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Roll No. | | | | | | | | | | | |

B.E. / B.Tech. (Full Time) DEGREE END SEMESTER EXAMINATIONS, NOVEMBER/DECEMBER 2013
Mechanical Engineering
Semester – 6
ME 516 / ME 9032 – Computational Fluid Dynamics
Regulation 2004 / 2008

Time : 3 Hours **Max. Marks : 100**

Answer ALL Questions
PART A (10 x 2 = 20 Marks)

1. If the continuity equation

$$\frac{\partial \rho}{\partial t} + div\left(\rho u\right) = 0$$

were to be regarded as a special case of the general equation

$$\frac{\partial}{\partial t}(\rho\phi) + div(\rho u\phi) = div(\Pi\, grad\phi) + S$$

what would be the expressions for Ø, ∏ and S?

2. How are partial differential equation classified?
3. Discuss the stability criteria of explicit and implicit schemes.
4. What are the errors involved in a numerical scheme?
5. What is an elliptic equation? Give an example.
6. What are the advantages of Crank-Nicolson method?
7. What is meant by boundedness?
8. What is the significance of Peclet Number?
9. What are the advantages of staggered grid?
10. How are the turbulence modes classified.

PART – B (5 X 16 = 80 MARKS)

11. Derive the continuity and X - momentum equations for a 2D incompressible flow.

12. (a) Consider the steady state heat conduction in a slab of thickness L = 0.01 m without any sources. The boundary surface at X = 0 is maintained at a constant temperature of 150^0C, while the boundary surface at X = L dissipates heat by convection with a heat transfer coefficient h into an ambient of at temperature T_∞. Compute the temperature in the slab by using finite difference method. Take 5 equal grid spacing. Take k= 18 W/ m ^{0}C, A = 10 x 10^{-3}m^2, h= 200W /m^2 ^{0}C and T_∞ = 25^{0}C.

(OR)

12. (b) A marble slab [$k = 2$ W/(m . ^{0}C), $\rho c = 2 \times 10^6$ J/m^3 ^{0}C] of thickness $L = 2$ cm is initially at a uniform temperature $T_i = 200^0$C. Suddenly one of its surfaces is lowered to 0^0C and is maintained at that temperature, while the other surface is kept insulated. Determine the temperature distribution in the slab after time t =16 seconds, using finite difference scheme and explicit method. Take the time step $\Delta t = 8$ seconds.

13. (a) A steel plate of thickness 5 cm is initially at 500^0C. It is suddenly plunged into cold water. As a result of this, the surface temperature drops to 70^0C and remains at this value for the rest of the cooling process. Estimate the mid plane temperature after the 3 time steps by dividing the thickness of the plate into 5 equal control volumes and suitable time step. Use finite volume method and explicit scheme. Take $k = 43$ W/mK , $\rho c_p = 3.7 \times 10^6$ m^2/s.

(OR)

(b) Write the discretisation equation for solving ID unsteady heat transfer problem using implicit scheme and finite volume method.

14. (a) A property Φ is transported by means of convection and diffusion through the one-dimensional domain. The boundary conditions are $\Phi_0 = 1$ at $x = 0$ and $\Phi_L = 0$ at $x = L$. Using five equally spaced cells and the central differencing scheme, calculate the distribution of Φ as a function of x for $u = 1.0$ m/s. Take the following data $L = 1.0$m $\rho = 1.0$ kg/m3: $\Gamma = 0.1$ kg/m/s.

(OR)

(b) Write the discretized equations for a steady one dimensional convection and diffusion problem by using hybrid scheme.

15. (a) Discuss the SIMPLE algorithm in detail.

(OR)

(b) Discuss the standard k-ε and low Reynolds number k-ε models.
