Reg. No.										

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

SECOND SEMESTER M.TECH END SEMESTER MAKE-UP EXAMINATION, APRIL 2019

(THERMAL SCIENCES & ENERGY SYSTEMS/CAAD/MET/TRIBOLOGY)

SUBJECT: COMPUTATIONAL FLUID DYNAMICS (MME 5242)

REVISED CREDIT SYSTEM

Time: 3 Hours **MAX. MARKS: 50**

Note: (i) Answer **ALL** the questions.
(ii) Missing data may suitably be assumed.
(iii) Draw neat schematic sketches wherever required

Q1A	Explain the **Basic Four Rules** enunciated for control volume formulation.	**-02-**
Q.1B	Derive the Energy Equation in the **non-conservative form.**	**-06–**
Q.1C	What are the **generic boundary conditions** that can be imposed in typical flow field analysis? Explain each with a physical example.	**-02-**
Q.2A	For the Laplacian thermal diffusive flow equation given by $k\dfrac{\partial^2 T}{\partial x^2}+k\dfrac{\partial^2 T}{\partial y^2}+\dot{q}_g=0,$ obtain the discretised equation using Finite Volume technique, in the form $a_P T_P = a_W T_W + a_E T_E + a_S T_S + a_N T_N + b$	**-03-**
Q.2B	A steel fin of thermal conductivity 45 W/m.K and having uniform rectangular cross section 25mm X 20 mm and length 200 mm, is fitted to an engine head at 375^{0}C. It is exposed to ambient convective air having convective heat transfer coefficient of 20 W/m^2.K. The average bulk temperature of the cooling air is 35^{o}C. The fin can be treated as slender with negligible heat transfer from the open end face of the fin. Use control volume approach to solve the problem assuming steady one dimensional heat transfer.	**-07-**
Q.3A	With a neat flow chart explain the **SIMPLE** algorithm of Patankar & Spalding.	**-03-**
Q.3B	Derive the **scale free format** of the three dimensional unsteady compressible flow Continuity equation.	**-03-**
Q.3C	Compare the relative advantages and limitations of Euler Explicit, Crank-Nicholson, and Pure Implicit schemes for solving an unsteady flow problem.	**-04-**
Q.4A	Explain what is meant by **False Diffusion**. Prove that whereas for grid aligned zero diffusive flow UDS predicts properly, for grid non-aligned zero diffusive flow, it predicts a false diffusion.	**-03-**

Q.4B	Set up the finite difference solution for a two dimensional steady state thermal diffusion along a very long square slab (2L x 2L size) with uniform internal heat generation, in which the exposed sides are at uniform temperature of T_∞.	**-07-**
Q.5A	Derive the non-dimensional form of the steady one dimensional convection-diffusion fluid flow equation and obtain the general solution in the form, $$\bar{T} = \frac{\left(e^{P\bar{X}} - 1\right)}{\left(e^{P} - 1\right)} \text{ where P is the Flow Peclet Number}$$ decline	**-04-**
Q.5B	Air is flowing in a square duct of side 25 mm. It enters the duct with a temperature of 150°C. The velocity at inlet is 35 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 1.5 kg/m/s. The length of the pipe is 500 mm. Water leaves the pipe at a temperature of 30°C. Apply the Upwind Differencing Scheme (UDS) for discretization and obtain the temperature distribution along the duct. Use three equally spaced control volumes to discretize the domain. Check the numerical solutions with the exponential exact method.	**-06-**