# A 1299

B.E./B.Tech. DEGREE EXAMINATION, MAY/JUNE 2006.

Fifth Semester

Mechanical Engineering

ME 333 — GAS DYNAMICS AND SPACE PROPULSION

Time : Three hours Maximum : 100 marks

Use of Gas tables permitted.

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. Differentiate between compressible and incompressible flows.

2. What is Mach cone?

3. Define Rayleigh flow.

4. What is meant by stagnation properties?

5. Define Normal shock.

6. What is Prandtl-Mayer relation?

7. Define propulsive efficiency.

8. What is ram jet?

9. Name some propellants for space application.

10. What is terminal velocity?

PART B — (5 × 16 = 80 marks)

11. (i) Differentiate super sonic and subsonic flows. (4)

(ii) A super sonic wind tunnel is designed for M = 3.0 at the test section. If the air supply in the reservoir is at 4 Bar and 26° C. Determine mass flow rate, the area of test section, the temperature and density at the throat and test section. The throat area is 0.09 $m^2$ $\gamma = 1.4$. (12)

12. (a) (i) For isentropic flow prove $\frac{T_0}{T} = \left(1 + \frac{\gamma - 1}{2} m^2\right)$. (6)

(ii) Air flows through a duct. The pressure and temperature at station 1 are $p_1 = 0.7$ Bar and $T_1 = 30°$ C. At a second station the pressure $p$ is 0.5 Bar. Calculate temperature and density at the second station. Assume the flow to be isentropic. (10)

Or

(b) Air is allowed to expand from initial state A (where $p_A = 2.068 \times 10^5\ N/m^2$ and $T_A = 333°$ k) to state B (where $p_B = 1.034 \times 10^5\ N/m^2$ and $T_B = 305°$ k). Calculate change in specific entropy of the air and show that the change in entropy is the same for

(i) an isobaric process from A to some intermediate state C followed by an isovolumetric change from C to B and

(ii) an isothermal change from A to some intermediate state D followed by an isentropic change from D to B. (16)

13. (a) (i) The pressure across an orifice in a duct delivering air drops from 10 bar to 6 bar. If the upstream Mach number is 0.60 determine final Mach number, the temperature ratio across the orifice and irreversibility of the process $\gamma = 1.4$. (8)

(ii) Air enters a constant area duct with a mach number 0.4. The duct length is 2.65 m and diameter is 80 mm. The inlet stagnation conditions are 3.5 bar and 37° C. The friction co-efficient is 0.008. What is exit stagnation pressure $\gamma = 1.4$? (8)

Or

(b) The flow of air in a long pipe is under isothermal condition. At the inlet the ratio of static to total pressure is 0.962. The inlet temperature is 300° K and inlet static pressure is 1 bar. Find the total static pressure, static temperature and Mach number at the exit. The total temperature ratio across the duct is 1.2. Take $\gamma = 1.4$. (16)

14. (a) (i) A compression shock occurs in a divergent flow passage. On the up stream side of the shock the velocity of air is 400 m/sec. and is at 2 Bar and 35° C. Determine

(1) mach number on the down stream side of the shock wave

(2) the air velocity on the down stream side

(3) change in entropy per unit mass of air as a result of shock $\gamma = 1.4$. (10)

(ii) State and prove Rankine Hugoniot equation. (6)

Or

(b)

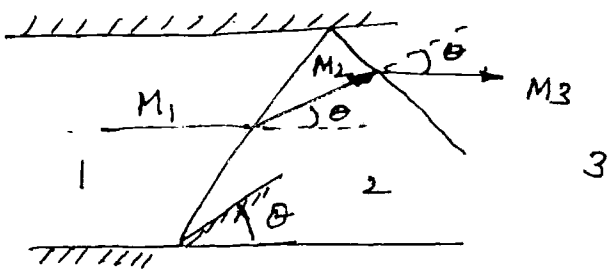


Fig. 1

Air flows at Mach number 4.0 and pressure $10^5\ N/m^2$ is turned abruptly by a wall into the flow with a turning angle of 20° as shown in fig. 1. If the shock is reflected by another wall determine the flow properties $M$ and $P$ down stream side of the reflected shock. (16)

15. (a) A turbo jet aircraft flies at 920 km/hr at an altitude of 5500 m where pa = 0.60 bar and temperature is –19° C. The compressor pressure ratio is 8 and maximum temperature at the compressor is 1000° C. Assuming ideal conditions determine the compressor work the pressures and temperatures throughout the cycle and the exit jet velocity. (16)

Or

(b) Briefly explain the construction and working of

(i) Rocket Engine

(ii) Ram jet Engine

(iii) Pulse jet Engine

(iv) Free piston gas generator. (4 × 4 = 16)

Tim

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