BENGAL ENGINEERING AND SCIENCE UNIVERSITY, SHIBPUR, HOW-3
B.E. (Mech) Part-IV 8^{th} Semester Final Examination, 2012

Subject: Computational Fluid Dynamics: (ME-805/6) Branch : Mech. Engg.

Time : 2 HRS. Full Marks : 35

Answer any three questions.
All questions carry equal marks.

1. (a) What do you mean by governing equations of fluid flow and heat transfer? Write different governing equations used in numerical heat transfer and fluid flow problem in vector form also in the expanded form for three dimensional cases. Include and mark the unsteady term, convection term, diffusion term and source term whenever possible (b) What are the different types of boundary conditions encountered in fluid flow and heat transfer problem? (c) Explain the concept of staggered grid arrangement.

2. The one dimensional governing equation for steady convection diffusion problem in the absence of source term is given by

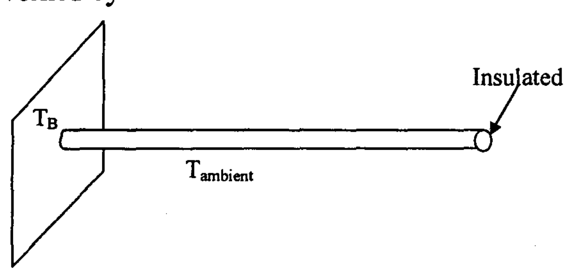
$\frac{d}{dx}(\rho u\phi)=\frac{d}{dx}\left(\Gamma\frac{d\phi}{dx}\right)$ where the symbols have their usual meanings. Using one dimensional continuity equation for steady flow and central differencing scheme show that the solution is given by $a_P\phi_P = a_W\phi_W + a_E\phi_E$, where the coefficients a_W, a_E and a_P are given by

$$a_W = D_w + \frac{F_w}{2},\quad a_E = D_e - \frac{F_e}{2} \quad \text{and} \quad a_P = a_W + a_E + (F_e - F_w)$$

where F and D represent convective mass flux per unit area and diffusion conductance respectively at cell faces.

3. Consider a cylindrical fin with uniform cross-section A as shown in the adjacent figure. The base is at a temperature of 100^0C (T_B) and the end is insulated. The fin is exposed to an ambient temperature of 20^0C. One dimensional heat transfer in this situation is governed by

$\frac{d}{dx}\left(kA\frac{dT}{dx}\right)-hP(T-T_\alpha)=0$, where h is the convective heat transfer coefficient, P the perimeter, k the thermal conductivity of the material and T_∞ the ambient temperature. Calculate the temperature distribution along the fin and compare the results with the analytical solution given by



$$\frac{T-T_\alpha}{T_B-T_\alpha}=\frac{\cosh[n(L-x)]}{\cosh(nL)}$$ where $n^2=\frac{hP}{kA}$, L is the length of the fin and x the distance along the fin. Take L = 1 m and $\frac{hP}{kA}=25$ m^{-2}.

4. Write short notes (any three):
Energy equation, Upwind Scheme, TDMA, Power Law Scheme, SIMPLE Algorithm