaning of **Total Derivative** with an example of marketing perishable banana fruit consignment. **-02-**

Q.3B Why staggered grids are needed while solving Convection dominated Diffusion flow problems. Sketch neatly the staggered grids for pressure and velocities. **-04-**

Q.3C Consider the Fourier thermal diffusive flow equation given by **-04-**

$$\frac{\partial^2 T}{\partial x^2}+\frac{\partial^2 T}{\partial y^2}+\frac{\partial^2 T}{\partial z^2}=\frac{1}{\alpha}\frac{\partial T}{\partial t}$$

(a) Prove that the characteristic of **flow is Elliptic in space and parabolic in time.**
(b) How do you determine the Boundary Conditions and Initial Conditions that are required to solve the above differential equation?
(c) Discretize the above equation with CDS for space and FDS for time.

Q.4A Illustrate with practical examples for each, Dirichlet, Neumann, Cauchy, and Robin Boundary conditions clearly. **-04-**

Q.4B Set up the finite difference solution in non-dimensional form matrix for a one dimensional unsteady state thermal diffusion by applying Crank-Nicholson Semi Implicit Method. **-06-**

Q.5A A property ϕ is transported by means of convection and diffusion through a one-dimensional duct. The boundary conditions are stated as ϕ_0=1 at x=0 and ϕ_L=0 at x=L. Using three equally spaced control volume cells and applying CDS calculate the distribution of ϕ along the duct for a velocity of flow u= 0.1 m/s. The length of the duct is 1 m and density ρ= 1 kg/m^3 and diffusive flux ${\Gamma}$ = 0.1 kg/m.s. Compare the results with exact analytical solution. **-07-**

Q.5B How do you classify Mathematically the fluid flow equations? Write the corresponding equations for each case and explain briefly the physical interpretation of the same. **-03-**

Q.6A Deduce the Velocity Correction equations as obtained by Patankar and hence deduce the Pressure Correction equation from the mass rate conservation. **-05-**

Q.6B Derive the non-dimensional form of the steady one dimensional convection-diffusion fluid flow equation and obtain the general solution in the form, **-05-**

$$\theta=\frac{\left(e^{PX}-1\right)}{\left(e^{P}-1\right)}$$ where P is the Peclet Number & θ is the non dimensional Temperature.