CBCS SCHEME

USN | | | | | | | | | | |

15AE61

Sixth Semester B.E. Degree Examination, Jan./Feb.2021
Aerodynamics – II

Time: 3 hrs. Max. Marks: 80

Note: 1. ***Answer any FIVE full questions, choosing ONE full question from each module.***
2. ***Use of appropriate Gas/Shock tables may be permitted.***

Module-1

1 a. Consider unsteady and compressible flow, obtain differential form of continuity equation using control volume approach. **(10 Marks)**

b. Show that the speed of sound in a calorically perfect gas is a function of temperature only. **(06 Marks)**

OR

2 a. Derive an expression for Area ratio as a function of Mach number and explain the variation of area ratio with Mach number with neat graph. **(10 Marks)**

b. Air is discharged from a reservoir at $P_0 = 6.91$ bar and $T_0 = 598$ K through a nozzle to an exit pressure of 0.98 bar. If the flow rate is 3600 kg/hr determine for isentropic flow:
(i) Throat area, pressure and velocity.
(ii) Exit area, Mach number and
(iii) Maximum velocity. **(06 Marks)**

Module-2

3 a. Derive Prandtl-Meyer relation for normal shock waves with usual notations. **(08 Marks)**

b. The state of a gas ($r = 1.3$, $R = 0.469$ kJ/kg-K) upstream of a normal shock wave is given by the following data : $M_1 = 2.5$, $P_1 = 2$ bar, $T_1 = 275$ K. Calculate the Mach number, pressure, temperature and velocity of the gas downstream of the shock. **(08 Marks)**

OR

4 a. Derive the Rankine-Hugoniot relation for a normal shock wave,

$$\frac{P_2}{P_1} = \frac{\frac{r+1}{r-1}\frac{S_2}{S_1} - 1}{\frac{r+1}{r-1} - \frac{S_2}{S_1}}$$ **(08 Marks)**

b. The velocity of a normal shock wave moving into stagnant air ($p = 1.0$ bar, $T = 290$ K) is 500 m/s. If the area of cross-section of the duct is constant determine,
(i) Pressure (ii) Temperature (iii) Velocity of air (iv) Stagnation temperature and
(v) Mach number imparted upstream of the wave front. **(08 Marks)**

Module-3

5 a. For oblique shock, obtain a relation for θ-β-M. **(10 Marks)**

b. A uniform supersonic stream with $M_1 = 3.0$, $p_1 = 1$ atm and $T_1 = 288$ K encounters a compression corner which deflects the stream by an angle $\theta = 20°$. Calculate the P_2, T_2, M_2, P_{02} and T_{02} behind the shock wave. Take $\beta = 37.8°$. **(06 Marks)**

OR

6 a. Explain Fanno line with h-s diagram and show that the gas velocity at the maximum entropy point (F) on the Fanno line is sonic. (08 Marks)
b. Briefly explain Shock Polar. (08 Marks)

Module-4

7 a. Derive Basic Potential equation for compressible flow. (10 Marks)
b. Derive the expression for pressure coefficient. (06 Marks)

OR

8 a. Derive Prandtl-Galuret compressibility correction for compressible and incompressible flow relation. (10 Marks)
b. Explain Von Karman rule for Transonic flow. (06 Marks)

Module-5

9 a. Explain velocity measurement for,
(i) Incompressible (ii) Compressible (iii) Supersonic flow. (10 Marks)
b. Briefly explain open circuit supersonic wind tunnel. (06 Marks)

OR

10 Write short notes on:
a. Shock tube.
b. Shadow technique.
c. Flow visualization
d. Schlieren technique. (16 Marks)

* * * * *