Name: **Enrolment No:**	UPES UNIVERSITY WITH A PURPOSE

UNIVERSITY OF PETROLEUM AND ENERGY STUDIES
End Semester Examination, April – May, 2022

Course: Supersonic and Hypersonic Flows **Semester: II**
Program: M.Tech CFD **Time 03 hrs.**
Course Code: ASEG 7034P **Max. Marks: 100**
Instructions: Gas tables will be provided during the examination.

SECTION A

S. No.		Marks	CO
Q1.	Discuss the change of flow properties across an expansion fan.	**4**	**CO1**
Q2.	Emphasis the design features of a supercritical airfoil.	**4**	**CO2**
Q3.	Define adiabatic flow. Is total pressure remains constant in an adiabatic flow?	**4**	**CO3**
Q4.	Discuss the interaction of two shock waves.	**4**	**CO4**
Q5.	Determine the highest density ratio that can be achieve behind a normal shock wave.	**4**	**CO5**
	SECTION B		
Q6.	Discuss the aerothermodynamics properties of hypersonic flow.	**10**	**CO1**
Q7.	Derive basic potential equation for compressible flow and discuss its advantages. **OR** Derive linearized form of velocity potential equation by applying small perturbation theory.	**10**	**CO2**
Q8.	Discuss about drag divergence mach number. How it can be delayed using Whitcomb's area rule.	**10**	**CO3**
Q9.	A Mach 1.5 flow with at standard sea level is expanded around a sharp corner through a deflection angle of 15^0. Calculate M_2, p_2, T_2, $p_{0,2}$, $T_{0,2}$, and the angles that the forward and rearward Mach lines make with respect to the upstream flow direction.	**10**	**CO3**
	SECTION-C		
Q 10.	Consider a Mach 3 flow at sea level conditions, the flow is deflected due to a compression corner with a deflection angle of 15^0. The shock wave reflected from a straight horizontal wall that is present above the corner. Calculate Mach number, pressure and temperature behind the reflected shock from the upper wall. Also, obtain the angle (φ), which the reflected shock makes with the upper wall. **OR** A supersonic flow at $M_1 = 3$, $T_1 = 285$ K, and $p_1 = 1$ atm is deflected upward through a compression corner with $\theta = 30.6^0$ and then is subsequently expanded around a corner of the same angle such that the flow direction is the same as its original direction. Calculate M_3, p_3, and T_3 downstream of the expansion corner	**20**	**CO4**

Q11.	Consider an infinitely thin flat plate at an angle of attack α in a Mach 3 flow. Calculate the lift and wave-drag coefficients for i. $\alpha = 5^0$ ii. $\alpha = 15^0$	**20**	**CO5**