Reg.No.										

MANIPAL INSTITUTE OF TECHNOLOGY
(A constituent institute of Manipal University)

VII SEMESTER. B.Tech. (MECHANICAL ENGINEERING)
END SEMESTER (MAKE UP) EXAMINATIONS, DEC 2015/JAN 2016

SUBJECT**:** COMPUTATIONAL FLUID DYNAMICS (MME 441)
(REVISED CREDIT SYSTEM)

Time: 3 Hours. MAX.MARKS: 50

Instructions to Candidates:
- Answer **ANY FIVE** full questions.
- Missing data may be suitably assumed.

Q.1A State the **Basic Four Rules** for control volume formulation. **-02-**

Q.1B Derive the Energy Equation in the non-conservative form and reduce the same to conservative form. **-08–**

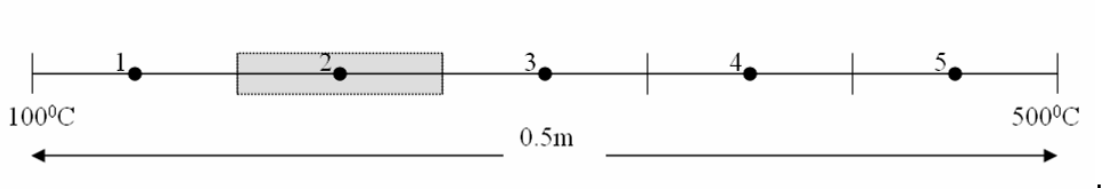
Q.2A For the 2-D Fourier thermal diffusive flow equation given by **-04-**

$$k_x \frac{d}{dx}\left[\frac{dT}{dx}\right] + k_y \frac{d}{dy}\left[\frac{dT}{dy}\right] + \dot{q}_g = 0$$

obtain the discretised equation using Finite Volume technique, in the form

$$a_P T_P = a_W T_W + a_E T_E + a_S T_S + a_N T_N + b$$

Q.2B Solve for steady state temperature distribution in a one dimensional bar having conductivity as 1000 w/m.K and a cross sectional area of 10X 10^{-}3 m, as given below: Use TDMA for computation of grid temperatures. **-06-**



Q.3A Enumerate the challenges and the respective strategies to overcome the same in the case of convection dominated diffusion flows. Deduce the velocity correction equation and hence derive the **Pressure Correction Equation** for Convection dominated Diffusion flow. **-06-**

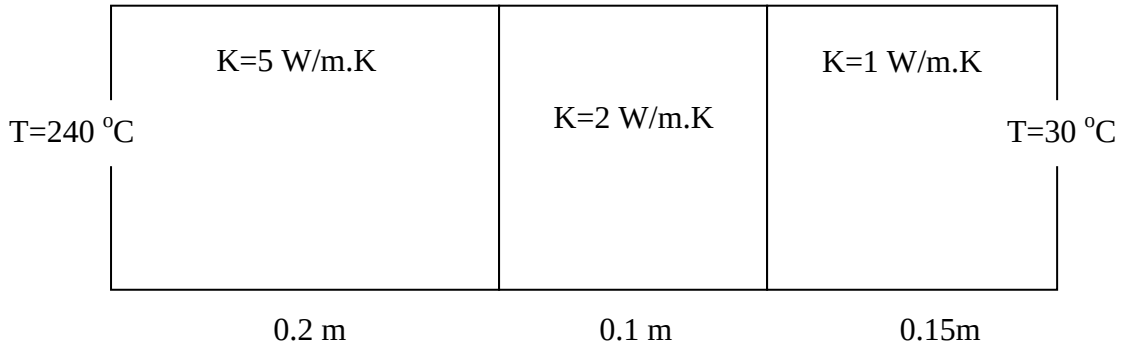
Q.3B Derive the scale-free (non-dimensional) form of the Continuity Equation for a differential control volume fixed in space. **-04-**

Q.4A Explain the SIMPLE algorithm of Patankar and Spalding with a neat flow diagram **-04-**

Q.4B Solve for steady state temperature distribution in a one dimensional pin fin exposed to 350^{o}C and the other end having an insulated free end. The fin is exposed to convective ambience having a convective heat transfer coefficient of 10 W/m^2.K and ambient temperature of 35 ^{0}C. The thermal conductivity of the fin material is 100 w/m.K and a cross sectional area of 0.0025m^2. The fin is 0.25m long. Discretize the domain into 5 control volumes and use TDMA for computation of grid temperatures. **-06-**

Q.5A Explain the characteristic advantages and limitations of solving a transient unsteady heat transfer problem by, **-03-**
(i) Euler's Explicit Method
(ii) Crank-Nicholson Semi-Implicit Method
(iii)Pure Implicit Method

Q.5B Determine the steady state temperature distribution for the one dimensional composite wall given below. Use **Control Volume Method. Use atleast three CVs.** **-07-**



Q.6A Deduce the finite difference expression for second order accurate mixed derivative given by, **-06-**

$$\left(\frac{\partial^2 u}{\partial x\,\partial y}\right)_{i,j} = \frac{u_{i+1,j+1} - u_{i+1,j-1} - u_{i-1,j+1} + u_{i-1,j-1}}{4\Delta x\,\Delta y} + O[(\Delta x)^2, (\Delta y)^2]$$

Q.6B With regard to finite difference discretization schemes of CDS and UDS, compare **-04-**
(a) Consistency
(b) Boundedness
(c) Transportiveness
(d) Accuracy