

M.A./M.Sc. Examination, 2019
Semester-IV
Mathematics
Optional Course: MMO-41(A03) (New Syllabus)
(Computational Fluid Dynamics-II)

Time: Three Hours

Full Marks: 40

Questions are of value as indicated in the margin.
Notations and symbols have their usual meanings.
Answer any **four** questions.

1. Derive the expressions of velocity components in laminar boundary layer flow of a circular jet. 10
 2. a) Derive Von Karman's integral equation for the boundary layer flow over a plate. 5
b) Determine the displacement thickness and momentum thickness for the laminar boundary layer on a flat plate for which the velocity distribution is given by the relation
$$u/U = 2(y/\delta) - 2(y/\delta)^3 + (y/\delta)^4 .$$
 2+3
 3. Describe Maccormack's technique for the solution of unsteady two dimensional Euler equations. 10
 4. a) Dimensionize incompressible Navier-Stokes equations and express equations in stream function vorticity formulation. Derive Poisson equation for pressure in this formulation. 4+3
b) Find the first and second orders accurate vorticity at the boundary wall of a flat plate. 1+2
 5. Find the compact high-order formulae for the wall boundary conditions at all the four walls in the case of flow in a rectangular cavity while solving Navier-Stokes equations for viscous, incompressible flow using stream function vorticity approach. 10
 6. a) What are the basic properties of turbulent flows? 4
b) Explain different averaging of flow variables in turbulent flows. Obtain three dimensional incompressible Reynolds Time Averaged Navier-Stokes equations. 6
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