UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESSION 2011/2012

COURSE NAME	:	**AERODYNAMICS**
COURSE CODE	:	**BDE4083/ BDE40803**
PROGRAMME	:	**BACHELOR OF MECHANICAL ENGINEERING WITH HONOURS**
EXAMINATION DATE	:	**JUNE 2012**
DURATION	:	**3 HOURS**
INSTRUCTION	:	**ANSWER ALL QUESTIONS.**

THIS PAPER CONSISTS OF THREE (3) PRINTED PAGES

Q1 (a) An infinitesimally small, moving fluid element of fixed mass can be adopted as a flow model. Sketch the forces that act on this element. Show only forces in the x direction.

(7 marks)

(b) Consider xy, yz, and zx planes. Give

(i) the relationship between the shear stress and the time rate of strain.

(ii) the expression for the normal stress in terms of the viscosity coefficient μ and the bulk viscosity coefficient λ.

(3 marks)

Q2 (a) Derive the complete Navier-Stokes equations for an unsteady, compressible, three-dimensional viscous flow. These equations should be written in terms of μ and λ.

(7 marks)

(b) Reduce the governing equations in Q2(a) for

(i) incompressible flow.

(ii) inviscid flow.

(3 marks)

Q3 (a) What are the aspects that tend to diminish the accuracy of CFD Navier-Stokes solutions for the prediction of skin friction drag and heat transfer?

(5 marks)

(b) Name five flow cases that can be practically studied by solving the complete Navier-Stokes equations.

(5 marks)

Q4 (a) Consider a wing on an aviation aircraft. It is a rectangular with a span of 9 m and chord of 1m. At sea level, the aircraft is flying at cruising speed (100 km/h). By assuming that that the skin friction drag on the wing can be can be approximated by that on a flat plate of the same dimensions, calculate the skin friction drag:

(i) In the case of completely laminar flow.

(ii) In the case of completely turbulent flow.

Compare the two results.

(At sea level, $\rho_\infty = 1.23\ \text{kg/m}^3$, $\mu_\infty = 1.7894\text{x}10^{-5}\ \text{Nsm}^{-2}$)

(10 marks)

(b) By considering the same case in Q4(a), calculate the boundary-layer thickness at the trailing edge for

(i) completely laminar flow, and

(ii) completely turbulent flow

(5 marks)