Reg. No.										

MANIPAL INSTITUTE OF TECHNOLOGY
MANIPAL
A Constituent Institution of Manipal University

II SEMESTER M.TECH (THERMAL SCIENCES & ENERGY SYSTEMS/CAAD/MET)
END SEMESTER EXAMINATION, APRIL 2017
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.

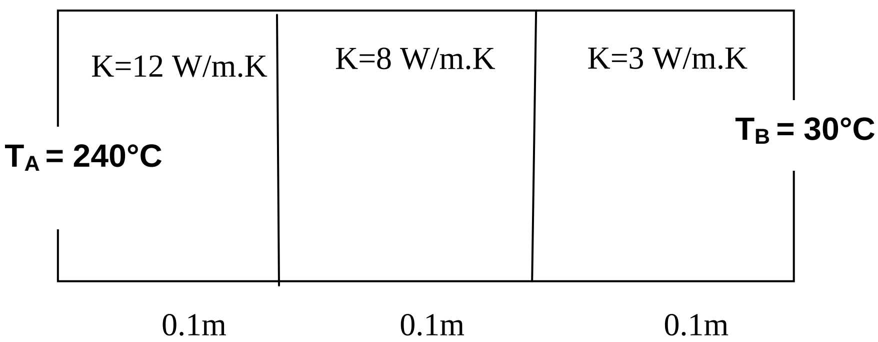
Q. 1A Explain the four basic models to describe fluid flow with a neat schematic sketch for each model of flow and list the salient features of each model. **-04-**

Q.1B Water is flowing in a square duct of side 25 mm. It enters the duct with a temperature of 90^{o}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^{o}C. Apply the following discretization schemes and obtain the temperature distribution along the pipe. **-06 -**
(1) Central Difference Scheme (CDS)
(2) Upwind Differencing Scheme (UDS)
Check the numerical solutions with the exponential exact method. Use three equally spaced control volumes to discretize the domain for numerical computation.

Q.2A Derive the non-dimensional form of the steady one dimensional convection-diffusion fluid flow equation and obtain the general solution in the form, **-04-**

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

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	With a neat Flow Diagram, explain the **SIMPLE** algorithm of Patankar and Spalding.	**-03-**
Q.3B	Apply the Von Neumann Stability Analysis to obtain the stability criterion for the one dimensional unsteady thermal diffusion equation given by, $$\frac{\partial T}{\partial t} = \alpha \frac{\partial^2 T}{\partial x^2}$$	**-05-**
Q.3C	Consider the Laplacian thermal diffusive flow equation given by $$\frac{\partial^2 T}{\partial x^2} + \frac{\partial^2 T}{\partial y^2} = 0$$ Show that this is an elliptic equation.	**-02-**
Q.4A	What is meant by Numerical False Diffusion? Explain the same with a neat schematic for grid-aligned and grid-nonaligned flows.	**-04-**
Q.4B	Explain clearly meaning of (1) Divergence of velocity field (2) Substantial Derivative (Total Derivative) of a physical property.	**-02-**
Q.4C	What are the difficulties in computing Convective-Diffusive flows? What are the strategies required to overcome them? Explain with neat sketches wherever required.	**-04-**
Q.5A	Derive the **Pressure Correction Equation** for Convection dominated Diffusion flow.	**-04-**
Q.5B	Explain with regard to control volume discretization schemes, the following: (a) Consistency (b) Boundedness (c) Transportiveness	**-03-**
Q.5C	Illustrate with an example Direchlet, Neumann and Robin Boundary conditions.	**-03-**