

**B.Tech. AEROSPACE ENGINEERING
(BTAE)****Term-End Examination**

00024

June, 2017

BAS-012 : AERODYNAMICS – I*Time : 3 hours**Maximum Marks : 70*

Note : Attempt any **seven** questions. All questions carry equal marks. Use of scientific calculator is permitted.

1. (a) How are drag and lift forces caused on a body immersed in a moving fluid ? Explain.
- (b) Draw and explain the concept of subsonic-supersonic flow through a convergent-divergent (CD) nozzle. Also show the variation in properties along the length of the nozzle. 5+5
2. (a) Discuss the applications of thin airfoil theory.
- (b) Explain how a flow over a circular cylinder can be transformed into a flow over a flat plate using Zhukovsky transformation. 5+5

3. (a) The velocity vector in a fluid flow is given by $\mathbf{V} = 3\hat{i} + 6\hat{j}$. Determine the equation of the streamline passing through the origin.

(b) What is circulation ? Derive an expression for circulation of a free-vortex of radius R. 5+5

4. (a) Draw the pitching moment curve for supersonic profiles. How do pitching moment and centre of pressure vary with the angle of attack for a supersonic profile ?

(b) The velocity components in a two-dimensional flow are

$$u = \frac{y^3}{3} + 2x - x^2y, \text{ and}$$

$$v = xy^2 - 2y - \frac{x^3}{3}.$$

Show that these components represent a possible case of an irrotational flow. 5+5

5. (a) Differentiate between the following :

(i) Stream function and Velocity potential function

(ii) Laminar flow and Turbulent flow

(b) If, for a two-dimensional potential flow, the velocity potential is given by $\phi = x(2y - 1)$ determine the velocity at the point P(4, 5). Also determine the value of stream function ψ at the point P. 5+5

6. (a) Explain the steady state boundary layer flow over a flat surface.

(b) The velocity vector in a fluid flow is given by

$$\mathbf{V} = 2x^3 \hat{\mathbf{i}} - 5x^2y \hat{\mathbf{j}} + 4t \hat{\mathbf{k}}.$$

Find the velocity and acceleration of a fluid particle at (1, 2, 3) at time $t = 1$. 5+5

7. (a) What do you mean by washin and washout for wings ?

(b) Experiments were conducted in a wind tunnel with a wind speed of 50 km/hour on a flat plate of size 2 m long and 1.0 m wide. The density of air is 1.15 kg/m^3 . The plate is kept at such an angle that coefficient of lift and drag are 0.75 and 0.15 respectively.

Determine 5+5

(i) lift force,

(ii) drag force,

(iii) resultant force and its direction, and

(iv) power exerted by the air on the plate.

8. (a) Derive the fundamental equation for thin airfoil theory and give the assumptions that are made.

(b) Define angular velocity, strain rate and vorticity of a fluid element. 5+5

9. Write short notes on any **two** of the following : $2 \times 5 = 10$

- (a) Finite Wing
 - (b) Kutta-Condition
 - (c) D'Alembert's Paradox
 - (d) Supercritical Airfoil
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