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**Question Paper Code : 41415**

**B.E./B.Tech. DEGREE EXAMINATION, APRIL/MAY 2018**

**Sixth Semester**

**Mechanical Engineering**

**ME 6604 – GAS DYNAMICS AND JET PROPULSION**

**(Regulations 2013)**

**Time : Three Hours**

**Maximum : 100 Marks**

**(Use of Approved Gas Table is Permitted)**

**Answer ALL questions.**

**PART – A**

**(10×2=20 Marks)**

1. State the difference compressible fluid and incompressible fluid.
2. A plane travels at a speed of 2400 km/h in an atmosphere of 5°C find the Mach Angle.
3. State assumptions made to derive the equations for isothermal flow.
4. What do you understand by choking in Rayleigh flow ?
5. Shock waves cannot be develop in subsonic flow ? State the reason.
6. Define strength of a shock wave.
7. Why after burners are used in turbojet engine ?
8. What is “thrust augmentation” ?
9. Compare solid and liquid propellant rockets.
10. Give the important requirements of rocket engine fuels.



## PART – B

(5×13=65 Marks)

11. a) A conical diffuser has entry and exit diameters of 15 cm and 30 cm respectively. The pressure, temperature and velocity of air at entry are 0.69 bar, 340 K and 180 m/s respectively. Determine (13)

- i) exit pressure
- ii) the exit velocity and
- iii) the force exerted on the diffuser walls assume the flow is isentropic,  $\gamma = 1.4$  and  $C_p = 1.00 \text{ J/kg K}$ .

(OR)

- b) Air flows isentropically through a convergent-divergent nozzle. The inlet conditions are pressure  $700 \text{ KN/m}^2$ , temperature  $320^\circ\text{C}$ , velocity  $50 \text{ m/s}$ . The exit pressure is  $105 \text{ KN/m}^2$  and the exit area is  $6.25 \text{ cm}^2$ . Calculate (13)

- i) Mach number, temperature and velocity at exit
- ii) Pressure, temperature and velocity at throat
- iii) Mass flow rate
- iv) Throat area.

12. a) i) A circular duct passes  $8.25 \text{ kg/s}$  of air at an exit Mach number of 0.5. The entry pressure and temperature are  $345 \text{ KPa}$  and  $38^\circ\text{C}$  respectively and the co-efficient of friction is 0.005. If the Mach number at entry is 0.15. Determine, (8)

- i) The diameter of the duct
- ii) Length of the duct
- iii) Pressure and temperature at exit and
- iv) Stagnation pressure loss.

- ii) Air flows through a pipe of 300 mm diameter. At inlet, temperature is  $35^\circ\text{C}$ , pressure is 0.6 bar and stagnation pressure is 12 bar. At a location 2 m downstream, the static pressure is 0.89 bar. Estimate the average friction coefficient between two section. (5)

(OR)



- b) The condition of gas in a combustion chamber at entry are  $M_1 = 0.28$ ,  $T_{01} = 380 \text{ K}$ ,  $P_{01} = 4.9 \text{ bar}$ . The heat supplied in the combustion chamber is  $620 \text{ kJ/kg}$ . Determine Mach number, pressure and temperature of the gas at exit and also determine the stagnation pressure loss during heating. Take  $\gamma = 1.3$  and  $C_p = 1.22 \text{ kJ/kg K}$ . (13)

13. a) Supersonic nozzle is provided with a constant diameter circular duct at its exit. The duct diameter is same as the nozzle diameter. Nozzle exit cross section is three times that of its throat. The entry conditions of the gas ( $\gamma = 1.4$ ,  $R = 287 \text{ J/kg K}$ ) are  $P_0 = 10 \text{ bar}$ ,  $T_0 = 600 \text{ K}$ . Calculate the static pressure, Mach number and velocity of the gas in duct. (13)

- a) When the nozzle operates at its design condition.  
b) When a normal shock occurs at its exit  
c) When a normal shock occurs at a section in the diverging part where the area ratio,  $A/A^* = 2$ .

(OR)

- b) An aircraft flies at a Mach number of 1.1 at an altitude of 15,000 metres. The compression in its engine is partially achieved by a normal shock wave standing at the entry of the diffuser. Determine the following for downstream of the shock. (13)

- 1) Mach number
- 2) Temperature of the air
- 3) Pressure of the air
- 4) Stagnation pressure loss across the shock.

14. a) i) Explain the principle of working of turbo jet engine and pulse jet engine. (8)  
ii) A converging nozzle operating with air and inlet conditions of  $P = 4 \text{ kg/cm}^2$ ,  $T_0 = 450^\circ\text{C}$  and  $T = 400^\circ\text{C}$  is expected to have an exit statics pressure of  $2.5 \text{ kgf/cm}^2$  under ideal conditions. Estimate the exit temperature and Mach number, assuming a nozzle efficiency is 92% when the expansion takes place to the same back pressure. (5)

(OR)



- b) A aircraft flies at a speed of 520 kmph at an altitude of 8000 m. The diameter of the propeller of an aircraft is 2.4 m and flight to jet speed ratio is 0.74. Find the following : (13)
- The rate of air flow through the propeller.
  - Thrust produced.
  - Specific thrust.
  - Specific impulse.
  - Thrust power.
15. a) i) Explain with a neat sketch the working of a gas pressure feed system used in liquid propellant rocket engines. (8)
- ii) Describe the important properties of liquid and solid propellants desired for rocket propulsion. (5)
- (OR)
- b) A rocket moves with a velocity of 10,000 km/hr with an effective exhaust velocity of 1400 m/s, the propellant flow rate is 5 kg/sec and the propellant mixture has a heating value of 6500 kJ/kg. Find (13)
- Propulsion efficiency.
  - Engine power output
  - Thermal efficiency
  - Overall efficiency.

## PART – C

(1×15=15 Marks)

16. a) Describe two practical situations where oblique shock waves are produced. How are strong and weak shocks generated and how it affects the flow ? (15)
- (OR)
- b) How is forward motion of an aircraft achieved by propeller action ? How does the aircraft lift off the ground ? Explain with help of illustrative sketches. (15)