Menoufia University
Faculty of Engineering
Shebin El-Kom
First Semester Examination
Academic Year: 2016-2017

Year: Post Grad. (PhD. Prep.)
Department: Mechanical Power
Subject: Advanced *Fluid Mechanics* (MPE703)
Time Allowed: 3 hours
Date: 02.01.2017

Allowed Tables and Charts: *None*

Answer all the following questions *(with neat sketches)*

Question (1) ***(50 Marks)***

A. Explain with neat sketches the following terms:
Length scale, Energy cascade, Energy backscatter, Two-point correlation. ***(8 Marks)***

B. For a boundary layer flow, derive the momentum integral equation of von –Kármán, in which the momentum thickness Θ and displacement thickness δ_1 are related to the wall shear stress τ_w with the presence of pressure gradient and free-stream velocity U_∞ as the following relation: $\frac{d\theta}{dx}+\frac{(2\theta+\delta_1)}{U_\infty}\frac{\partial U_\infty}{\partial x}=\frac{\tau_{wall}}{\rho U_\infty^2}$ ***(18 Marks)***

C. Derive the growth of the turbulent boundary layer thickness, the displacement thickness, the momentum thickness and the wall skin friction coefficient of a turbulent flow over a flat plate (without pressure gradient). How do you compute the total drag force of the plate? ***(14 Marks)***

D. Discuss the different regions in the boundary layer. Write the law of the wall, from which how do you derive the Clauser's plot relation? ***(10 Marks)***

Question (2) ***(50 Marks)***

A. For 3-dimensinal incompressible flow develop the continuity and Navier-Stokes equations in Cartesian coordinates. Reduce the final forms to steady incompressible flow. ***(20 Marks)***

B. Explain how to develop the turbulent Reynolds-stresses tensor matrix in three-dimensional turbulent flow. ***(15 Marks)***

C. Give a brief outline of the Blasius solution of laminar boundary layer for flow over a flat plate in the form: $ff''+2f'''=0$. What are the boundary conditions from which the analytical solution can be developed. Write the function of the boundary layer and displacement thicknesses developing in streamwise direction. ***(15 Marks)***

Best wishes

Professor Wageeh El-Askary