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BAS-012

B.Tech. AEROSPACE ENGINEERING (BTAE)

Term-End Examination

00013

June, 2018

BAS-012 : AERODYNAMICS – I

Time : 3 hours *Maximum Marks : 70*

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

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1. (a) Define 'streamline'. What do streamlines indicate ?

(b) Consider the following steady, incompressible, two-dimensional velocity field :

$$V = x^2 \hat{i} + (-2xy - 1) \hat{j};$$

Is this flow rotational or irrotational ? Justify your answer. *3+4*

2. (a) How is the Mach number of a flow defined ? What does a Mach number 2 indicate ? What is a compressible fluid ?

(b) A tank is filled with oil whose density is $\rho = 850 \text{ kg/m}^3$. If the volume of the tank is $V = 2 \text{ m}^3$, determine the amount of mass in the tank. *3+4*

3. A steady two-dimensional incompressible flow field in the xy-plane has a stream function given by

$$\psi = ax^2 - by^2 + cx + dxy$$

where a, b, c, d are constants.

(i) Obtain expressions for velocity components u, v.

(ii) Verify that the flow field satisfies the incompressible continuity equation. *3+4*

4. (a) Is it possible to accelerate a gas to a supersonic velocity in a converging nozzle ? Explain.

(b) A 100 litre container is filled with 1 kg of air at a temperature of 27°C. What is the pressure in the container ? *3+4*

Given :

Gas constant of air R = 0·287 kPa m^3/kg K.

5. (a) Consider the steady two-dimensional velocity field given by :

$V = (1{\cdot}6 + 1{\cdot}8\,x)\,\hat{i} + (1{\cdot}5 - 1{\cdot}8\,y)\,\hat{j}$.

Verify that this flow field is incompressible.

(b) For a certain incompressible two-dimensional flow field, the velocity component in the y direction is given by the equation $v = 3xy - x^2y$.

Determine the velocity component in the x-direction so that the continuity equation is satisfied. *3+4*

6. (a) Define any ***three*** of the following :

(i) Pitching moment

(ii) Downwash

(iii) Airfoil

(vi) Magnus effect

(b) Differentiate between any ***two*** of the following :

(i) Lagrangian and Eulerian approach

(ii) Sink and Source flows

(iii) Laminar and Turbulent flows *3+4*

7. (a) Define and explain Bernoulli's equation.

(b) State all the assumptions of Bernoulli's equation. List down its engineering applications. *3+4*

8. A flat plate 2 m × 2 m moves at 40 km/hour in stationary air of density 1·25 kg/m^3. If the co-efficient of drag and lift are 0·2 and 0·8 respectively, find :

(a) the lift force,

(b) the drag force,

(c) the resultant force, and

(d) the power required to keep the plate in motion. *7*

9. Show that the vorticity for a plane flow on the x-y plane is given by 7

$$\omega_z = -\left(\frac{\partial^2 \psi}{\partial x^2} + \frac{\partial^2 \psi}{\partial y^2}\right).$$

10. Describe the construction of a pitot tube with the help of a neat diagram. What physical quantity can be measured by a pitot tube and how can it be measured ? 7

11. Explain subsonic, transonic, supersonic and hypersonic flows in terms of Mach number. Also give neat sketches with Mach number regimes for each of them.

12. Explain in detail the boundary layer separation with the help of neat sketches. 7