

**B.E. MECHANICAL ENGINEERING THIRD YEAR 2<sup>nd</sup> SEM EXAMINATION 2019**

**ELEMENTS OF COMPUTATIONAL FLUID DYNAMICS**

Time : Three hours

Full Marks : 100

*Answer any four questions*

1. a) Explain how partial differential equations are classified and then discuss the mathematical behavior of solutions of these different classes of equations giving examples from actual fluid dynamic flows. 12
- b) Obtain an expression for the third order accurate finite difference discretization expression for  $\partial^3 u / \partial x^3$ . 8
- c) What do you mean by a *well posed problem*? 5
2. a) Explain the different sources of errors encountered while solving a discretized equation. 7
- b) Discuss the various aspects of grid generation for use in finite difference solutions with emphasis on *adaptive grids*. 8
- c) Obtain the CFL condition of stability for one dimensional wave equation. 10
3. a) Derive the incompressible Navier-Stokes equations from the compressible Navier-Stokes equations and hence discuss why the CFD solution technique is different for the two sets of equations. 10+7
- b) Explain the significance of the terms *numerical dissipation* and *artificial viscosity* as encountered in CFD. 8
4. a) Discuss the characteristics of the predictor and corrector steps of the

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McCormack technique. How is this method different from the Lax –Wendroff method? 12

b) Discuss the relaxation technique and its use with low speed inviscid flow. 13

5. a) What is the need for staggered grid ?  
b) How is pressure correction introduced in finite difference method?  
c) Discuss the main features of the SIMPLE algorithm.

6+6+13