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Reg. No. : ....

Name : ....

Seventh Semester B.Tech. Degree Examination, November 2015
(2008 Scheme)
08.703 : GAS DYNAMICS (M)

Time : 3 Hours Max. Marks : 100

Instructions : *1) Answer **all** questions from Part – **A**.*

*2) Answer **one full** question from **each** Module in Part – **B**.*

*3) Compressible **flow tables** are **permitted**.*

PART – A

1. What is a continuum ? Under what conditions are the assumptions of a continuum valid ?
2. Define bulk modulus of elasticity and the coefficient of compressibility for compressible flow.
3. Explain the phenomenon of chocking in isentropic flow.
4. Discuss the classification of flow based on Mach number.
5. Give examples for the practical applications of the Rayleigh and the Fanno flow models.
6. Define mass flow density. Show three Fanno curves on T-s coordinates for increasing mass flow densities.
7. Show that for Rayleigh flow, at maximum enthalpy point Mach number is given by $\frac{1}{\sqrt{\gamma}}$.
8. Discuss the possibility for a "rarefaction shock".
9. Define shock strength. Write down the expression for shock strength.
10. With a neat sketch explain the working of a Rayleigh Pitot tube. **(10×4=40 Marks)**

PART – B

Module – I

11. a) Explain with sketches the flow through (i) a convergent nozzle (ii) a convergent -divergent nozzle, for different back pressures. 10

    b) An accelerating duct has to increase the Mach no. of air from 0.2 to 0.9. Find area ratio required for the duct. If static temperature of air at inlet is 500 K, find (a) stagnation temperature (b) critical temperature (c) maximum possible velocity (d) static temperature at exit of the duct. 10

P.T.O.

12. a) Explain the effect of Mach no. variation on area ratio in subsonic and supersonic flows and show that for one dimensional isentropic flow;

$$\frac{dA}{A} = \frac{dp}{\rho c^2}\left[1 - M^2\right]$$ 10

b) Conditions of air ($\gamma = 1.4$, $C_p = 1.0$ kJ/kg/K) at entry of a nozzle are p = 2 bar, T = 330 K and c = 145 m/s. If the exit pressure is 1.5 bar, determine for isentropic flow, the Mach numbers at entry and exit, flow rate and maximum possible flow rate. What is the shape of the nozzle ? 10

Module – II

13. a) Starting from the fundamental laws, prove that at the maximum entropy point on the Fanno curve, the Mach number is unity. 10

b) The conditions of a gas ($\gamma = 1.3$, $C_p = 1.22$ kJ/kg/K) at entry of a constant area duct are : M_1 0.28, $p_{01} = 4.965$ bar, $T_{01} = 383$ K. 627 kJ/kg of heat is supplied to the gas. Determine at the exit section : Mach number, pressure and temperature of the gas and the stagnation pressure loss. 10

14. a) Prove that the Mach numbers at the maximum enthalpy and maximum entropy points on the Rayleigh line are $\frac{1}{\sqrt{\gamma}}$ and 1.0 respectively. Show the isenthalpic and isentropic lines at these points on the Rayleigh line on h-s and p-v planes. 10

b) Air enters a long pipe ($f = 0.003$) of 25.4 mm diameter at a Mach number of 2.5. $T_0 = 310$ K and p = 0.507 bar. Determine for the section at which the Mach number reaches 1.2, the static pressure and temperature, stagnation pressure and temperature and the distance of this section from the inlet. Assume adiabatic flow. 10

Module – III

15. a) With neat sketches explain the working of the Schlieren Apparatus. 10

b) A normal shock occurs in the diverging section of a convergent divergent nozzle. Nozzle area ratio is 3 and static pressure at exit is 0.4 times the stagnation pressure at entry. If the flow is isentropic throughout except across the shock, determine (i) M_x, M_y (ii) Area of cross section of the nozzle at the section where the shock occurs. 10

16. a) With a neat sketch explain the working of shadowgraph. 10

b) A gas ($\gamma = 1.3$, R = 287 J/kg/K) at $p_1 = 1$ bar, $T_1 = 400$ K, enters a 30 cm diameter duct ($f = 0.003$) at a Mach number of 2. A normal shock occurs at a Mach number of 1.5 and the exit Mach number is 1. Determine : (i) Lengths of duct upstream and downstream of the shock. (ii) Mass flow rate of the gas (iii) Change in entropy upstream and downstream of the shock and across the shock. 10

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