Menoufiya University
Faculty of Engineering
Shebin El-Kom
MPE 630
Academic Year: 2019-2020

Year: *Postgraduate*
Department: *Mechanical Power*
Subject: *Gas Dynamics*
Time Allowed: *3 Hours*
Date: *10-8-2020*

Allowed Tables and Charts: (*Gas Dynamics Tables and Charts*)

-Assume any missing data

Answer all the following Questions (100 *Marks*)

Question (1) (35 Marks)

1.1) For turbulent boundary layer, derive the equations for calculating the following: Boundary layer thickness, displacement thickness, momentum thickness, and shape factor. **[10 marks]**

1.2) A hydrofoil 0.37 m long and 1.83 m wide is placed in a water flow of 13 m/s, with $\rho = 1030$ kg/m^3 and $\nu = 1.05 \times 10^{-6}$ m^2/s.

a) Estimate the boundary layer thickness at the end of the plate. **[5 marks]**

b) Estimate the displacement thickness at the end of the plate. **[5 marks]**

c) Estimate the momentum thickness at the end of the plate. **[5 marks]**

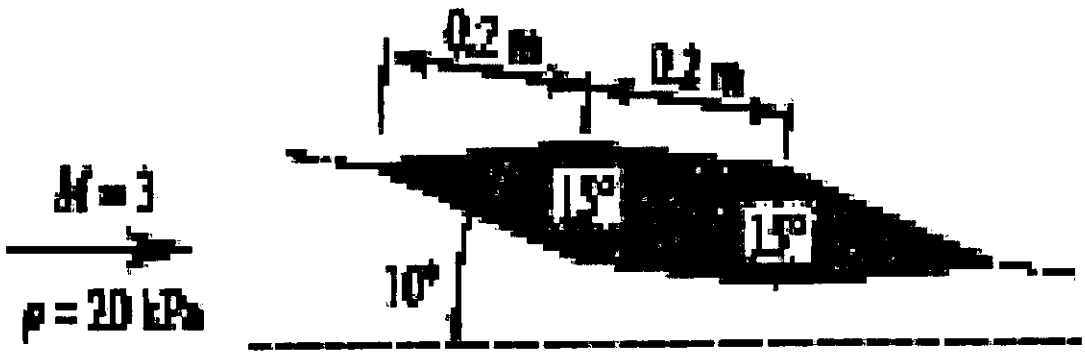
d) Estimate the shape factor. **[5 marks]**

e) Estimate the friction drag force on both sides of the plate. **[5 marks]**

Question(2) (30 Marks)

2.1) Explain with drawing, the meaning of drag and lift forces on airfoil? **[5 marks]**

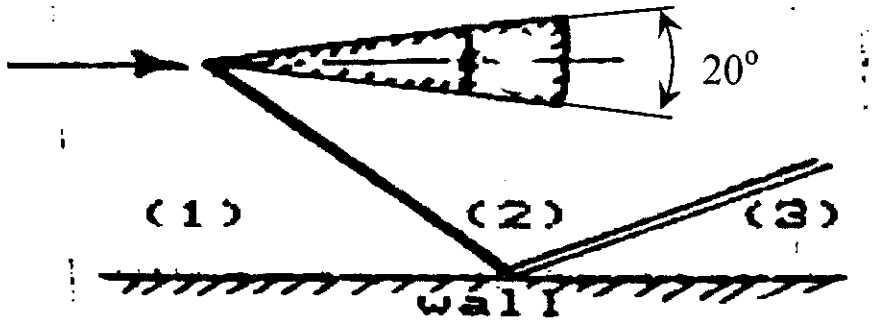
2.2) Consider a two-dimensional flow over the double-wedge airfoil in the following figure. Sketch the flow patterns and show graphically how does the pressure vary over the surface shown of the airfoil, then find the lift and drag per meter span acting on the airfoil. **[25 marks]**



Question (3) (35 Marks)

3.1) Draw the boundary layer growth showing the difference between the velocity profiles of the laminar and turbulent zones. What is the critical value of Reynolds number and how is it calculated? **[10 marks]**

3.2) An oblique shock wave is reflected over a wall as shown in the figure where the flow direction after the reflected shock is parallel to the wall. If P_1= 1 bar, M_1=3, T_1=280 K and δ =10°., find the flow properties and Mach numbers in regions (2) and (3). What happens when the angle of the first shock, δ, becomes larger and larger? **[25 marks]**



Best Wishes