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Question Paper Code : 52531

B.E./B.Tech. DEGREE EXAMINATIONS, APRIL/MAY 2019.

Fifth Semester

Aeronautical Engineering

AE 6503 — AERODYNAMICS – II

(Regulation 2013)

Time : Three hours Maximum : 100 marks

(GAS tables are permitted)

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. Define compressibility.
2. If design Mach number is 2.5, at what pressure ratio does the CD nozzle chokes first time?
3. What is meant by slip line?
4. What is transonic lambda shock?
5. What is meant by small perturbation flow?
6. State Prandtl — Glauert rule.
7. Define drag divergence Mach number.
8. What is wave drag?
9. Sketch the schematic of shock tube.
10. List out the advantage of induction supersonic tunnels.

PART B — (5 × 13 = 65 marks)

11. (a) (i) Show that the maximum discharge velocity $V_{max(comp)}$ is 1.9 times of $V_{max(incomp)}$. (5)

(ii) Obtain the mass flow relation in terms of Mach number. (8)

Or

(b) Air is expanded through a convergent–divergent nozzle from a large reservoir in which the pressure and temperature are 600 kPa and 40°C, respectively. The design backpressure is 100 kPa. Find

(i) The ratio of the nozzle exit area to the nozzle throat area. (3)

(ii) The discharge velocity from the nozzle under design considerations. (5)

(iii) At what back-pressure will there be a normal shock at the exit plane of the nozzle? (5)

12. (a) (i) A shock wave across which the pressure ratio is 1.25 is moving into still air at a pressure of 100 kPa and a temperature of 15°C. Find the velocity, pressure, and temperature of the air behind the shock wave. (8)

(ii) Write short note on shock polar. (5)

Or

(b) For the flow over the half – diamond wedge shown in Fig.12. (b). Find the inclinations of shock and expansion wave and the pressure distribution.

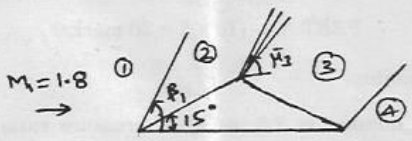

Fig.12. (b)

13. (a) Derive an expression for the velocity potential equation. And state the assumption made.

Or

(b) Explain the design procedure of convergent – divergent nozzle using the method of characteristics.

14. (a) (i) Write short notes on transonic area. (5)

(ii) Explain the detail about the uses of super critical airfoil in drag reduction. (8)

Or

(b) Determine the flow field around a symmetric double wedge of 20 degree included angle kept at 15 degree angle of attack to a supersonic stream of Mach number 2.4 and the stagnation temperature 300 K. Using shock expansion theory, determine the velocity jump.

15. (a) (i) What are the peculiar observed problems in the operation of hypersonic tunnels. (8)

(ii) Explain the construction of blow down tunnel with neat sketch. (5)

Or

(b) 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 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.

PART C — (1 × 15 = 15 marks)

16. (a) Air flows steadily from a large reservoir through a convergent–divergent nozzle into a 0.3 m diameter pipe with a length of 3.5 m. The conditions in the reservoir are such that the Mach number and the pressure at the inlet to the pipe are 2 and 101.3 kPa, respectively. The average friction factor f, for the flow in the pipe is estimated to be 0.005.

(i) If no shocks occur, find M and ρ at the exit of the pipe. (4)

(ii) If there is a normal shock at the exit of the pipe, find the back-pressure in the chamber into which the pipe is discharging. (5)

(iii) Find the back-pressure in the chamber into which the pipe is discharging when there is a shock halfway down the pipe. (6)

Or

(b) Consider adiabatic air flow through a duct. At a certain section of the duct, the flow area is 0.2 m^2, the pressure is 80 kPa, the temperature is 5°C, and the velocity is 200 m/s. If, at this section, the duct area is changing at a rate of 0.3 m^2/m (i.e., $dA/dx = 0.3$ m^2/m) find $d\rho/dx$, dV/dx and $d\rho/dx$ (i) by assuming incompressible flow and (ii) taking compressibility into account.