Reg. No.										

Manipal Institute of Technology, Manipal

(A Constituent Institute of Manipal University)

IISEMESTER M.TECH (ATPES) END SEMESTER EXAMINATIONS

MAY 2016

SUBJECT: COMPUTATIONAL FLUID DYNAMICS [MME 548]

REVISED CREDIT SYSTEM

Time: 3 Hours MAX. MARKS: 50

Instructions to Candidates:

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

1A. Explain the difficulties and the corresponding strategies for solving convective dominated diffusion flow problems. **04**

1B. Set up the solution using the semi-implicit Crank-Nicholson approach, for one dimensional transient heat conduction in a rectangular bar with a uniform heat generation suddenly exposed to a cooling medium at T_∞ , in the non-dimensional form by obtaining the discretized equation using Taylor series. **06**

2A. Explain with a simple example the Dirichlet, Neumann, Cauchy and Robin's Boundary Conditions. **02**

2B. Water is flowing in a square duct of side 25 mm. It enters the duct with a temperature of 150^{o}C. The velocity at inlet is 20 m/s which can be assumed to remain constant along the duct. The diffusive flux (Γ) through the duct can also be assumed to be constant at 800 kg/m/s. The length of the pipe is 400 mm. Water leaves the pipe at a temperature of 80^{o}C. Apply the following discretization schemes and obtain atleast three unknown temperatures of the flow medium along the pipe. Comment on the solution obtained.
(1) Central Difference Scheme (CDS)
(2) Upwind Differencing Scheme (UDS).
Check the numerical solutions with the exact analytical exponential method. **08**

3A. Derive the non-dimensional form of the steady one dimensional convection-diffusion fluid flow equation and obtain the general solution in the form,

$$\theta = \frac{\left(e^{PX} - 1\right)}{\left(e^{P} - 1\right)}$$ where P is the Peclet Number

Sketch the nature of general solution. **05**

3B. The price of a lorry load of bananas depends on the ripening effect due to time and due to shipment distance. The time rate of price lost due to ripening is given by Rs.650 per day(negative) and rate of shipment price per unit distance is Rs.10 per km (positive). At what speed the lorry load of bananas be transported so that price of the load can be kept the same at any place and time. **02**

3C. Deduce the scale-free (non-dimensional) form of the Compressible flow Continuity Equation for differential control volume fixed in space. **03**

4A. Derive the full Navier-Stokes Momentum equation for a differential control volume moving space. **07**

4B. What is meant by Numerical False Diffusion? Compare the same for grid-aligned and grid-non aligned flow conditions. **03**

5A. With a neat flow diagram, explain the **SIMPLE** algorithm of Patankar and Spalding. **04**

5B. Solve for steady state temperature distribution for a one dimensional fin of 25 mm diameter and having base temperature at 350^{o}C and the free end kept at 60^{0} C. The fin is exposed to convective ambience having a convective heat transfer coefficient of 15 W/m^2.K and ambient temperature of 35 ^{0}C. The thermal conductivity of the fin material is 45 W/m.K. The fin is 0.6 m long. Discretize the domain into 6 **control volumes** and use TDMA for computation of grid temperatures. **06**

6A. Deduce the velocity correction equations and derive the **Pressure Correction Equation** for Convection dominated Diffusion flow. **06**

6B. Explain with regard to CDS and UDS discretization methods the following:
(a) Consistency
(b) Boundedness
(c) Transportiveness
(d) Accuracy **04**