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Question Paper Code : X60853

B.E./B.Tech. DEGREE EXAMINATIONS, NOVEMBER/DECEMBER 2020
Sixth Semester

Mechanical Engineering
ME 2351/10122 ME 602/ME 64 – GAS DYNAMICS AND JET PROPULSION
(Regulations 2008/2010)
(Common to PTME 2351 – Gas Dynamics and Jet Propulsion for B.E.
(Part–Time) Fifth Semester – Mechanical Engineering – Regulations 2009)

Time : Three Hours Maximum : 100 Marks

Use of Gas Tables is permitted.
Answer ALL questions.

PART – A **(10×2=20 Marks)**

1. Find the sonic velocity through air at 0°C.

2. Distinguish between Mach wave and normal shock.

3. What are the various conditions needed to describe the flow is Rayleigh flow ?

4. How Fanno flow is differ from Rayleigh flow ?

5. How shock condensation of a shock wave is defined ?

6. What is compression corner ?

7. List out the different types of jet engines.

8. Give the components of a turbo jet.

9. What is monopropellant ?

10. Classify the rocket engines.

PART – B **(5×16=80 Marks)**

11. a) i) Air is discharged from a reservoir at 1 MPa and 500 K through a nozzle to an exit pressure of 0.09 MPa. If the flow rate through the nozzle is 3600 kg/h determine for isentropic flow.
    1) Area, pressure and velocity at throat section
    2) Mach number and area at exit section. **(10)**

    ii) A fluid flows through a variable area (CD) duct. Assume that the favorable pressure gradient is maintained throughout the duct. Now using this condition fill in the following blanks with the words decreasing or increasing.

    If M < 1 (and dA is _____), then dp and dv must be _____ and _____

    If M > 1 (and dA is _____), then dp and dv must be _____ and _____ **(6)**

(OR)

b) i) Discuss the Von Karman's rules of supersonic flow. **(8)**

ii) Calculate the velocity and mach number of a supersonic aircraft flying at an altitude of 1000 m where the temperature is 280 K. Sound of the aircraft is heard 2.15 seconds after the passage of aircraft on the head of an observer. **(8)**

12. a) Air at P_1 = 3 bar, T_1 = 288 K and M_1 = 1.5 is brought to sonic velocity in a frictionless constant area duct through which heat transfer takes place. Calculate (i) Final pressure, final temperature and the heat added during the process, (ii) What will be the mach number, pressure and temperature of air if this heat is extracted from the air ? **(16)**

(OR)

b) A convergent-divergent nozzle is provided with a pipe of constant cross section at its exit. The exit diameter of the nozzle and that of the pipe is 50 cm. The mean coefficient of friction for the pipe is 0.002. The stagnation pressure and temperature of air at the nozzle entry are 10 bar and 620 K. The mach numbers at the entry and exit of the pipe are 1.6 and 1.0 respectively. Determine (i) The length of the pipe. (ii) Diameter of the nozzle throat and (iii) Pressure and temperature at the pipe exit. **(16)**

13. a) A jet of air at 270 K and 0.7 bar has an initial mach number of 1.9. If it passes through a normal shockwave, determine the following for downstream of the shock.
    i) Mach number
    ii) Pressure
    iii) Temperature

iv) Speed of sound
v) Jet Velocity
vi) Density.

(OR)

b) A gas at a pressure of 340 m bar, temperature of 355 K and entry Mach number of 1.4 is expanded isentropically to 140m bar. Calculate the following :
i) Deflection angle
ii) Final Mach number
iii) Final temperature of the gas. Take $\gamma = 1.3$.

14. a) The diameter of the propeller of an aircraft is 2.5 m. It flies at a speed of 500 kmph at an altitude of 80 m. For a flight to jet speed ratio of 0.75 determine :
i) The flow rate of air through the propeller
ii) Thrust produced
iii) Specific thrust
iv) Specific impuse and
v) The thrust power.

(OR)

b) Explain the working principle of the ramjet engines with neat sketch and state its advantages and disadvantages.

15. a) Explain with a neat sketch the working of a turbo-pump feed system used in a liquid propellant rocket.

(OR)

b) A rocket flies at 10,080 kmph with an effective exhaust jet velocity of 1400 m/s and propellant flow rate of 5.0 kg/s. If the heat of reaction of the propellants is 6500 kJ/kg of the propellant mixture, determine :
i) Propulsion efficiency and propulsion power
ii) Engine output and thermal efficiency
iii) Overall efficiency.

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