Seat No: ______________ Enrollment No: ____________________

PARUL UNIVERSITY

FACULTY OF ENGINEERING & TECHNOLOGY

B.Tech.Summer 2018-19 Examination

Semester: 5 **Date:21/05/2019**

Subject Code: 03101330 **Time:10:30am to 01:00pm**

Subject Name: Gas Dynamics **Total Marks: 60**

Instructions:

1. All questions are compulsory.
2. Figures to the right indicate full marks.
3. Make suitable assumptions wherever necessary.
4. Start new question on new page.

A. Objective Type Questions - (All are compulsory) (Each of one mark) **(15)**

1. Entropy of a fluid stays constant when it flows through
- a. Normal shock
- b. Oblique shock
- c. Expansion fan
- d. All of the above

2. Which of the following statements are true for flow across a stationary normal shock?
- P) Stagnation temperature stays constant.
- Q) Stagnation pressure decreases.
- R) Entropy increases.
- S) Stagnation pressure increases.

a) P, Q and R b) Q, R and S
c) P, R and S d) P, Q and S

3. Increase in free stream Mach number over a wedge shaped body in supersonic flow with an attached oblique shock will cause the oblique shock wave to

a) move closer to the body b) move away from the body
c) detach from the body d) become a normal shock

4. What type of shock wave is preferred in a supersonic flow over a body
- a. Normal shock
- b. Oblique shock
- c. Bow shock
- d. None of the above

5. Consider steady, inviscid flow in a Convergent-Divergent (CD) nozzle with a normal shock in the divergent position. The static pressure along the nozzle downstream of the normal shock
- a. remains constant
- b. increases isentropically to the static pressure at the nozzle exit
- c. decreases isentropically to the static pressure at the nozzle exit
- d. can increase or decrease, depending on the magnitude of the static pressure at the nozzle exit.

Fill in the blanks.

6. As the strength of the shock __________, the losses increase.

7. In a C-D nozzle with a normal shock in the divergent position the static pressure downstream of the normal shock _____________ isentropically.

8. Supersonic flow through a convex curve generates _______________ to turn the flow.

9. For a flow across an oblique shock component of velocity normal to shock decreases while tangential component ________________.

10. For a flow through a Prandtl-Meyer expansion wave _________________ remains constant.

Answer only in one sentence.

11. What happens to the total temperature for a flow through a constant area pipe with heat transfer?
12. What is Rayleigh flow?
13. What is total pressure?
14. How to calculate the nozzle performance?
15. When does expansion waves form.

Q 2. Answer the following questions in brief. (Attempt any three) **(15)**

A. Explain the working principle of a nozzle and what is chocked flow.
B. In the test section of a supersonic wind tunnel, a Pitot tube in the flow reads a pressure of 1.13 atm. A static pressure measurement (from a pressure tap on the sidewall of the test section) yields 0.1 atm. Calculate the Mach number of the flow in the test section.
C. Draw oblique shock wave and normal shock wave and show the change in properties along the shock wave in both.
D. Explain, what happens when Supersonic flow over convex and concave corners takes place?

Q 3.

A. Show and explain with a neat sketch how Mach number and pressure ratio varies across the supersonic nozzle for different back pressures. **(7)**

B. Calculate the lift and drag over the flat plate of length 'c' at an angle of 2 degree in the uniform supersonic flow of Mach number 4 at 101 KPa. If the angle of attack is increased from 2 degrees to 90 degree keeping the free stream conditions same. Comment on the variation of lift and drag for this plate? **(8)**

OR

The pressure upstream of a normal shock wave is 1 atm. The pressure and temperature downstream of the wave are 10.33 atm and 772 K, respectively. Calculate the Mach number and temperature upstream of the wave and the total temperature and total pressure downstream of the wave. **(8)**

Q 4.

A. Show subsonic and supersonic flow over a pitot tube and derive an expression to calculate velocity for subsonic compressible flow. **(7)**

OR

Just upstream of a shock wave, the air temperature and pressure are 288 K and 1 atm, respectively; just downstream of the wave, the air temperature and pressure are 690 K and 8.656 atm, respectively. Calculate the changes in enthalpy, internal energy, and entropy across the wave.) **(7)**

B. Consider a flat plate at an angle of attack α to a Mach 2.4 airflow at 1 atm pressure. What is the maximum pressure that can occur on the plate surface and still have an attached shock wave at the leading edge? At what value of α does this occur? **(7)**