AN F311 – Principles of Aerodynamics

Comprehensive Semester Exam – Semester 1 (2021-22)

180 Mins – 80 Marks (40% Weightage)

**CLOSED BOOK**

**SECTION-1**

**This section contains short or one line kind of questions. Do not write more than two lines for any of the question. Each question carries 2 Marks. Write all the questions for this section at one place.**

**8x2 Marks = 16 Marks**

1. Net circulation enclosed by a symmetric airfoil at zero angle of attack?

2. What is incompressibility assumption?

3. What is downwash? How does it affect the lift generation?

4. What is induced drag?

5. If the u1 and u2 are the velocity components along the shock wave for the fluid upstream and downstream of an oblique shock wave, what is the relationship between u1 and u2?

6. What is stagnation speed of sound and how is it different from speed of sound for a compressible fluid flow?

7. Will the speed of sound be unique for a given supersonic fluid flow over a body?

8. What kind of shock wave we can expect in a ram jet air breathing engines?

Section – II

1. In a NACA 4412 airfoil, what is the location of camber, maximum camber and maximum thickness? (2x3 = 6Marks)

2. For a two dimensional thin flat plate of chord length 10cm placed in a uniform flow with a free-stream velocity of 8m/s, wherein the plate makes an angle of 5deg with flow field. Determine the lift force per unit span-wise depth? Determine the coefficient of moment about the leading edge, and at the aerodynamic center? Consider the density of the fluid as 1kg/m3.

 (6+2+2 = 10Marks)

3.

a. Derive conservation of mass and momentum for one dimensional steady, compressible and inviscid flow from Navier Stokes equations. (4+5 = 9Marks)

b. If we are using a static pitot tube for measuring the sub-sonic compressible fluid flow having a density of 1kg/m3 and speed 250m/s at 25degC. The stagnation pressure reading from the pitot tube? (2 Marks)

c. Derive the relationship between the stagnation temperature and the sonic temperature? What will be the sonic temperature for the problem given in part (b) (6+2 = 8Marks)

4. What is the physical interpretation of the Mach number? Derive Mach number using this physical interpretation. (2+8 = 10Marks)

5. For a supersonic flow over a wedge, show that the angle which the shock wave makes with the horizontal, i.e. Mach angle, for the supersonic flow over a wedge is $sin^{-1}(1/M)$. If the angle of wedge is smaller than Mach angle then what is the type of shock wave that will be generated? If the disturbance propagates with a speed greater than speed of sound, what will be the shock wave angle with respect to the Mach angle? If the wedge angle is greater than the shock wave angle what will happen to the shock wave? (5+1+2+2 = 10 Marks)

6. For a finite sized thin airfoil which can be assumed as flat plate at 3.14deg to the free-stream, if the lift distribution is elliptic in nature due to the finite aspect ratio of 10. What will be the induced drag coefficient? For an inviscid flow, what will be the total drag? What will be the slope of the lift coefficient vs angle of angle for the finite sized airfoil? (4+1+4 = 9 Marks)