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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 (C_a) 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)

Important Note : 1. On completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages.
2. Any revealing of identification, appeal to evaluator and/or equations written eg, 42+8 = 50, will be treated as malpractice.

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 $\Gamma(Y)$ 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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