Seat No: _____________ **Enrollment No: __________________**

PARUL UNIVERSITY

FACULTY OF ENGINEERING & TECHNOLOGY

B.Tech. Summer 2018 - 19 Examination

Semester: 5 **Date: 18/05/2019**
Subject Code: 03101303 **Time: 10:30am To 01:00pm**
Subject Name: Aerodynamics-II **Total Marks: 60**

Instructions:
1. All questions are compulsory.
2. Figures to the right indicate full marks.
3. Make suitable assumptions wherever necessary.
4. Justify your answers using suitable diagrams.
5. Start new question on new page.

Q 1. Objective Type Questions - (All are compulsory) (Each of one mark) **15**

1. In a two-dimensional, steady, fully developed, laminar boundary layer over a flat plate, if x is the streamwise coordinate, y is the wall normal coordinate and u is the streamwise velocity component, which of the following is true?

a) $\frac{\partial u}{\partial x} >> \frac{\partial u}{\partial y}$ b) $\frac{\partial u}{\partial y} >> \frac{\partial u}{\partial x}$

c) $\frac{\partial u}{\partial x} = \frac{\partial u}{\partial y}$ d) $\frac{\partial u}{\partial x} = -\frac{\partial u}{\partial y}$

2. Winglets are used on wings to minimize

a) Skin friction drag b) profile drag
c) Wave drag d) induced drag

3. Consider a flow of air (ρ_∞ = 1.23 kg/m^3) over a wing of chord length 0.5 m and span 3 m. Let the free stream velocity be v = 100 m/s and the average circulation around the wing be Γ = 10 m^2/s per unit span. The lift force acting on the wing is

a) 615 N b) 1845 N
c) 3690 N d) 4920 N

4. Laminar flow airfoils are used to reduce

a) Trim drag b) skin friction drag
c) Induced drag d) wave drag

5. A model airfoil in a wind tunnel that is operating at 50 m/s develops a minimum pressure coefficient of -6.29 at some point on its upper surface. The local speed at that point is

a) 50 m/s b) 125 m/s
c) 135 m/s d) 150 m/s

6. Why centre of pressure moves with change of angle of attack?
7. Sketch the effect of Aspect ratio on C_L versus C_D curve.
8. Write the Bernoulli's equation and its limitation for viscous flows.
9. What are the features of Supercritical airfoil?
10. Write the specifications of NACA 23012.
11. Aerodynamics centre is a _________ point on a chord line of an airfoil.
12. For the __________ boundary layer case skin friction drag is lower.
13. Formula for lift force per unit span by *Kutta-Joukowski theorem* is __________.
14. The d'Alembert's paradox says that the ______ force is zero on a body moving with constant velocity relative to the fluid.
15. The critical Reynold's of flat plate is ________.

Q 2. Answer the following questions in brief. (Attempt any three) **15**

A. Define starting vortex using Kelvin's circulation theorem.

B. What is reverse swing in cricket ball? How aerodynamics plays a role on it?

C. Explain the methods of reducing the transonic wave drag

D. A symmetrical airfoil section produces a lift coefficient of 0.53 at an angle of attack of 5^o measured from its chord line. An untwisted wing of elliptical planform and aspect ratio 6 is made of this airfoil. At an angle attack of 5^o relative to its chordal plane, this wing would produce how much lift coefficient?

Q 3. **A**. Derive nonlinear Navier-Stokes equations for the boundary-layer. **7**

B Derive the linearized supersonic pressure coefficient formula. Using linearized theory, calculate the lift and drag coefficients for a flat plate at a 5° angle of attack in a Mach 3 flow. **8**

OR

B. Derive the Prandtl-Glauert compressibility correction factor for compressible flow an airfoil. If the theoretical lift coefficient for a thin, symmetric airfoil in an incompressible flow is $c_l = 2\pi\alpha$. Calculate the lift coefficient for $M_\infty = 0.7$.

Q 4. **A**. For a thin airfoil prove the theoretical result that *the lift coefficient is linearly proportional to angle of attack.*

7

OR

A. Consider an NACA 23012 airfoil. The mean camber line for this airfoil is given by

$$\frac{z}{c} = 2.6595\left[\left(\frac{x}{c}\right)^3 - 0.6075\left(\frac{x}{c}\right)^2 + 0.1147\left(\frac{x}{c}\right)\right] \qquad \text{for } 0 \le \frac{x}{c} \le 0.2025$$

and

$$\frac{z}{c} = 0.02208\left(1 - \frac{x}{c}\right) \qquad \text{for } 0.2025 \le \frac{x}{c} \le 1.0$$

Calculate (*a*) the angle of attack at zero lift, (*b*) the lift coefficient when $\alpha = 4^\circ$.

B. Prove that the *coefficient of induced drag $C_{D,i}$ is inversely proportional to aspect ratio* for elliptical lift distribution. **8**