Reg. No.										

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

II SEMESTER M.TECH (THERMAL SCIENCES & ENERGY SYSTEMS/CAAD/MET)
END SEMESTER MAKE-UP EXAMINATION JUNE 2018
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 schematic sketches wherever required.

Q.1A Explain clearly Dirichlet, Neumann, and Robin generic boundary conditions used in CFD study. Implement the boundary conditions for the open end face of a 1-D slender fin exposed to each of the generic boundary conditions mentioned. **-03-**

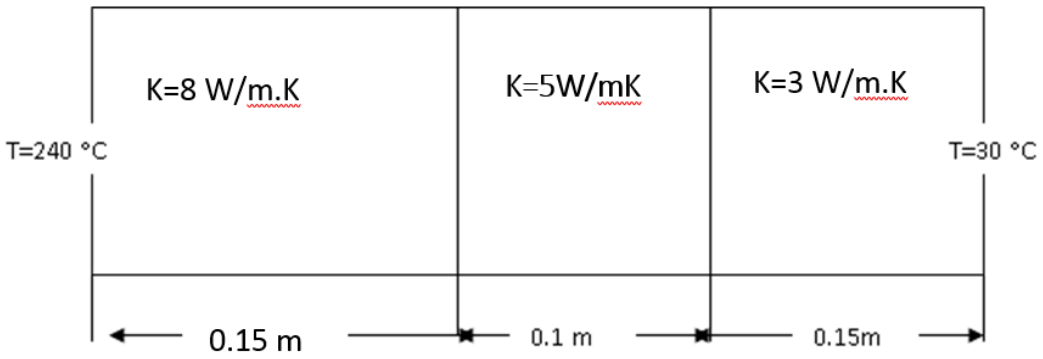
Q.1B Derive the x directional Navier Stokes equation in the non-conservative form given by **-07-**

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

and convert the LHS to the conservative form.

Q.2A Enumerate the desirable properties for discretization schemes used in the convective flow dominated diffusion process following control volume methodology. **-04-**

Q.2B Determine the steady state temperature distribution for the one dimensional composite wall given below using Finite Difference Method. Solve by TDMA. **-06-**



Q.3A Derive the scale-free steady one-dimensional convection dominated diffusion **-06-**

fluid flow equation and obtain the general solution in the form,

$$\bar{T} = \frac{\left(e^{P\bar{X}} - 1\right)}{\left(e^{P} - 1\right)} \quad \text{where P is the Flow Peclet Number}$$

Sketch the characteristic response graph of the general solution.

Q.3B With a neat flow diagram explain the SIMPLE algorithm of Patankar-Spalding. **-04-**

Q.4A What are the difficulties and the corresponding strategies applied for computing a Convection dominated Diffusion fluid flow problem. **-04-**

Q.4B Derive the non-dimensional form of **the transient (unsteady) one dimensional heat conduction** in a rectangular bar with a uniform heat generation at an initial temperature of T_i, suddenly exposed to a cooling medium at T_∞ .Obtain the discretized equations and set up the solution using the semi implicit Crank-Nicolson approach. **-06-**

Q.5A Explain with schematic sketches the different models of flow used in formulating of governing equations of fluid dynamics. Bring out the relative advantages and limitations of each model. **-04-**

Q.5B Air (of density=1 kg/m^3) is flowing in a square duct of side 25 mm. It enters the duct with a temperature of 320°C. The velocity at inlet is 15 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 kg/m.s. The length of the duct is 600 mm. Air leaves the duct at a temperature of 130°C. Obtain the temperature distribution along the duct using Central Differencing Scheme (CDS) first using three equally spaced unknown control volumes. Whether stable solution is possible?. If not change the number of control volumes suitably to get a stable solution. Finally, check the stable numerical solution with the exponential exact solution. **-06-**