Register Number: ………………..

B.E DEGREE EXAMINATIONS: NOV 2015

(Regulation 2009)

Seventh Semester (Fast Track)

AERONAUTICAL ENGINEERING

AER145: Boundary Layer Theory

Time: Three Hours **Maximum Marks: 100**

Answer all the Questions:-

PART A (10 x 1 = 10 Marks)

1. The non-dimensional number relating to continuum concept is
   a) Reynolds Number b) Knudsen Number
   c) Froude Number d) Euler Number
2. Laser Doppler Anemometry is not applicable for
   a) Supersonic flows b) Flow near the wall
   c) Non-transparent flow d) Multiphase flows
3. A higher Shape Factor implies
   a) Strong adverse pressure gradient b) Strong favourable pressure gradient
   c) Flow is laminar d) Flow is unsteady
4. Choose the expression for the momentum thickness of an incompressible boundary layer
   a) $\frac{5.0x}{\sqrt{R_{ex}}}$ b) $\int_0^\infty \left(1-\frac{u}{U_\infty}\right)dy$
   c) $\int_0^\infty \frac{u}{U_\infty}\left(1-\frac{u}{U_\infty}\right)dy$ d) $\int_0^\infty \left(\frac{u}{U_\infty}\right)dy$
5. For an incompressible laminar boundary layer,
   a) $\frac{\partial^2 u}{\partial y^2} > 0$ b) $\frac{\partial^2 u}{\partial y^2} < 0$
   c) $\frac{\partial^2 u}{\partial y^2} = \infty$ d) $\frac{\partial^2 u}{\partial y^2} = \text{constant}$
6. The boundary layer separation is caused by
   a) Favourable pressure gradient b) Adverse pressure gradient
   c) Reduction of pressure to vapour pressure d) Boundary layer thickness reducing to zero

7. Prandtl number is defined as

a) $\frac{\textit{Momentum diffusivity}}{\textit{Thermal diffusivity}}$

b) $\frac{\text{Thermal } \textit{diffusivity}}{\textit{Momentum diffusivity}}$

c) $\frac{\text{Convective heat transfer}}{\textit{Conductive} \text{ heat transfer}}$

d) $\frac{\text{Thickness of thermal boundary layer}}{\text{Thickness of velocity boundary layer}}$

8. Thermal diffusivity α is defined as

a) $\frac{\rho c}{k}$

b) $\frac{k}{\rho c_p}$

c) $\frac{h}{\rho c_p}$

d) $\frac{k}{\rho Cv}$

9. Isotropic turbulence implies

a) Velocity fluctuations have directional preference

b) Velocity fluctuations are independent of direction

c) Viscous effects are predominant

d) Non homogeneous

10. In a turbulent flow over a flat plate the transition to turbulence is normally observed at a Reynolds number (based on distance along the plate length) of

a) $3.5*10^5$

b) $2.4*10^7$

c) around 2700

d) 15000

PART B (10 x 2 = 20 Marks)

11. Define fluid from fluid dynamic point of view.
12. What is King's law for hot wire anemometry?
13. Define displacement thickness.
14. What is the basic difference between laminar and turbulent boundary layer?
15. What is the significance of Blasius solution?
16. Define shape factor and explain its significance.
17. What is Reynolds analogy?
18. What are Falkner- Skan wedge flows and what is its importance?
19. Define turbulence intensity.
20. What are the factors causing transition to turbulence?

PART C (5 x 14 = 70 Marks)

21. a) Derive the momentum equation in differential form in Cartesian coordinates.

(OR)

b) With a neat sketch describe the operating principle of Doppler anemometer.

22. a) (i) Derive an expression for displacement thickness for incompressible laminar boundary layer. (7)

(ii) Derive an expression for momentum thickness for incompressible laminar boundary layer. (7)

(OR)

b) Water flows over a flat plate at a free stream velocity of 0.15 m/s. There is no pressure gradient and laminar boundary layer is 6 mm thick.

Assume velocity profile as $\frac{u}{U_\infty} = \sin\frac{\pi}{2}\left[\frac{y}{\delta}\right]$ calculate the local wall shear stress and skin friction coefficient ($\mu = 1.02 * 10^{-3} \frac{kg}{ms}, \rho = 1000 \text{ kg / m}^3$)

23. a) Derive the momentum integral relation of Karman and explain its significance.

(OR)

b) Write short notes on the following:

(i) Self similar profiles (7)

(ii) Blasius solution for flat plate flow (7)

24. a) Derive an expression for the thermal boundary layer thickness in terms of Reynolds Number and Prandtl Number.

(OR)

b) Write short note on:

(i) Pohlhausen method (7)

(ii) Boundary layer transition (7)

25. a) Derive the universal velocity defect law of Prandtl. Represent that graphically.

(OR)

b) Write short notes on

(i) Law of the wall (7)

(ii) Law of the wake (7)

****