Reg. No. : ....

Name : ....

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D – 1519

Seventh Semester B.Tech. Degree Examination, November 2017
(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. What you mean by continuum flow ? Define Knudsen number.
2. What is stagnation state ?
3. What do you mean by sonic boom ?
4. Differentiate between over expanded and under expanded nozzles.
5. Distinguish between shock waves and expansion waves.
6. Graphically represent the θ-β-M relation for oblique shocks.
7. What are the assumptions made in the Fanno flow and draw Fanno curve.
8. What is the Mach number at maximum static enthalpy in Rayleigh flow for $\gamma = 1.6$?
9. State the differences between interferometer and shadowgraph methods.
10. State the importance of Rayleigh supersonic Pitot formula. **(10×2=20 Marks)**

PART – B

Module – I

11. Define Conservation Momentum and derive momentum equation for infinitesimal element moving with flow. **20**

OR

P.T.O.

12. i) A large chamber contains a perfect gas under conditions p_1, T_1, h_1 and so on. The gas is allowed to flow from the chamber (with $q = w_s = 0$). Show that the velocity cannot be greater than $V_{max} = a_1\left(\frac{2}{\gamma - 1}\right)^{1/2}$.

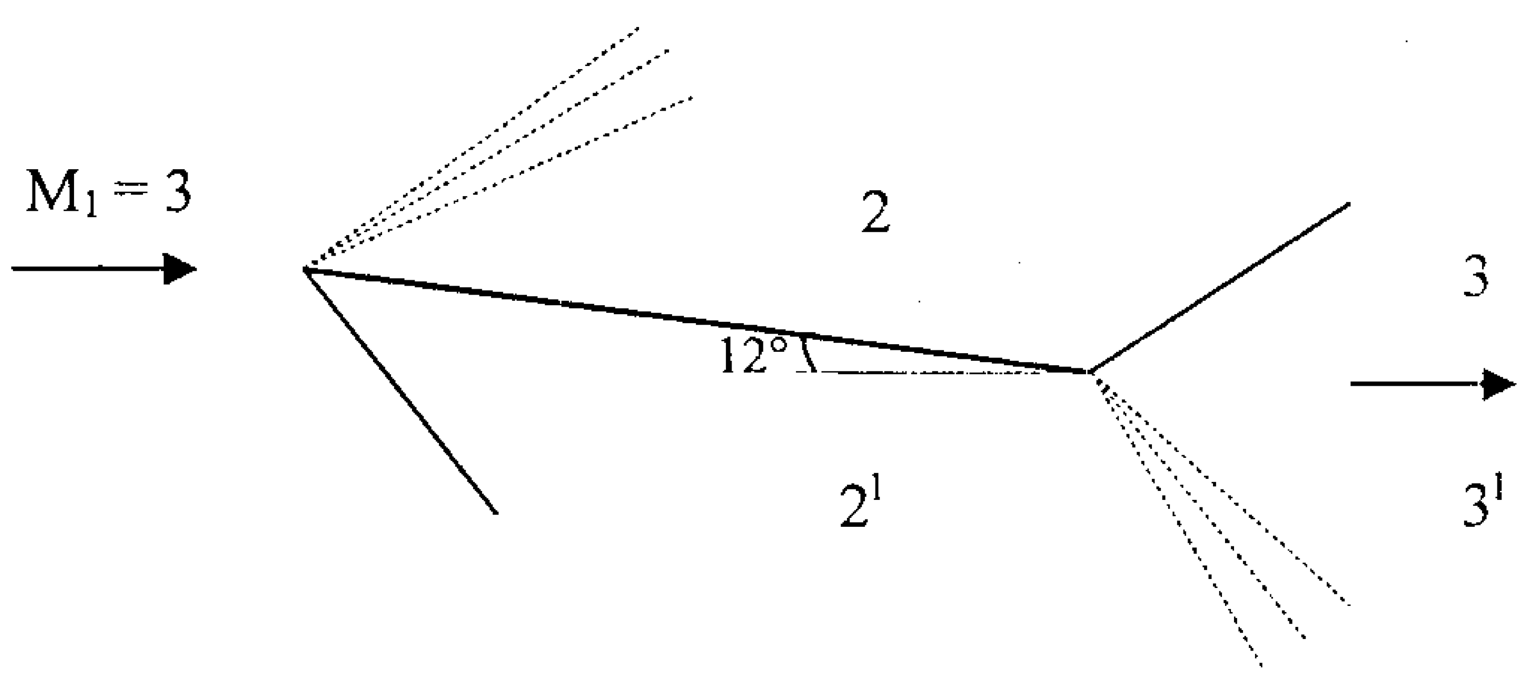
    If the velocity is the maximum, what is the Mach number ? **5**

    ii) Derive the area-Mach number-velocity relation and explain why convergent-divergent nozzle is needed for supersonic flow. **5**

    iii) Derive an expression for speed of sound. **10**

Module – II

13. For the flat plate shown in Fig., calculate the flow Mach numbers at zones 2, 2^1, 3 and 3^1 assuming the slipstream deflection to be negligible. **20**



OR

14. i) Derive Prandtl relation for a normal shock in a perfect gas. **10**

    ii) A converging-diverging nozzle with an area ratio of 5.9 is fed by air from a chamber with a stagnation pressure of 6.89 bar. Exhaust is to the atmosphere at 1 bar. Show that this nozzle is operating between the second and third critical points and determine the conditions after the first shock. **10**

Module – III

15. i) Atmospheric air at 101.35 kPa and 300 K is drawn through frictionless bell-mouth entrance into a 3 m long tube having a 0.05 m diameter. The average friction coefficient $\bar{f} = 0.005$ for the tube. The system is perfectly insulated.

1) Find the maximum mass flow rate and the range of backpressure that will produce this flow.

2) What is the exit pressure required to produce 90% of the maximum mass flow rate and what will be the stagnation pressure and the velocity at the exit for that mass flow rate ? **14**

ii) Sketch Fanno line in enthalpy-entropy diagram and mark subsonic and supersonic branches on it and explain. **6**

OR

16: i) Show that the local Mach number is unity at the point of maximum entropy on the Rayleigh line. **10**

ii) The stagnation temperature of air entering a combustion chamber is increased to 3.5 times its initial value. If the air at entry is at 500 kN/m^2, 105°C with a Mach number of 0.25, determine,

1) Mach number, pressure and temperature at exit
2) Change in stagnation pressure
3) Change in entropy
4) Heat added per kg of air. **10**

Module – IV

17. i) Draw a neat sketch of the flow field around a Pitot tube placed in a supersonic flow. Derive the Rayleigh Pitot tube formula. **4**

ii) A point in a supersonic flow has static pressure of 0.4 atm when a Pitot tube is inserted in the flow at this point, the pressure measured by the Pitot tube is 3 atm. Calculate the Mach number at this point. **4**

iii) Calculate the mass flow rate, the nozzle throat area, and the reservoir pressure and temperature required for a supersonic wind tunnel operation with test-section conditions of Mach 3, static pressure of 0.2 atm and static temperature of 300 K. The test-section area is 0.05 m^2. Assume the flow to be isentropic. **12**

OR

18. i) What do you mean by shock tube ? What are the applications of it ? Explain the working principle with illustrative sketches. **10**

ii) Explain closed circuit supersonic wind tunnel with suitable sketches. **10**

(4×20=80 Marks)