CBCS SCHEME

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21AE/AS42

Fourth Semester B.E. Degree Examination, Dec.2023/Jan.2024
Aerodynamics

Time: 3 hrs. Max. Marks: 100

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

Module-1

1 a. Derive the pressure coefficient using non-lifting flow over a circular cylinder. **(10 Marks)**

b. Write short note on D'Alembert's paradox. **(04 Marks)**

c. Plot the streamlines and potential lines for a uniform flow of velocity 5 m/s. **(06 Marks)**

OR

2 a. Derive an expression for lift curve slope for a symmetric airfoil using classical thin airfoil theory. **(10 Marks)**

b. Draw the combination of source, sink and uniform flow and write the expression denoting the stream function of that flow combination. **(04 Marks)**

c. Air flows radially outward from a source of strength 0.628 m^2/s. The pressure at a radius of 50 mm is 200 kN/m^2. Find (i) Pressure at a radius of 500 mm (ii) Plot streamlines and potential lines. **(06 Marks)**

Module-2

3 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 $\frac{b}{2}$ is the semi-span of wing. Obtain the expression for induced angle of attack and induced drag coefficient. **(10 Marks)**

b. Derive the induced velocity for semi-infinite and infinite vortex filament using Biot-Savart law. **(10 Marks)**

OR

4 a. Derive an expression for lift coefficient and induced drag coefficient in terms of circulation strength $\Gamma(y)$ for a finite wing through Prandtl lifting line theory. **(10 Marks)**

b. Consider a finite wing with an aspect ratio of 8 and taper ratio of 0.8. Air foil section is thin and symmetrical. 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-3

5 a. Explain in detail about simplified horse shoe vortex model with proper expression. **(10 Marks)**

b. Describe in detail about super critical airfoil. **(04 Marks)**

c. Explain with neat sketch about formation flight. **(06 Marks)**

OR

6 a. Explain the following with a neat sketch :
   (i) Drag Divergence Mach number.
   (ii) Transonic area rule. **(10 Marks)**

b. Explain briefly about subsonic and supersonic leading edges. **(04 Marks)**

c. Write short notes on the following :
   (i) Downwash on tailplane.
   (ii) Ground effect. **(06 Marks)**

Module-4

7 a. Draw a neat sketch showing the variation of pressure along the convergent divergent duct for various back pressure and explain. **(10 Marks)**

b. Derive the expression for static temperature and density ratio in terms of Mach number. **(10 Marks)**

OR

8 a. Derive the expression for area ratio of compressible flow through a variable area duct. **(10 Marks)**

b. Derive the expression for mass flow rate per unit area in terms of Mach number and explain the condition for maximum mass flow rate. **(10 Marks)**

Module-5

9 a. Derive Prandtl equations for normal shock waves in perfect gas. **(10 Marks)**

b. Classify shocks according to the position with respect to the body. **(04 Marks)**

c. Obtain the expression for downstream Mach number across oblique shock wave. **(06 Marks)**

OR

10 a. Derive the expression for Rankine Hugonict equation of a normal shock wave. **(10 Marks)**

b. Explain briefly about detached shocks and Mach reflection with neat sketch. **(10 Marks)**

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