Registration No.: | | | | | | | | | | |

Total Number of Pages: 02

Course: B.Tech
Sub_Code: RME6D002

6th Semester Regular/Back Examination: 2024-25
SUBJECT: Compressible Flow and Gas Dynamics
BRANCH(S): MECH
Time: 3 Hours
Max Marks: 100
Q.Code: S166

Answer Question No.1 (Part-I) which is compulsory, any eight from Part-II and any two from Part-III.
The figures in the right hand margin indicate marks.

Part-I

Q1 **Answer the following questions:** **(2 x 10)**

a) Define Mach number and explain its significance in compressible flow analysis.
b) Differentiate between subsonic, transonic, and supersonic flows with appropriate examples.
c) What is stagnation temperature? Discuss its relevance in compressible flow applications.
d) What is a normal shock wave? Mention its effect on pressure, temperature, and density.
e) What are some characteristics of weak and strong oblique shock waves?
f) Does $M \rightarrow \infty$ imply $a \rightarrow \infty$?
g) Define Prandtl-Meyer expansion waves and their significance in supersonic flows.
h) Explain the function of a convergent-divergent nozzle in both subsonic and supersonic flow conditions.
i) What is choking in compressible flow? Discuss the parameters that influence it.
j) What is the Fanno line?

Part-II

Q2 **Only Focused-Short Answer Type Questions- (Answer Any Eight out of Twelve)** **(6 x 8)**

a) Show that the total temperature is constant across a stationary normal shock wave.
b) Compare shock waves and expansion waves with respect to entropy changes and pressure variations.
c) Describe oblique shock waves, their properties, and practical applications.
d) Illustrate the working of a supersonic wind tunnel and its importance in aerodynamic testing.
e) Discuss the area-velocity relationship in compressible flow for subsonic and supersonic regimes.
f) Derive the equations for isentropic flow through a nozzle and explain how area changes affect the flow.

g) Explain Rayleigh flow and its applications in heating and cooling processes.

h) What is Mach angle? Discuss its determination and importance in supersonic aircraft design.

i) Explain Fanno flow and discuss how friction affects compressible fluid dynamics.

j) Derive the continuity equation for steady, compressible flow and discuss its significance.

k) Discuss the complications that arise when applying the method of characteristics to axisymmetric flow problems. How do these complications affect the solution process?

l) Explain the concept of linearized supersonic flow. Discuss its assumptions, governing equations, and applications in aerodynamic design.

Part-III

Only Long Answer Type Questions (Answer Any Two out of Four) **(16 x 2)**

Q3 Derive the pressure, temperature, and density ratios across a normal shock wave and interpret their physical significance. **(16)**

Q4 Discuss the design and performance optimization of convergent-divergent nozzles, including conditions for maximum mass flow rate and supersonic expansion. **(16)**

Q5 Derive the energy equation for compressible fluid flow and explain its significance in high-speed aerodynamic applications. **(16)**

Q6 Explain with suitable examples the various types of problems that can be solved using the method of characteristics. **(16)**