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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/July - 2015

Computational Fluid Dynamics

Time: 3 hrs *Max. Marks: 100*

Note**: i) Answer any **FIVE** full questions selecting at least **TWO** full questions from each **part.
ii) Any missing data may be suitably assumed

PART - A

1. a What are the elements involved in a complete CFD Analysis? 10

   b. Write down the expression for conservatives from a energy momentum equations. 5

   c. What are the disadvantages of CFD? 5

2 a. With line diagram briefly explain the classification of Partial differential equations. 8

   b. Briefly discuss the physical behavior of equilibrium and time marching problem with suitable example. 12

3 a. Develop the algorithm of the Newton - Raphson method. 12

   b. Use Gaussian elimination method to solve: 8

$$20x_1 + 15x_2 + 10x_3 = 45$$
$$-3x_1 + 2.249x_2 + 7x_3 = 1.751$$
$$5x_1 + x_2 + 3x_3 = 9$$

4 a. Obtain the finite difference equation for the following second order equations using Taylors expansion. 10

   i) i) $\frac{\partial^2 T}{\partial x^2}$ ii) $\frac{\partial^2 T}{\partial y^2}$ iii) $\frac{\partial^2 T}{\partial x \partial y}$

   b. Using FTCS scheme discretize the PDE given below. 4

$$\frac{\partial^2 T}{\partial t} = \alpha \frac{\partial^2 T}{\partial x^2}$$

   c. Determine the stability requirement necessary for solving first order wave equations. Using FTBS scheme. 6

PART – B

5 a. What is upwind scheme? Explain the scheme with respect to wave equation. 6

   b. Difference between numerical dissipation and disporsion. 8

   c. Distinguish between implicit and explicit schemes with examples. 6

Contd….2

6 a. The aluminum alloy of length 50 cm, with radius of 5 mm them is maintained at a temperature 200ºC. The fin is losing heat to the surrounding media at 25ºC using finite difference method with 6 nodes along X – direction. Find local temperatures the Governing D.E. is, 14

$$\frac{\partial^2 T}{\partial x^2} - \frac{hp}{KA}(T_b - T_\infty) = 0$$

Where K = 180 W/m K, and h = 15 W/m^{2}K.

b. Write the finite difference algorithms for the simple explicit and simple implicit scheme that can be used to solve heat equations. 6

7 a. What are the advantages of FVM over FDM? Explain. 6

b. Consider a sources free heat conduction in a insulated rod of length of 0.5 m whose ends are maintained at constant temperature of 100ºC and 500ºC respectively the one dimensional problem is governed by 14

$$\frac{d}{dx}\left(\frac{K\,dT}{dx}\right) = 0$$

Calculate steady state temperature distribution in the rod using 5 volume elements given that K = 1000 W/mK and cross section area A = 1 x 10^{-2} m^2.

8 a. Explain important properties of descritization scheme. 10

b. Derive the general decritized form for one dimensional heat diffusion equation by FVM and also tabulate coefficient of ϕ for all the directions. 10

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