Ex/PG/ME/T/129B/2019

M.E. MECHANICAL ENGG 1st YR. 2nd SEM. EXAM - 2019

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.

   b) Obtain an expression for the third order accurate finite difference discretization expression for $\partial^3 u/\partial x^3$.

   c) What do you mean by a *well posed problem*?

   12 + 8 + 5

2. a) What do you mean by stability of a difference equation?

   b) What is the difference between implicit and explicit approaches in CFD analysis?

   c) Obtain the CFL condition for a first order wave equation.

   6 + 6 + 13

3. a) Discuss the concept and major steps of finite volume method (FVM) with a neat sketch of the computational domain with mesh indexing, and coefficients.

   b) For the solution of a steady one-dimensional diffusion equation given by $k\dfrac{\partial^2 T}{\partial x^2} = 0$ (subjected to T = 100 K at x = 0 and T = 500 K at x = 0.5 m (the other end), k = 1 kW/m/K, A = 0.01 m^2), prepare the set of algebraic equations and the coefficient matrices using FVM.

   12 + 13

4. a) Mention the full forms of SIMPLE and SIMPLER. What are the use of these algorithms.

   b) Derive pressure correction equation clearly stating the approximation used for this derivation.

   c) How to derive pressure equation?

   6 + 12 + 7

5. a) Discuss the properties of discretization schemes in FVM for the convection-diffusion problems.

   b) Draw the flow chart of SIMPLE and SIMPLER algorithms.

   c) What is the use of under-relaxation factor?

   13 + 10 + 2