CWM-1.4(A)

Ph.D. Course Work Examinations, July-2023

MATHEMATICS

Course-IV-1.4(A): Advanced Fluid Mechanics

Time: 3 Hours **Max. Marks:70**

Instructions to Candidates: (i) Answer any Five full questions.

(ii) Each questions carries equal marks.

1. (a) Compute δ_1, δ_2 and δ_3 when velocity distribution in the boundary layer is $u = U\left(\frac{y}{\delta}\right)^n$.

   (b) Discuss the Blasius-Toppler solution for the boundary layer flow over a flat plate. (7+7)

2. (a) Discuss the Prandtl's boundary layer theory and what are the importance of Prandtl's boundary layer theory in fluid dynamics?

   (b) What are the main limitations of ideal fluids? (8+6)

3. (a) Derive Von Karman's integral equation for steady flow under no pressure gradient.

   (b) Based on the Von Karman's integral equation, Determine the local frictional coefficient C_f, for floe over a flat plate. (7+7)

4. (a) Explain Momentum integral equation for boundary layer by Von Karman.

   (b) Obtain the Energy integral equation for two-dimensional steady laminar flow of incompressible fluid over a semi-infinite plate. (7+7)

5. (a) Write short note on (i) Free convection (ii) forced convection (iii) Nusselt number and (iv) Prandtl number.

   (b) Derive Reynold's first integral. (7+7)

6. (a) Derive thermal boundary layer equations for the flow over a semi-infinite flat plate.

   (b) Explain the solution for cooling problem when the dissipation term is neglected. (7+7)

7. (a) In a duct in which air is flowing, a normal shock wave occurs at a Mach number 1.5. The static pressure and temperature upstream of the shock are $170\,KN/m^2$ and $23^0\,C$

respectively. Take $\gamma = 1.5$ and determine (i) pressure (ii) temperature and (iii) Mach number downstream of the shock and (iv) Strength of the shock.

(b) Discuss Wave equations in two and three dimensions. (7+7)

8. (a) Find the profile $\phi(x,t)$ of a dimensional wave propagation if at $t = 0, \phi = F(x)$ and $\frac{\partial \phi}{\partial t} = G(x)$.

(b) Explain Mack number and its importance. (7+7)

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