Enrollment No./Seat No.:

GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering - SEMESTER - V EXAMINATION - WINTER 2025

Subject Code: 3150107 **Date: 21-11-2025**

Subject Name: Aerodynamics

Time: 10:30 AM TO 01:00 PM **Total Marks: 70**

Instructions

1. Attempt all questions.

2. Make suitable assumptions wherever necessary.

3. Figures to the right indicate full marks.

4. Simple and non-programmable scientific calculators are allowed.

			Marks
Q.1	**(a)**	1. What happens to the flow direction when an oblique shock wave occurs? A) The flow direction remains unchanged B) The flow direction changes by a deflection angle C) The flow direction reverses D) The flow direction becomes parallel to the shock wave 2. Which parameter decreases across an oblique shock wave? A) Pressure B) Temperature C) Mach number D) Density 3. Oblique shock waves occur only when the flow is: A) Subsonic B) Sonic C) Supersonic D) Incompressible	**03**
	(b)	1. Which of the following is true about the flow behind the oblique shock? A) It is always supersonic B) It is always subsonic C) It can be either subsonic or supersonic depending on the shock angle D) It is always sonic 2.Prandtl's relation is used to relate which of the following quantities? A) Pressure and temperature across a shock B) Flow deflection angle and shock angle C) Velocity components normal and tangential to the shock D) Pressure ratio and Mach number	**04**
	(c)	What is an airfoil, and what is its primary function in aerodynamics?	**07**
Q.2	**(a)**	How does the angle of attack (α) influence the lift generated by an airfoil?	**03**
	(b)	What does the acronym NACA stand for, and what is the significance of the NACA series in aerodynamics?	**04**
	(c)	List three different applications of airfoils outside of conventional fixed-wing aircraft.	**07**
		OR	
	(c)	What is an airfoil's Lift Curve, and what defines its critical point?	**07**
Q.3	**(a)**	Explain the concepts of Airfoil Stalling and Flow Separation.	**03**
	(b)	What is the primary function of a Wind Tunnel, and what are the two main types based on geometry?	**04**

(c) What is a vortex sheet and how is it used to model flow over an aerofoil in potential flow theory? **07**

OR

(a) Compare the contribution of skin friction drag for Laminar Flow versus Turbulent Flow on an airfoil. **03**

(b) Consider an airfoil in a flow at standard sea level conditions with a freestream velocity of 100 m/s. At a given point on the airfoil, the pressure is 0.9×10^5 N/m^2. Calculate the velocity at this point. **04**

(c) Define internal energy and enthalpy. 3 kg/s of air to be discharged through a smoothcircular duct at a velocity of 10 m/s. The pressure of air in the pipe are 1.5 bar and 300K. Find out the Enthalpy and internal energy of air and the diameter of duct. **07**

Q.4 **(a)** Explain in short the difference between flow and non flow work. **03**

(b) Explain the unique mechanism of lift generation on a high-sweep Delta Wing at high angles of attack. **04**

(c) How does the Vortex Lattice Numerical Method (VLM) improve upon the Classical Lifting Line Theory? **07**

OR

(a) What are the key assumptions and the main result of Prandtl's Classical Lifting Line Theory (LLT)? **03**

(b) What is the fundamental difference in flow structure between a 2D airfoil (infinite wing) and a Finite Wing? **04**

(c) What are the key characteristics of Modern Low-Speed Airfoils (e.g., for general aviation or sailplanes)? **07**

Q.5 **(a)** 1.What happens to the entropy across an oblique shock wave? **03**

A) It remains constant
B) It decreases
C) It increases
D) It first decreases then increases

2.Which of the following is a fundamental assumption in the analysis of oblique shock waves?

A) Flow is incompressible
B) Shock wave is a discontinuity with zero thickness
C) Viscosity effects dominate the flow
D) Shock waves can only occur in subsonic flows

3.Which of the following is NOT true about the Rankine–Hugoniot conditions?

A) They describe the jump conditions across a shock wave
B) They assume inviscid and adiabatic flow
C) They apply to normal shocks only
D) They are based on conservation laws

(b) Explain Normal Shock with sketch. **04**

(c)	A normal shock moves with velocity 750 m/s into stagnant air at 150 kPa and 200 K.Find the static temperature after the shock has passed and the velocity imparted to the fluid by the shock.	**07**

OR

(a)	Explain suprsonic flow over a compression corner.	**03**
(b)	Explain Oblique shock with sketch.	**04**
(c)	Fluid is air and can be treated as a perfect gas. If the condition before theshock wave are: M = 2.0, P = 138kPa and T = 278K. Determine the entropy change across the shock.	**07**

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