CBCS SCHEME

USN

17AE552

# Fifth Semester B.E. Degree Examination, Aug./Sept.2020
## Gas Dynamics

Time: 3 hrs. Max. Marks: 100

**Note:** *1. Answer any FIVE full questions, choosing ONE full question from each module.*
*2. Use of Gas table is permitted.*





### Module-1

1 a. Derive Bernoulli's equation for an isentropic compressible flow. **(10 Marks)**

b. Derive the steady flow energy equation for the following systems :
i) Turbines ii) Nozzle. **(10 Marks)**

**OR**

2 a. Water Plows through a pipe AB 1.2m diameter at 3m/s and then passes through a pipe BC 1.5m diameter. At C, the pipe branches. Branch CD is 0.8m in diameter and carries one third of the flow in AB. The flow velocity in branch CE is 2.5m/s. Find the volume rate of flow in AB, the velocity in BC, the velocity in CD and the diameter of CE. **(12 Marks)**

b. State the momentum principle and derive momentum equation. **(08 Marks)**

### Module-2

3 a. Draw a Fanno line and show that, $h = ho - \frac{1}{2}\left(\frac{G}{\rho}\right)^2$. **(10 Marks)**

b. Define Rayleigh flow process and by a suitable graph, explain the Rayleigh curve and its significance and also show that at maximum entropy point, the flow is sonic analytically. **(10 Marks)**

**OR**

4 a. Air with specific heat $C_P$ = 1.005kJ/kg-k, $\gamma$ = 1.38, $P_1$ = 3bar, $T_1$ = 500k flows with a velocity 200m/s with diameter 30cm of duct. Determine :
i) Mass flow rate ii) Mach number iii) Stagnation temperature iv) Stagnation pressure. Assume flow as compressible. **(10 Marks)**

b. A circular duct passes 8.25kg/s of air at an exit Mach number of 0.5. The entry pressure and temperature are 3.45 bar and 38°C respectively and the coefficient of friction 0.005. If the Mach number at entry is 0.15, determine : i) the diameter of duct ii) length of duct iii) pressure and temperature at the exit iv) stagnation pressure loss. From isentropic flow table, for $\gamma$ = 1.4, at $M_1$ = 0.15, $(P_1/P_{01})$ = 0.984. **(10 Marks)**

### Module-3

5 a. A gas ($\gamma$ = 1.4, R = 0.287 kJ/kg-k) at a Mach number of 1.8, P = 0.8 bar and T = 373k, passes through a normal shock. Determine its density after the shock. Compare this value in an isentropic compression through the same pressure ratio. Assume for normal shock table for $\gamma$ = 1.4, at $M_x$ = 1.8, $\frac{P_y}{P_x} = 3.613$, $\frac{T_y}{T_x} = 1.532$. **(10 Marks)**

b. Derive Prandtl – Meyer relation for normal shock waves with usual notation. **(10 Marks)**

**OR**

6 a. A Re-entry Vehicle (RV) is at an altitude of 15,000m and has a velocity of 1850m/s. A bow shock wave envelops the RV. Neglecting dissaciation, determine the static and stagnation pressure and temperature just behind the shock wave on the RV centre line where the shock wave may be treated as normal shock. Assume that the air behaves as perfect gas, with $\gamma = 1.4$, $R = 287 J/kg \cdot k$. **(10 Marks)**

b. Show that the maximum heat transfer in a Rayleigh flow is given by, $Q_{max} = \frac{(1-m^2)}{2(1+r)m^2} \cdot C_p \cdot T_1$. **(10 Marks)**

**Module-4**

7 a. Explain De–Laval nozzle. Derive an expression for area ratio as a function of Mach number for a De-Laval nozzle. **(10 Marks)**

b. A conical diffuser has entry and exit diameters of 15cm and 30cm respectively. The pressure, temperature and velocity of air at entry are 0.69bar, 340K and 180m/s respectively. Determine :
i) exit pressure
ii) exit velocity
iii) force exerted on diffuser wall. Assume isentropic flow, $\gamma = 1.4$, $C_p = 1 kJ/kg \cdot K$. **(10 Marks)**

**OR**

8 a. With neat sketch, explain types of nozzle. **(10 Marks)**

b. With a plot explain the effect of back pressure on nozzle. **(10 Marks)**

**Module-5**

9 a. Define similitude and explain the types of similarities. **(10 Marks)**

b. Explain the classification of flames. Explain the types. **(10 Marks)**

**OR**

10 a. Determine an expression for velocity of flame propagation. **(10 Marks)**

b. Explain the flame stabilization with the help of a stability loop. **(10 Marks)**

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