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 ρ = 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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