Reg. No.										

MANIPAL INSTITUTE OF TECHNOLOGY

MANIPAL

(A constituent unit of MAHE, Manipal)

IV SEMESTER B.TECH. (AERONAUTICAL ENGINEERING)

END SEMESTER EXAMINATIONS, MAY/JUNE 2018

SUBJECT: AERODYNAMICS [AAE 2201]

REVISED CREDIT SYSTEM
(12/06/2018)

Time: 3 Hours MAX. MARKS: 50

Instructions to Candidates:

- Answer **ALL** the questions.
- Missing data may be suitable assumed.

1A. Explain the followings **(4)**
(a) Rotational flow
(b) Stream function
(c) Circulation
(d) Aerodynamic Centre

1B. Define induced drag. Also show that coefficient of induced drag is inversely proportional to the aspect ratio. **(3)**

1C. The velocity vector in a fluid flow is given by $V = 4x^3i - 10x^2yj + 2tk.$ **(3)**
Find the velocity and acceleration of a fluid particle at (2,1,3) at time t=1.

2A. Take non-lifting flow over a circular cylinder of a given radius, with free stream velocity is 20 ft/s. If it is doubled, does the shape of streamlines change? Explain. **(2)**

2B. Explain combination of uniform flow with source and sink. Obtain expressions for stream and velocity potential functions. **(4)**

2C. Lift coefficient for a lifting flow over a circular cylinder is 5. Calculate the peak(negative) pressure coefficient. Also find the location of stagnation points. **(4)**

3A. Write a brief note on wind tunnel flow visualization techniques. **(2)**

3B. Explain the working of low speed closed circuit wind tunnel with a neat sketch. **(4)**

3C. Consider a low-speed subsonic wind tunnel with a 12/1 contraction ratio for the nozzle. If the flow in the test section is at standard sea level conditions with a velocity of 50 m/s. Calculate the height difference in a U-tube mercury **(4)**

manometer with one side connected to the nozzle inlet and the other to the test section.

4A. With the help of fundamental equation of thin airfoil theory derive and prove that for symmetric airfoil, center of pressure is at quarter chord point of the airfoil and lift is directly proportional to angle of attack. **(5)**

4B. For an airfoil, camber is described by following equation **(5)**

$$\frac{z}{c} = 0.195\left(0.765\frac{x}{c} - \left(\frac{x}{c}\right)^2\right) \text{ for } \quad 0 \le \frac{x}{c} \le 0.38$$

$$\frac{z}{c} = 0.164\left(0.26 + 0.915\frac{x}{c} - \left(\frac{x}{c}\right)^2\right) \text{ for } \quad 0.38 \le \frac{x}{c} \le 1$$

Use thin airfoil theory to calculate (a) the angle of attack at zero lift (b) lift coefficient when $\alpha=4^o$ (c) the moment of coefficient about quarter chord point (d) the location of centre of pressure in terms of x_{cp}/c, when $\alpha=4^o$

5A. Why do we prefer thicker airfoil in civil aviation? Write down the effect of C_{Lmax} on thicker and thinner airfoils. **(2)**

5B. Derive and prove that for elliptical lift distribution both the induced angle and induced drag are directly proportional to its coefficient of lift. **(4)**

5C. Write down key features of modern subsonic airfoils and explain the various types of drag on an airfoil. **(4)**