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Question Paper Code : 80851

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

Sixth Semester

Mechanical Engineering

ME 2351/10122 ME 602/ME 64 — GAS DYNAMICS AND JET PROPULSION

(Regulations 2008/2010)

(Common to PTME 2351 for B.E. (Part-Time) — Fifth Semester – Regulations 2009)

Time : Three hours   Maximum : 100 marks

Use of Gas Tables is permitted.

Answer ALL questions.

PART A — ($10 \times 2 = 20$ marks)

1. How mach number changes in nozzle?

2. Define zone of action and zone of silence.

3. What is impulse function and give its uses?

4. Give the expression for $\frac{T_0}{T}$ and $\frac{T^*}{T}$ for isentropic flow through variable area in terms of mach number.

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

6. What is compression corner?

7. Define propulsive efficiency.

8. What is the type of compressor used in turbo jet?

9. What are the requirements of good liquid propellants?

10. What are the advantages of a hybrid rocket?

PART B — ($5 \times 16 = 80$ marks)

11. (a) A nozzle in a wind tunnel gives a test-section Mach number of 2.0. Air enters the nozzle from a large reservoir at 0.69 bar and 310 K. The cross-sectional area of the throat is 1000 cm^2. Determine the following quantities for the tunnel for one dimensional isentropic flow:

(i) Pressures, temperatures and Velocities at the throat and test Section.

(ii) Area of cross-section of the test section

(iii) Mass flow rate

(iv) Power required for driving the compressor.

Or

(b) Derive the energy equations : $a^2/\gamma-1+\frac{1}{2}c^2 = \frac{1}{2}c^2{}_{\max} = a_0{}^2/\gamma-1 = h_0$. Stating the assumptions used.

12. (a) (i) Show that $\dfrac{dA}{A} = \dfrac{dP}{\rho C^2}\left(1 - M^2\right)$ for one dimensional isentropic flow. (4)

(ii) Air at $P_0 = 10$ $T_0 = 400\ K$ is supplied to a 5 cm diameter pipe. The friction factor for the pipe surface is 0.002. If the mach number changes from 3.0 at the entry to 1.0 at the exit, determine, the length of the pipe and the mass flow rate. (12)

Or

(b) Air is supplied to a combustion chamber is a gas turbine plant at 350K, 0.55 bar and 75 m/s. The air-fuel ratio is 29 and the calorific value of the fuel is 42 mJ/kg. Assuming $\gamma = 1.4$ and $R = 287$ J/kgK for the gas, determine

(i) The initial and final mach numbers (4)

(ii) Final pressure, temperature and velocity of the gas (4)

(iii) The maximum stagnation temperature attainable (4)

(iv) Stagnation pressure loss in the combustion chamber. (4)

13. (a) Air flows through a C-D nozzle from a reservoir where stagnation temperature is known to be 333 K. At some section 'X' in the diverging section, a normal shock occurs. The location of the shock is such that the static pressure measured at the throat is 0.8 times the total pressure measured after the shock. If the flow is isentropic except across the shock, determine

(i) The area ratio A_x / A_{throat}

(ii) The air velocity behind the shock.

Or

(b) Air having a Mach number 3.0, approaches a Symmetrical wedge having a wedge angle of 30°. The pressure and temperature of the air are 1.0 bar and 27°C. Find the Mach number and velocity of flow downstream of the shock wave, assuming that a weak oblique shock is formed. Also find the Pressure, density, temperature and total pressure downstream of the shock wave.

14. (a) Explain with neat sketches the Principle of operation of

(i) Turbofan engine and

(ii) Turbojet engine.

Or

(b) An aircraft propeller flies at a speed of 440 kmph. The diameter of the propeller is 4.1 m and the speed ratio is 0.8. The ambient conditions of air at the flight altitude are T = 255K and P = 055 bar Find the following:

(i) Thrust

(ii) Thrust Power

(iii) Propulsive efficiency.

15. (a) (i) Draw a neat sketch explaining the general working of the Hybrid propellant Rocket. (10)

(ii) Comparison between solid and liquid propellant propulsion. (6)

Or

(b) A rocket operating at an altitude of 19 km with the following data:

Propellant flow rate 1 kg/s, Thrust chamber pressure = $28 \times 10^5 N / m^2$. Thrust chamber temperature = 2500 K and Nozzle area ratio = 10.12. Calculate :

(i) Thrust

(ii) Effective jet velocity and

(iii) Specific impulse,

Take γ = 1.3 and R = 355J/kgK. (16)