C 41683 (Pages : 2) Name..............................

Regr. No..............................

EIGHTH SEMESTER B.TECH. (ENGINEERING) DEGREE EXAMINATION APRIL 2013

ME 09 802—COMPRESSIBLE FLUID FLOW

(2009 Admissions)

Time : Three Hours Maximum : 70 Marks

Part A

Short answer questions.
All *questions are compulsory.*

1. State the physical principles based on which the equations of fluid mechanics are derived.
2. What are the different regimes of compressible flow ? Give suitable sketches.
3. Define one dimensional and quasi one dimensional flows.
4. Define Fanno flow. State some practical applications.
5. Explain strength of normal shock. Show that the strength of a normal shock increases with Mach number.

(5 × 2 = 10 marks)

Part B

Analytical / problem solving questions.
Answer **four** *out of six.*

6. Differentiate between static pressure, stagnation pressure, and dynamic pressure.
7. An aeroplane is flying at an altitude of 16 km at a Mach number of 2.2. The temperature at this altitude is –56°C. Determine the speed of the aeroplane in m/s. Take $\gamma = 1.4$, R = 287 J/kg K.
8. Air flows through a duct at a pressure of 0.196 MPa. With a velocity of 350 m/s. The temperature of the air is 40°C. Determine the isentropic stagnation pressure, temperature and density.
9. Derive the Prandtl-Meyer relation for normal shocks.
10. Calculate the velocity, Temperature and pressure after a normal shock in suspersonic flow with upstream conditions of $u_1 = 680$ m/s, $T_1 = 228$ K, $p_1 = 1$ atm., $\gamma = 1.4$.
11. What is coking in isentropic flow ? Prove that in choked isentropic flow through a convergent divergent nozzle, the pressure at the throat is $0.528\ P_0$. Where P_0 is the stagnation pressure.

(4 × 5 = 20 marks)

Part C

Analytical / Problem solving questions.
Answer all questions.

Module I

12. (a) Derive continuity, momentum and energy equation of one dimensional inviscid compressible flow through a control volume.

Or

(b) Using one dimensional energy equation, derive compressible Bernoulli's equation of one dimensional isentropic flow. Show that in compressible flow the dynamic pressure is not the difference between stagnation pressure and static pressure.

Model II

13. (a) Derive area Mach number relation for flow through a convergent divergent nozzle. Graphically show the axial variation of pressure ratio p/p_0 with p_e/p_0 in a convergent divergent nozzle.

Or

(b) Isentropic flow of air takes place through a variable area duct. At one section the Mach number is 1.5 and further downstream the Mach number has increased to 2.8. Find the area ratio.

Module III

14. (a) Air enters a 50 mm diameter pipe at a Mach number of 0.25. The exit Mach number is 0.49. Friction factor for the pipe is 0.004. Determine the length of the pipe.

Or

(b) Air enters a constant area duct, at 200 m/s and has the static conditions of 300 K and 100 kPa. If 50000 j/kg is rejected along the duct, find the exit Mach number, Stagnation temperature change R = 287 J/kg K. $\gamma = 1.4$

Module IV

15. (a) Briefly describe the measurement of velocity in incompressible flow, compressible subsonic flow and supersonic flow by Pitot and static pressure measurements.

Or

(b) A Pitot tube is inserted into an air flow where the static pressure is 1 atm. Calculate the flow Mach number when the Pitot tube measurement are (i) 1.276 atm. ; (ii) 2.714 atm ; (iii) 12.06 atm.

(4 × 10 = 40 marks)