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Question Paper Code : 70836

B.E./B.Tech. DEGREE EXAMINATIONS, NOVEMBER/DECEMBER 2021.

Sixth Semester

Mechanical Engineering

ME 6604 — GAS DYNAMICS AND JET PROPULSION

(Regulations 2013)

Time : Three hours Maximum : 100 marks

(Use of standard Gas Tables are permitted)

Answer ALL questions.

PART A — ($10 \times 2 = 20$ marks)

1. How is static temperature of low related to total temperature?

2. Draw the Mach cone for $M = 2$ and mark all the features.

3. What do you mean by friction chocking?

4. List the governing equations that useful to describe the Rayleigh flow.

5. List the applications of the moving shock wave.

6. State the necessary conditions for a norm& shock to occur in compressible flow.

7. What is the thrust specific fuel consumption?

8. What is meant by By-Pass Ratio of turbofan engine?

9. Define escape velocity.

10. Name any two solid propellant fuels and oxidizers.

PART B — ($5 \times 13 = 65$ marks)

11. (a) (i) Derive the energy equation for the compressible gas flow through the nozzle. (5)

(ii) Describe various flow regions of fluid flow. (8)

Or

(b) (i) Derive the energy equation as applicable for the nozzle. (5)

(ii) The pressure, temperature and Mach Number at the entry of the flow passage is 245 kPa, 265°C and 1.4 respectively. If the exit Mach number reaches 2.5, taking specific heat ratio as 1.3 and gas constant as 0.469 kJ/kg.K, determine the stagnation temperature and temperature and velocity of the gas at the exit. (8)

12. (a) (i) List the effect of friction on fluid flow. (6)

(ii) If air enters the constant area square duct of side 0.3 mat 2 bar, 350 K and 120 m/s, calculate the pressure, temperature and Mach number at the exit if the duct is 10 m long. (7)

Or

(b) (i) Draw the Rayleigh curve and explain the effect of heat transfer on supersonic flow. (6)

(ii) Find the heat transfer required to obtain Mach number of 0.9, and also calculate the total pressure and temperature at exit, if the air enters the constant area pipe of diameter 0.25 m 1.5 bar, 300 K and 30 m/s. (7)

13. (a) State and prove Prandtl –Meyer relation for a normal shock.

Or

(b) A gas at a pressure of 340 mbar, temperature of 355 K and entry Mach number of 1.4 is expanded isentropically to 140 mbar. Calculate the following

(i) deflection angle,

(ii) final Mach number,

(iii) Final temperature of the gas. Take γ = 1.3. (13)

14. (a) An air craft flies at 960 kmph. Its turbojet engine takes in 40 kg/sec of air and uses air fuel ratio of 50 1, C.V = 43 MJ/kg, for maximum thrust power. Find

(i) jet velocity

(ii) thrust

(iii) thrust power

(iv) propulsive, thermal and overall efficiency

(v) specific impulse

(vi) TSFC.

Or

(b) A turbojet engine uses a mass flow rate of 50 kg/sec and propels air craft at speed of 880 kmph. Isentropic enthalpy drop 188 kJ/kg. Velocity co-efficient is 0.96. Fuel air ratio is 1.2%.Combustion efficiency 95% C.V = 44 MJ/kg Determine

(i) thermal efficiency

(ii) mass flow rate of fuel in kg/hr.

(iii) η_p

(iv) η_{overcall} .

15. (a) A rocket nozzle has a throat area of 18 cm2 and combustion chamber pressure of 25 bar. If the specific impulse is 127.42 s and weight flow rate 44.145 N/s determine:

(i) The thrust coefficient

(ii) Propellant weight flow rate

(iii) Specific propellant consumption

(iv) Characteristics velocity.

Or

(b) Describe with the aid of illustrative diagrams of any two arrangements of solid propellant grains employed for restricted and unrestricted burning. Indicate the directions of burning and flow of gases.

PART C — (1 × 15 = 15 marks)

16. (a) The speed of supersonic aircraft flying at an altitude of 1100 m corresponds to a Mach number (M) of 2.5. Estimate the time elapsed between the instant the aircraft was directly over head of an observer and the instant the observer feels the disturbance due to aircraft. Consider the following three cases and presume that the temperature at the given height is 280 K.

(i) when the observer is stationary

(ii) when the observer is moving in the direction of the aircraft at M = 0,5 and

(iii) when the observer is moving in the opposite direction with M = 0.5.

Or

(b) Air is moving in a constant area duct at the temperature of –50°C and 52.5 kPa. The velocity at this section is 167 m/s. Assume Rayleigh flow process and Find

(i) Stagnation properties at inlet

(ii) Properties at section where static temperature is maximum and

(iii) Properties at section where chocking condition is exist.

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