CBCS SCHEME

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15AE552

# Fifth Semester B.E. Degree Examination, Jan./Feb. 2023
## Gas Dynamics

Time: 3 hrs. Max. Marks: 80

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



### Module-1

1 a. Derive continuity equation in differential form for 3 – dimensional flow. **(08 Marks)**

b. Using Euler's equation. Derive the relation of Bernoullis equation for both incompressible and compressible flow. **(08 Marks)**

**OR**

2 a. Define flow and non-flow process. Also derive steady flow energy equation for a flow process. **(08 Marks)**

b. Derive the expression for thrust and explain it with neat sketch. **(08 Marks)**

### Module-2

3 a. Write a short note on Acoustic velocity and different regime of speed. **(06 Marks)**

b. Explain Mach number and the Mach cone and angle. **(06 Marks)**

c. Explain the Rayleigh curve with the help of a neat sketch. **(04 Marks)**

**OR**

4 a. Air flowing in a duct has a velocity of 300 m/s, pressure 1.0 bar and temperature 290K. Take $\gamma = 1$ and R = 287 J/kg K. Determine :
i) Stagnation pressure and temperature
ii) Velocity of sound in the dynamic and stagnation conditions
iii) Stagnation pressure assuming constant density. **(08 Marks)**

b. Draw a fannoline and show that, $h = h_0 - \frac{1}{2}\left(\frac{G}{\rho}\right)^2$. **(08 Marks)**

### Module-3

5 a. Derive Prandtl – Meyer relation for normal shock waves with usual notations. **(08 Marks)**

b. A Re-entry Vehicle (RV) is at an altitude of 15000m and has a velocity of 1850 m/s. A bow shock wave envelops the RV, Neglecting dissociation, 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 $\gamma = 1.4$ and R = 287 J/kg-K. Given At 15000 multitude $P_1 = 1.2108 \times 10^4 N/m^2$, $T_1 = 216.5K$. **(08 Marks)**

**OR**

6 a. Draw an oblique shock and derive relation between $\theta$, $\beta$, M. **(07 Marks)**

b. Briefly explain the following with neat graph.
i) Oblique shock waves
ii) Expansion waves
iii) Normal shock waves. **(09 Marks)**

## Module-4

7 a. Drive the following relations for one-dimensional isentropic flow :

i) $\frac{dA}{A} = \frac{dP}{\rho c^2}(1-M^2)$

ii) $\frac{P^*}{P} = \left[\frac{2}{\gamma+1} + \frac{\gamma-1}{\gamma+1}M^2\right]^{\frac{\gamma}{\gamma-1}}$. **(08 Marks)**

b. Air at a stagnation state of 3 atm and 300K is accelerated to 200 m/s. Determines the pressure, temperature and Mach number of the flow. **(08 Marks)**

**OR**

8 a. Derive Area – Mach number relation for De-level nozzle and explain the possibilities for various ($A/A^*$) ratios. **(08 Marks)**

b. A convergent – divergent nozzle is designed to deliver mach 1.8 helium stream. If this nozzle has to run with air, with a normal shock at the exit, determine the stagnation pressure required if the back pressure is 30 KPa. Also, find the Mach number ahead of the shock. **(08 Marks)**

## Module-5

9 a. Derive on the basis of dimensional analysis suitable parameters to present the thrust developed by a propeller. Assume that the thrust (T) depends upon the angular velocity $W_1$, speed of advance V, diameter D, dynamic viscosity $\mu$, mass density $\rho$, elasticity of the fluid medium which can be denoted by the speed of sound in the medium C. **(08 Marks)**

b. Explain about :
i) Reynold's number and Reynold's model law
ii) Mach number and Mach model law
Also write the application. **(08 Marks)**

**OR**

10 Write short notes on any four :
i) Flame propagation
ii) Flame velocity
iii) Premixed flame
iv) Diffusion flame
v) Theories of flame propagation
vi) Flame stabilization. **(16 Marks)**

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