2019

MSc

2nd Semester Examination

APPLIED MATHEMATICS WITH OCEANOLOGY AND COMPUTER PROGRAMMING

PAPER – MTM-201(OLD)

Full Marks : 50 marks

Time : 2 Hours

The figures in the right-hand margin indicate full marks.

Candidates are required to give their answers in their own words as far as practicable.

Illustrate the answers wherever necessary.

(FLUID MECHANICS)

Answer question number ***ONE*** and any ***FOUR*** from the rest

1. Answer any ***FOUR*** questions: 4x2=8
   a) Describe one, two and three-dimensional flow.
   b) Draw an infinitesimally small moving element and show all the energy fluxes along x-direction associated with the above element.
   c) Write down the expression for stream function for uniform flow past a circular cylinder
   and hence draw stream lines around and inside the cylinder.
   d) What are the differences between laminar and turbulent flows? Also show the route to Turbulent flow from laminar flow as Reynold's number increases.
   e) Approximate the boundary layer equations outside the boundary layer.
   f) Define vortex line and vortex tube.

2. a) Derive the continuity equation for the model of an infinitesimally small element fixed in space.
   b) Write down all the possible boundary conditions for tangential and normal component of velocity and temperature. [4+4]

3. a) Derive the expression for substantial derivatives of x-component of the velocity and hence discuss its physical significance.
   b) State and prove the Blasius Theorem. [3+5]

4. a) What do you mean by analytical/exact solution of the Navier-Stokes Equation? With the necessary assumptions, find the exact solution for the case of Couette flow.
   b) Write down the complete Navier-Stokes equations in conservation form for compressible flow, and then reduce these equations for incompressible flow. Finally write down these equations for later case in vector form. [4+4]

5. a) What are the observations of Ludwig Prandtl for boundary layer theory?
   b) Based on the above observation, derive the set of governing equations for the boundary layer flow along a flat plate. Write down the proper boundary conditions for the above set of equations. [2+6]

6. a) Draw infinitesimally small moving fluid element and show the forces in the x-direction for derivation of the z-component of the Navier-Stokes equation.
   b) Finally derive the z-component of the Navier-Stokes equation in non-conservatives form. [3+5]

7. State and prove the Kelvin's theorem for barotropic fluid. [1+7]

[Internal Assessment: 10 Marks]