CBCS SCHEME

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17AE/AS42

Fourth Semester B.E. Degree Examination, Dec.2019/Jan.2020
Aerodynamics – I

Time: 3 hrs. Max. Marks: 100

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

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.

Module-1

1 a. Derive the integral form of continuity equation according to control volume approach and hence deduce the differential form. **(10 Marks)**

b. Define the following with relevant expression :
i) Path line ii) Stream line iii) Streak line iv) Circulation. **(10 Marks)**

OR

2 a. The stream function for a two dimensional flow is given by $\psi = 2xy$, calculate the velocity at point P(2, 3). Find the velocity potential function ϕ. **(07 Marks)**

b. Obtain an expression for
i) Angular velocity
ii) Vorticity
iii) Velocity Potential **(09 Marks)**

c. Relation between the stream function and velocity potential. **(04 Marks)**

Module-2

3 a. Obtain the expression for N' and A' and the moment M'_{LE} interms of P, θ and τ. **(10 Marks)**

b. Define centre of pressure and prove that $-L^1 X_{cp} = -\frac{C}{4}L' + M'_{C/4}$ **(05 Marks)**

c. NACA 4412 airfoil section at an angle of attack of 4°, coefficient of lift is 0.85 and $C_{m,\,C/4} = -0.09$. Calculate the centre of pressure. **(05 Marks)**

OR

4 a. Derive $\overline{X}_{ac} = -\frac{m_0}{a_0} + 0.25$ where $\overline{X}_{ac}$ the location of the aerodynamic centre is as a function of Chorld length, m_0 is the slope of moment coefficient curve and a_0 is the slope of lift coefficient curve. **(10 Marks)**

b. Consider the NACA 23012 airfoil At $\alpha = 4°$, $C_\ell = 0.55$ and $C_{m,C/4} = -0.005$. The zero lift angle of attack is $-1.1°$ also at $\alpha = -4°$, $C_{m\ C/4} = -1.0125$. Calculate the location of the aerodynamic center for the NACA 23012 airfoil. **(10 Marks)**

Module-3

5 a. Consider Non-lifting flow over a circular cylinder and derive the expression.
$C_p = 1 - 4\,\text{Sin}^2\theta$ **(10 Marks)**

b. Lifting flow over a circular cylinder with diameter of 0.5m. The free stream velocity is 25m/sec and the maximum velocity on the surface of the cylinder is 75 m/sec. The free stream condition are those for a standard altitude of 3km. Calculate the lift/unit span of the cylinder (Assume $\rho = 0.90926$ kg/m^3 at 3km attitude, maximum velocity occurs at when $\theta = 90°$) **(10 Marks)**

OR

6 a. Explain the following with neat sketches and relevant expression.
   i) Kelvin's circulation theorem
   ii) Kutta – Joukowski theorem
   iii) Kutta condition. **(10 Marks)**

b. Using classical thin airfoil theory, obtain the expression $\frac{dC_\ell}{d\alpha} = 2\pi$ for a symmetric airfoil. **(10 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. Use 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 coefficient. **(12 Marks)**

OR

8 a. Discuss briefly the following :
   i) Down wash
   ii) Induced Drag
   iii) Heimboltz's theorem **(10 Marks)**

b. Consider a finite wing with an aspect ratio of 0.8. The airfoil section is thin and symmetric. Calculate the lift and induced drag coefficient for the wing when it is at an angle of attack of 5°. Assume $\delta = \tau$ and $\delta = 0.055$. **(10 Marks)**

Module-5

9 a. Explain simplified horse shoe vortex model and prove that $S^1 = \frac{\pi}{4}S$. **(10 Marks)**

b. Explain influence of Down wash on the tail plane and prove that

$$\frac{d\xi}{d\alpha} = \frac{8a_0}{\pi^3\,AR}(1+\text{Sec}\,\beta)$$ **(10 Marks)**

OR

10 a. What are high lift devices? Explain with neat sketches. **(10 Marks)**

b. Write a notes on the following :
   i) Formation of flight
   ii) Transonic area rule
   iii) Ground effects. **(10 Marks)**

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