Aerodynamics-1 VTU CBCS Question Paper Set 2018

CBCS Scheme

USN | | | | | | | | | | |

15AE42

Fourth Semester B.E. Degree Examination, Dec.2017/Jan.2018
Aerodynamics – I

Time: 3 hrs. Max. Marks: 80

Note: ***Answer FIVE full questions, choosing one full question from each module.***

Module-1

1 a. Explain briefly Mach number regimes with relevant sketches of flow over an airfoil. **(08 Marks)**

b. Consider the velocity field given by $u = \frac{y}{(x^2+y^2)}$ and $v = \frac{-x}{(x^2+y^2)}$. Calculate the equation of the stream line passing through the point (0, 5) and also calculate the vorticity. **(08 Marks)**

OR

2 a. Define following with relevant expressions:
(i) Path line (ii) Stream line (iii) Angular velocity (iv) Circulation **(08 Marks)**

b. Derive the integral form of momentum equation, according to control volume approach. **(08 Marks)**

Module-2

3 a. Explain airfoil-section nomenclature and wing planform geometry with a neat sketch. **(08 Marks)**

b. Obtain the expression for N′ and A′ in terms of τ, p and θ. Deduce C_n and C_a. **(08 Marks)**

OR

4 a. Explain briefly the center of pressure and aerodynamic center. **(08 Marks)**

b. Consider the NACA 23012 airfoil. At $\alpha = 4^\circ$, $C_l = 0.55$ and $Cm_{C/4} = -0.005$. The zero-lift angle of attack is -1.1°. Also, at $\alpha = -4^\circ$, $Cm_{C/4} = -0.0125$. Calculate the location of the aerodynamic center for the NACA 23012 airfoil. **(08 Marks)**

Module-3

5 a. Obtain an expression for the following for a lifting flow over cylinder:
(i) Stream function (ψ) (ii) Location of stagnation points.
(iii) Pressure co-efficient. **(08 Marks)**

b. Consider the lifting flow over a circular cylinder with a diameter of 0.5 m. The freestream velocity is 25 m/s and the maximum velocity on the surface of the cylinder is 75 m/s. The freestream conditions are those for a standard altitude of 3 km. Calculate the lift per unit span on the cylinder. (Assume $\rho = 0.90926$ kg/m^3 at 3 km altitude, maximum velocity occurs at when $\theta = 90^\circ$) **(08 Marks)**

OR

6 a. Write short notes on the following:
(i) Kutta condition (ii) Kelvin's circulation theorem. **(08 Marks)**

b. Using classical thin airfoil theory, obtain the expression $C_l = 2\pi\alpha$ for a symmetric airfoil. **(08 Marks)**

Module-4

7 a. Obtain the expression for the velocity, induced by infinite and semi-infinite vortex element using the Biot-Savart law. **(08 Marks)**

b. Explain Downwash and induced drag. **(08 Marks)**

OR

8 a. The circulation distribution over a finite wing is of elliptic form, $\Gamma(y) = \Gamma_0 \sqrt{1 - \left(\frac{2y}{b}\right)^2}$, where $b/2$ is the semi span of wing. Obtain the closed form of expression, the induced angle of attack and induced drag co-efficient. **(08 Marks)**

b. Consider a finite wing with an aspect ratio of 8 and taper ratio of 0.8. The airfoil section is thin and symmetric. Calculate the lift and induced drag co-efficient for the wing when it is at an angle of attack of 5°. Assume that $\delta = \tau = 0.055$. **(08 Marks)**

Module-5

9 a. Briefly explain simplified horse-shoe vortex model and formation flight. **(08 Marks)**

b. What are high lift devices? List them. Explain their effects on aerodynamic characteristic. **(08 Marks)**

OR

10 a. What is swept wing? Bring out the aerodynamic characteristics of swept wing, with relevant graphs and sketches. **(08 Marks)**

b. Explain (i) Drag-Divergence Mach number. (ii) Transonic area rule. **(08 Marks)**

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15AE42

Fourth Semester B.E. Degree Examination, June/July 2017
Aerodynamics – I

Time: 3 hrs. Max. Marks: 80

Note: Answer FIVE full questions, choosing one full question from each module.

Module-1

1 a. Derive the differential form of energy equation through control volume approach. **(08 Marks)**

b. Consider the velocity field given by $u = \frac{y}{(x^2+y^2)}$ and $v = \frac{x}{(x^2+y^2)}$. Calculate the equation of the streamline passing through the point (0, 5) and calculate the circulation around a circular path of radius 5m. Assume that u and v are in units of meters per second. **(08 Marks)**

OR

2 a. Derive the differential form of momentum equation through control volume approach. **(08 Marks)**

b. Derive an equation for vorticity ξ. **(08 Marks)**

Module-2

3 a. Derive an expression for the axial force coefficient (Ca) and normal force coefficient (C_n) of an airfoil. **(12 Marks)**

b. Consider an airfoil at 12° AoA. The normal and axial force coefficients are 1.2 and 0.03 respectively. Calculate the lift and drag coefficient. **(04 Marks)**

OR

4 a. Define centre of pressure and aerodynamic centre. Derive $M'_{LE} = -\frac{C}{4}L' + M'_{C/4} = -X_{Cp}L'$ for centre of pressure with neat sketches showing force and moment system. **(08 Marks)**

b. Consider two different points on the surface of an airplane wing flying at 80 m/s. The pressure coefficient and flow velocity at point 1 are -1.5 and 110 m/s respectively. The pressure coefficient at point 2 is -0.8. Assuming compressible flow, calculate the flow velocity at point 2. **(08 Marks)**

Module-3

5 a. Briefly explain the following elementary flows with neat sketches and write Ψ and ϕ for each of them:
i) Uniform flows
ii) Source and sink flows
iii) Doublet flow
iv) Vortex flow **(12 Marks)**

b. Consider the lifting flow over a circular cylinder. The lift coefficient is 5. Calculate the peak (negative) pressure coefficient. **(04 Marks)**

OR

6 a. Derive the expression $C_l = 2\pi\alpha$, using the classical thin airfoil theory. **(08 Marks)**

b. Consider the lifting flow over a circular cylinder with a diameter of 0.5 m. the freestream velocity is 25 m/s, and the maximum velocity on the surface of the cylinder is 75 m/s. The freestream conditions are those for a standard altitude of 3 km. Calculate the lift per unit span on the cylinder. **(04 Marks)**

c. Consider a thin flat plate at 5 deg angle of attack, calculate the :
   i) Lift coefficient
   ii) Moment coefficient about the LE
   iii) Moment coefficient about the quarter chord point and
   iv) Moment coefficient about the TE. **(04 Marks)**

Module-4

7 a. Derive an expression for lift coefficient and induced drag coefficient in terms of circulation strength Γ(Y) for a finite using through Prandtl's classical lifting line theory. **(10 Marks)**

b. Obtain the expression for the velocity induced by infinite vortex filament using the Biot-Savart law. **(06 Marks)**

OR

8 a. Derive the expression for the induced angle of attack and induced drag coefficient using elliptical lift distribution. **(10 Marks)**

b. Discuss briefly the following:
   i) Vortex filament
   ii) Helmholtz's vortex theorem **(06 Marks)**

Module-5

9 What are high lift devices? Discuss in detail about the high lift devices and explain their effects on airplane performance with a neat sketch. **(16 Marks)**

OR

10 a. Discuss the advantages and disadvantages of forward-swept wings. **(08 Marks)**

b. Write short notes on the following:
   i) Formation of flight
   ii) Influence of down wash on tail plane
   iii) Ground effect **(08 Marks)**

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