(Pages : 3) **E – 5275**

Reg. No. : ....

Name : ....

Seventh Semester B.Tech. Degree Examination, October 2018
(2013 Scheme)
13.703 : GAS DYNAMICS (M)

Time : 3 Hours Max. Marks : 100

Instructions : *1) Answer **all** questions from Part – **A** and **four full** questions from Part – **B**.*
*2) Choosing **not** more than **one** question from **each** Module from Part – **B**.*
*3) Gas table is **permitted**.*

PART – A

1. Define compressibility.
2. Define characteristic Mach number and what is the maximum value of it ?
3. Define chocked flow in nozzles.
4. Write down the adiabatic compressible Bernoulli's equation.
5. What do you understand by weak oblique shock ?
6. Define simple and non-simple regions.
7. What is Moody diagram ?
8. Define Rayleigh flow and draw Rayleigh curve.
9. How do you measure velocity in a supersonic flow ?
10. What is meant by compressibility correction factor ? **(10×2=20 Marks)**

PART – B

Module – I

11. i) The Mach number of an aircraft is the same at all altitudes. If its speed is 90 kmph slower at 7000 m altitude than at sea level, what is its Mach Number ? 5

ii) Helium gas (molecular weight 4.003) at 250 kPa and 100°C flows through a rectangular duct of cross-section 40 cm × 50 cm, with a velocity of 500 m/s. Determine the Mach number, stagnation temperature, stagnation pressure and mass flow rate. Assume helium to be an ideal gas. 5

iii) Differentiate between compressible and incompressible flows. How can you establish the limiting Mach number below which the flow is treated "incompressible" ? Show your workout. 10

OR

P.T.O.

12. i) Derive the compressible Bernoulli's equation from one-dimensional Euler's equation. 5

ii) Derive a relation for compressibility correction to dynamic pressure. 5

iii) Show that in flow from a reservoir the maximum velocity that may be reached is given by $u^2_{max} = 2h_0$. Assume the gas to be a perfect gas. 10

Module – II

13. i) A gas which has a molar mass of 39.9 and a specific heat ratio of 1.67 is discharged from a large chamber in which the pressure is 500 kPa and the temperature is 30°C through a nozzle. Assuming one-dimensional isentropic flow, find :

1) If the pressure at some section of the nozzle is 80 kPa, the Mach number, temperature and velocity at this section.

2) If the nozzle has a circular cross-section and if its diameter is 12 mm at the section discussed in (1) above, the mass flow rate through the nozzle. 10

ii) A weak pressure wave (a sound wave) across which the pressure rise is 0.05 kPa is travelling down a pipe into air at a temperature of 30°C and a pressure of 105 kPa. Estimate the velocity of the air behind the wave. 10

OR

14. i) Derive Rankine-Hugoniot equation. 10

ii) Discuss the $\theta - \beta - M$ relation for oblique shocks and give an example for experiencing strong shock solution. 6

iii) Show that $V_{max\ (comp)} \approx 1.9V_{max(incomp)}$. 4

Module – III

15. i) Air flows through a constant area duct whose walls are kept at a low temperature. The air enters the pipe at a Mach number of 0.52, a pressure of 200 kPa and a temperature of 350°C. The rate of heat transfer from the air to the walls of pipe is estimated to be 400 kJ/kg of air. Find the Mach number, temperature and pressure at the exit of the pipe. Assume that the flow is steady, that the effects of wall friction are negligible and that the air behaves as a perfect gas. 10

ii) Considering flow through a constant area duct with simple heat addition, show that the temperature at states 1 and 2 can be expressed as

$$\frac{T_2}{T_1} = \frac{M_2^2\left(1+\gamma M_1^2\right)^2}{M_1^2\left(1+\gamma M_2^2\right)^2}$$

where M_1 and M_2 are the Mach numbers at states 1 and 2, respectively and γ is the specific heats ratio. **10**

OR

16. i) Air flows through a pipe of 25 mm diameter and 51 m long. The conditions at the exit of the pipe are $M_2 = 0.8$, $P_2 = 1$ atm and $T_2 = 270$ K. Assuming the flow to be adiabatic and on dimensional, calculate M_1, P_1 and T_1 at the pipe entrance. Take the friction coefficient to be 0.005. **10**

ii) For the Rayleigh flow show that the Mach number $M = 1/\sqrt{\gamma}$, at which the temperature is maximum. Further find the value of T_{max}/T^* for $\gamma = 1.4$. **10**

Module – IV

17. i) Derive a relation for compressibility correction to dynamic pressure and for pressure coefficient. **10**

ii) Describe the Schlieren method of supersonic flow visualization with a neat sketch. **10**

OR

18. i) Explain the principle, construction, working and types of hot wire anemometer with neat sketch. **14**

ii) Explain the procedure for estimating the mean from measurements. **6**

(4×20=80)