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P.E.S. College of Engineering, Mandya - 571 401

(An Autonomous Institution affiliated to VTU, Belgaum)

Eighth Semester, B.E - Mechanical Engineering

Semester End Examination; June - 2016

Computational Fluid Dynamics

Time: 3 hrs *Max. Marks: 100*

***Note**: Answer any **FIVE** full questions selecting at least **TWO** questions from each part.*

PART - A

1 a.	With the help of a block diagram explain the methodology involved in solving a problem in CFD.	8
b.	Derive continuity equation in Cartesian coordinate systems.	5
c.	Starting from Newton's second law of motion obtain an expression for momentum equation along X – axis.	7
2 a.	Write a short notes on the physical interpretations of ; i) Hyperbolic equations ii) Parabolic equations iii) Elliptic equations.	12
b.	Show that Laplace Equation [$\nabla^2\phi = 0$] is an Elliptic Equation. Also write a note on its physical behavior.	8
3 a.	Solve the equations by Gauss Elimination method. $x+4y-z=-5$ $x+y-6z=-12$ $3x-y-z=4$	8
b.	Solve the equations by Gauss Siedal iteration method. $20x+y-2z=17$ $3x+20y-z=-18$ $2x-3y+20z=25$	12
4 a.	Write the finite difference equations for the following partial differentials. i) $\frac{\partial^2 u}{\partial y^2}$ ii) $\frac{\partial u}{\partial y}$ (using central differencing scheme) iii) $\frac{\partial^2 u}{\partial x \partial y}$ iv) $\frac{\partial^2 u}{\partial x^2}$	12
b.	What is Courant Number? Define Discretiztion error and round off error with respect to the finite difference scheme.	8

Contd…2

PART - B

5 a. List down the advantages and disadvantages of explicit and implicit methods of discretization. 5

b. Consider an aluminum alloy fin [K = 200 W/mºC] of length 6 cm with radius 0.8 cm. The base of the fin is maintained at a temperature of 220ºC. The fin is loosing heat to the surrounding media at T_∞ = 27ºC with heat transfer co-efficient h = 18 W/m^{2}ºC using Finite difference scheme with 6 nodes along the x – direction of fin. Find nodal temperatures assume the sin to be tip insulated [i.e. $\frac{dT}{dx(x=l)} = 0$. The Governing differential equation is given by $\frac{\partial^2 T}{\partial x^2} - \frac{hP}{KA}(T_s - T_\infty) = 0$ 15

6 a. Discuss Von-Neumann Stability criteria for heat equation $\frac{\partial T}{\partial t} = \alpha \frac{\partial^2 T}{\partial r^2}$ 5

b. An insulated rod initially at OºC, the boundary conditions are changed to 100ºC at the left end and 50ºC on the other end. The length of the rod is 10 cm and thermal diffusivity is 8.35x10^{-5}m^2/s. Using the discretizaion with Δx = 2 cm. Determine the temperature of the node after 25 using an explicit method. Comment on the time step selected based on stability criteria. 15

7 a. Consider source free heat conduction in an insulated rod of length 0.5 m whose ends are maintained at constant temperature of 100ºC and 500ºC the one dimensional problem is governed by $\frac{d}{dx}\left[K\frac{dT}{dx}\right] = 0$ calculate the steady sate temperature distribution in rod. Assume 5 volume elements, K = 1000 W/mºC and A = 10^{-2}m^2. 15

b. Discuss the benefits of Finite volume method over Finite difference method. 5

8 a. Discretize the following one dimensions steady state conduction equation using Finite volume method. 10

$$\frac{d}{dx}\left[K\frac{dT}{dx}\right] + S = 0$$

b. A property ϕ is transported by means of convection and diffusion through the one dimensional domain the boundary conditions are ϕ_0 = 1 at x = 0 and ϕ_2 = 0 at x = L, using five equally spaced calls and central differencing scheme for convection and diffusion calculate the distribution of ϕ as a function of x for U = 2.5 m/s. 10

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