Reg. No.										

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

SECOND SEMESTER M.TECH END SEMESTER EXAMINATION, APRIL 2018
(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.

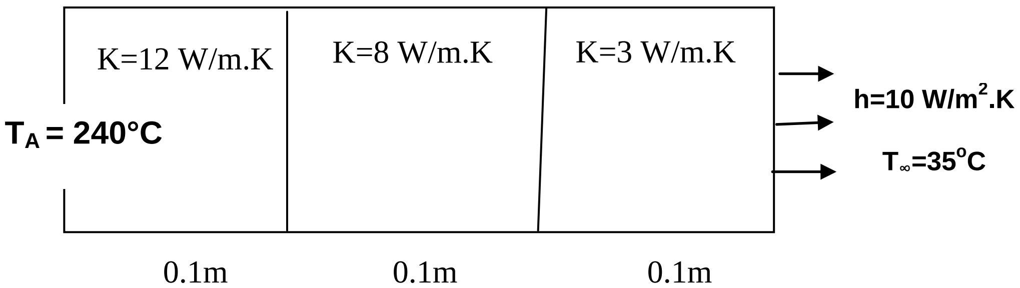
Q.1A Describe how you would implement various boundary conditions for a typical CFD problem involving a compressible axisymmetric pipe flow. **-02-**

Q.1B Water is flowing in a square duct of side 25 mm. It enters the duct with a temperature of 90°C. The velocity at inlet is 2 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 600 kg/m/s. The length of the pipe is 800 mm. Water leaves the pipe at a temperature of 30°C. Apply the following discretization schemes and obtain the temperature distribution along the pipe. **-08-**
(1) Central Difference Scheme (CDS)
(2) Upwind Differencing Scheme (UDS)
Check the numerical solutions with the exponential analytical exact method. Use three equally spaced control volumes to discretize the domain for numerical computation.

Q.2A Derive the Von Neumann stability criterion for the one dimensional unsteady thermal diffusion equation given by, **-04-**

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

Q.2B Determine the steady state temperature distribution for one dimensional heat diffusion in a composite wall as shown below, using Control Volume Method. Use only three control volumes of equal size. **-06-**



Q.3A Set up the non-dimensional GDE for one dimensional unsteady flow and discretize the same using Taylor series and deduce the numerical solution matrix using Crank-Nicholson Semi Implicit Scheme. **-04-**

Q.3B Derive the x directional Navier Stokes equation (in the non-conservative form given by **-06-**

$$\rho \frac{Du}{Dt} = -\frac{\partial p}{\partial x} + \frac{\partial \tau_{xx}}{\partial x} + \frac{\partial \tau_{yx}}{\partial y} + \frac{\partial \tau_{zx}}{\partial z} + \rho f_x$$

and convert the LHS to the conservative form given by,

$$\rho \frac{Du}{Dt} = \frac{\partial (\rho u)}{\partial t} + \nabla \bullet (\rho u \mathbf{V})$$

Q.4A Derive an expression for Reynold Transport Theorem. **-03-**

Q.4B Explain clearly meaning of Divergence of velocity field with a schematic (2) What is Substantial Derivative (Total Derivative) of a physical property, explain with a physical example. **-03-**

Q.4C What are the difficulties in computing Convective-Diffusive flows? What are the strategies required to overcome them? Explain with neat schematic sketches wherever required. **-04-**

Q.5A Deduce the Patankar's Velocity Correction Equations and hence derive the **Pressure Correction Equation** for Convection dominated Diffusion flow. **-05-**

Q.5B Solve for steady state temperature distribution in a one dimensional slender bar having conductivity k as 100 w/m.K and a diameter of 25 mm, as given below: Use TDMA or otherwise for computation of grid temperatures. **-05-**