2017

M.Sc. 2nd Semester Examination

APPLIED MATHEMATICS WITH OCEANOLOGY AND COMPUTER PROGRAMMING

PAPER—MTM-201

Full Marks : 50

Time : 2 Hours

The figures in the 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 Q. No. *1* and any *four* from the rest.

1. Answer any *four* questions : 4×2

(a) Describe one, two and three-dimensional flows.

(b) Discuss the similarity and dissimilarity between the vorticity and energy equations.

(c) Write equations for inside and outside of the boundary layer for a flat plate at angle of attack of zero incidence in 2D steady, incompressible flow without effects of gravity.

(d) Draw an infintesmally small moving element and show all energy fluxes along x-direction associated with the above element.

(e) Define vortex line and vortex tube.

(f) Write the expression for stream function for a uniform flow past a circular cylinder and hence draw stream lines around and inside the cylinder.

2. (a) Write the continuity equation for incompressible and viscous fluid flow in four forms : Integral-Conservation, Integral-Nonconservation, Differential-Conservation and Differential-Nonconservation.

(b) By some simplification, show that all above four forms of the continuity equation are equivalent to each other.

2+6

3. Draw infinitesimally small moving fluid element and show the forces in the z-direction for derivation of the z-component of the Navier-Stokes equation.

Finally derive the z-component of the Navier-Stokes equation in non-conservative form. 3+5

4. Consider steady, laminar, fully developed flow between two parallel plates separated by a distance 2H. The fluid is driven between the plates by an applied pressure gradient in the x-direction. It is assumed that the conduction in the y-direction is much greater than the conduction in x-direction.

(a) Determine the fully developed velocity distribution of the fluid as a function of the mean velocity.

(b) Determine the fully developed temperature distribution as a function of the surface and mean temperatures.

5+3

5. Write the Navier-Stokes equation in vector form and energy equation for Newtonian, imcompressible, viscous fluid flow with negligible gravity and radiation effects.

Make the above equations in non-dimensional form (Navier-Stokes equation in terms of Reynolds number $Re = \frac{UL}{\gamma}$, and energy equation in terms of Re and Prandtl number $Pr = \nu/\alpha$) with the help of characteristics length, velocity, pressure and temperature as L, U, rU^2 and $(T_W - T_C)$ respectively, where symbols have their usual meaning. 2+6

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

7. (a) Define the rectilinear vortex and then find the complex potential due to a vortex of strength k placed at a point z_0.

   (b) State and prove the Blasius' Theorem. 4+4

[Internal Assessment —10]