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B.E./B.Tech. DEGREE EXAMINATION, NOVEMBER/DECEMBER 2017
Sixth Semester
Mechanical Engineering
ME 6604 – GAS DYNAMICS AND JET PROPULSION
(Regulations 2013)

Time : Three Hours | Maximum : 100 Marks

Use of Standard Gas Tables Permitted.
Answer ALL questions.

PART – A **(10×2=20 Marks)**

1. What do you understand by compressibility effect ?
2. Differentiate between first and third critical of CD nozzle.
3. What are the conditions to be satisfied by Fanno flow ?
4. What are the advantages and limitations of Gas Tables ?
5. State the application of Rankine-Hugoniot Relation.
6. What is the nature of flow after the oblique shock wave ? and Why ?
7. What is the thrust specific fuel consumption ?
8. What is meant by By-Pass Ratio of turbofan engine ?
9. What is meant by thrust coefficient of a Rocket engine ?
10. How is solid propellant ignited ?

PART – B **(5×16=80 Marks)**

11. a) i) Derive the expression between the stagnation to static temperature ratio and the Mach number of the flow. **(6)**

ii) A nozzle is attached with a combustion chamber pressure of 48 bar to expand the gas to an optimum exit pressure of 0.5 bar. The combustion chamber is found to be at 3500 K and gas flow rate is 4 kg/s. If the gas constant is 280 J/kg/K and specific heat ratio is 1.23, find the nozzle exit velocity, exit Mach number area and the pressure at the throat. **(10)**

(OR)

b) i) Why sometimes venturi effect and shock wave found in CD nozzle ? Explain. **(6)**

ii) A converging-diverging nozzle is designed to operate with exit Mach number of 2.5. The nozzle is supplied from an air reservoir at pressure of 10 bar. Ambient pressure is 100 kPa. In an accident the nozzle edge is damaged and one-third portion of its diverging part is damaged and hence removed . Assume area in the diverging part is varying linearly with length. Find exit Mach number and pressure of the jet issuing out of the truncated nozzle. **(10)**

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 m at 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. **(10)**

(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 at 1.5 bar, 300 K and 30 m/s. **(10)**

13. a) i) Show that the flow after the normal shock wave is always subsonic. **(6)**

ii) Gas at 2 bar, 600 K and Mach number of 2.2 encounters a normal shock wave, find the static pressure and temperature, total pressure and temperature, Mach number and entropy change after the normal shock wave. Take specific heat ratio as 1.3. **(10)**

(OR)

b) i) Plot the flow across the oblique shock wave and explain the variation of normal and tangential component of velocity. **(6)**

ii) Gas at 3 bar, 860 K and Mach number of 3 encounters a oblique shock wave, inclined at 52° to the flow direction, find the flow deflection angle, final static pressure and temperature, total pressure and temperature and Mach number. Take specific heat ratio as 1.3. **(10)**

14. a) i) Derive the expression for the propulsive efficiency of jet engine in terms of speed ratio. **(6)**

ii) A jet aircraft is flying at an altitude of 5500 m (density ratio = 0.58), ambient pressure is 51 kPa and temperature is – 20°C. The velocity of the aircraft is 270 m/s. If heating value of the fuel is 44 MJ/kg, the pressure ratio across the compressor is 6 and inlet area is 0.95 m^2, determine the velocity of the jet leaving the engine, thrust power and the propulsive efficiency. Take maximum temperature as 1200 K. **(10)**

(OR)

b) i) Explain the working of turbofan engine with neat sketch. **(6)**

ii) Describe advantages and disadvantages of turbofan engine over turbojet engine and turboprop engine. **(10)**

15. a) i) Explain the working of solid propellant Rocket with neat sketch. **(6)**

ii) A rocket develops 9 kN thrust with 3.5 kg/s of propellant flow rate while flying at 400 m/s. If the heating value of the propellant is 7 kJ/kg, calculate the jet velocity, specific impulse and overall efficiency. **(10)**

(OR)

b) i) Derive the expression for the characteristic velocity in terms of combustion chamber temperature. **(6)**

ii) Describe the working of a multi-stage rocket. **(10)**

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