Code No: H2104/R13

M. Tech. II Semester Regular/ Supplementary Examinations, July-2016

COMPUTATIONAL FLUID DYNAMICS

(Common to TE, MD, MED and AMS)

Time: 3 Hours **Max. Marks: 60**

Answer any FIVE Questions
All Questions Carry Equal Marks

1. a Show that the classification of the following PDE is different for different values of the parameter M. 6

$$(1-M^2)\frac{\partial^2\phi}{\partial x^2}+\frac{\partial^2\phi}{\partial y^2}=0$$

   b Explain the implications of the classification of the above PDE on its solution strategies. 6

2. a Explain in detail the similarities, differences, advantages and disadvantages between finite difference methods, finite volume methods and finite element methods used for solving fluid flow problems. 8
   b What are the different types of boundary conditions encountered in solving fluid flow problems? 4

3. a Write the Burger's equation. What types of problems are governed by Burger's equation? 6
   b Discretize Burger's equation using any finite difference scheme of your choice. Give the name of the scheme you have selected and comment on its order of accuracy 6

4. a Consider the first order wave equation given below 6

$$\frac{\partial u}{\partial t}+a\frac{\partial u}{\partial x}=0 \quad a>0$$

   Discretize the above PDE using Forward Time Forward Space (FTFS) finite difference scheme.
   b Using von Neumann stability analysis finds the criteria for the stability of the discretized equation from part (a) above. 6

5. a Define vorticity and stream function. 6
   b Discuss the relative merits and demerits of primitive variable formulation and vorticity-stream function formulation for solving the incompressible fluid flow problems. 6

6. a Derive the compressible potential equation from 2D Navier Stokes equations. 10
   b For what types of flows are compressible potential equation is generally used? 2

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7. Solve the following PDE using finite volume method via finite differences on the square mesh shown in figure. 12

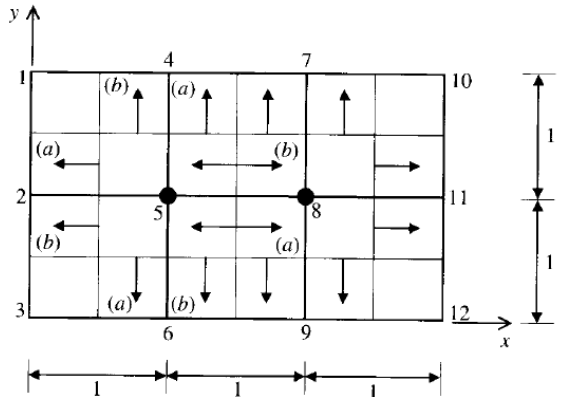
$$\frac{\partial^2 u}{\partial x^2} + \frac{\partial^2 u}{\partial y^2} = f$$

The boundary conditions and source terms are also given below.

$u_1 = u_2 = u_3 = u_6 = u_9 = u_{12} = 0$

$u_4 = 8,\ u_7 = 32,\ u_{10} = 72,\ u_{11} = 18$

$f_5 = 8,\ f_8 = 20$



8. a Explain generalized Galerkin method for formulating finite element equations for unsteady flow problems. 6

b Explain the meaning of the term 'residual' in variational methods. 6

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