Reg No.:_____ Name:_____

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

Seventh Semester B.Tech Degree Regular and Supplementary Examination December 2021 (2015 Scheme)

Course Code: ME409

Course Name: COMPRESSIBLE FLUID FLOW

Max. Marks: 100 Duration: 3 Hours

Use of Gas table is permitted. Assume suitable value for missing data

PART A

Answer any three full questions, each carries 10 marks. Marks

1 Derive Adiabatic Energy equation applicable to Nozzles/Diffusers (10)

2 A jet of air at 500 K has sonic velocity. Determine (10)

i) Velocity of sound at 500 K

ii)Velocity of sound at the stagnation conditions

iii)Maximum Velocity of jet

iv)Stagnation Enthalpy

v)Crocco Number

Take $\gamma = 1.4$ and R=287 J/kg-K for air.

3 a) A gas with $\gamma = 1.3$ flows through a nozzle. Determine the critical pressure ratio $\frac{P^*}{P_0}$ (2)

b) A Nozzle in a wind tunnel gives a test section Mach Number of 2.5. Air enters the nozzle from a large reservoir at 0.75 bar and 320 K. The cross sectional area of the throat is 1000cm^2. Determine the following for the tunnel for one-dimensional isentropic flow: (8)

i)pressure, temperature and velocities at throat and test sections

ii) Mass Flow rate

4 A certain Diffuser has area ratio 3:1. If air (γ =1.4, R = 287 J/kg-K) enters the diffuser with a Mach number of 0.8, pressure of 5 bar and a temperature of 60^{0}C, compute the exit Mach number, exit velocity, exit temperature, exit pressure and percentage change in impulse function. (10)

PART B

Answer any three full questions, each carries 10 marks.

5 a) Make a list of flow properties which i) increases, ii) Decreases, iii)Remains constant across a normal shock (4)

b) A gas (γ =1.4, R = 287 J/kg-K) at a Mach Number of 2, static pressure of 0.9 bar and static temperature of 400 K, passes through a normal shock. Determine its density after the shock. Compare this value with that attained in an isentropic compression through the same pressure ratio. (6)

6 a) Explain the significance of Rankine -Hugoniot relations. (2)

b) Starting from adiabatic energy equation derive Prandtl-Meyer relation. (8)

7 A gas (γ=1.4, R= 287 J/kg-K) at P_1 = 1 bar, T_1 = 400 K enters a 30 cm diameter duct at a Mach number of 3. A normal shock occurs at a Mach number of 2 and exit Mach number is 1. If the mean value of friction factor is 0.005 determine: (10)

i)Length of the duct upstream and downstream of the shock wave

ii)Mass flow rate of gas

iii)Change in entropy upstream of shock, across the shock and down stream of shock

8 a) Write assumptions of Fanno flow (4)

b) Dry air having a pressure of 0.35 MPa and 32 ºC enters a long constant area duct with a velocity of 150 m/s. The pipe Diameter is 30 cm and the friction factor is 0.005. Calculate the maximum possible length for the Pipe (6)

PART C

Answer any four full questions, each carries 10 marks.

9 The conditions of a gas in a combustor at entry are P_1 = 0.343 bar, T_1= 300 K, and C_1 = 56 m/s. Determine Mach number, pressure, temperature and velocity at the exit, if the increase in stagnation enthalpy of the gas between entry and exit is 1172.5 kJ/kg (take γ =1.4 and C_p = 1.005 kJ/kg.K). (10)

10 a) Give two practical examples of Rayleigh flow (2)

b) Prove that the Mach Number at the maximum entropy point on the Rayleigh line is 1.0 (8)

11 Air at 300 K, 55 KPa and 70 m/s enters the combustion chamber in a gas turbine power plant. The air-fuel ratio is 32 and the calorific value of the fuel is 42 MJ/kg. Taking γ =1.4 and R = 287 J/kg-K for the gas, determine: (10)

a) The initial and final Mach numbers,

b)Final pressure, temperature and velocity of gas

c) percent stagnation pressure loss in the combustion chamber

d) The maximum stagnation temperature attainable

12	a)	Draw a Keil probe and write a short on it	(4)
	b)	Explain the principle of interference of light in direct determination of density in a gaseous flow field	(6)
13		Explain about constant current and constant temperature Hot wire Anemometer with the aid of circuit diagrams	(10)
14	a)	Explain the principle of Shadowgraph with the aid of a neat diagram	(4)
	b)	Sketch and explain the working of a Stagnation Temperature probe	(6)

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