Name:

Enrolment No:

UNIVERSITY OF PETROLEUM AND ENERGY STUDIES

End Semester Examination, December 2022

Course: Aerodynamics II | **Semester: V**

Program: B. Tech. ASE/ASE-AVE | **Time : 03 hrs.**

Course Code: ASEG 3011 | **Max. Marks: 100**

Instructions: Assume missing data, if any, appropriately. The use of tables for Isentropic flow properties, Normal shock tables, Oblique shock tables, Prandtl's Meyer function and *θ-β-M* chart is permitted.

SECTION A

(5Qx4M=20Marks)

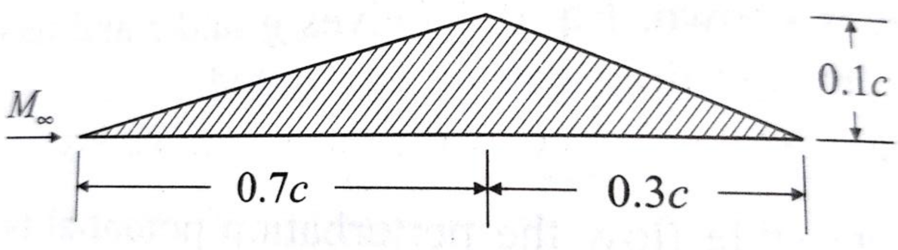
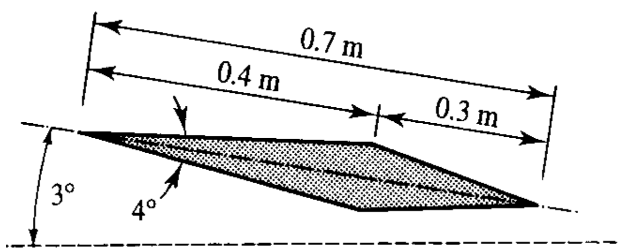
S. No.		Marks	CO
Q 1	Supercritical airfoils have cusp shaped bottom surface near the trailing edge. Give reasons.	**04**	**CO4**
Q 2	A pitot-static tube is placed in a supersonic flow in which the static temperature is 0°C. Measurements indicate that the static pressure is 80 kPa and that the ratio of pitot to the static pressure is 4.1. Find the Mach number and the velocity in the flow.	**04**	**CO1**
Q 3	Oblique shock waves of same family always intersect. Give reasons	**04**	**CO2**
Q 4	Slip lines are formed when two shocks of opposite family and unequal strengths intersect each other. Give reasons	**04**	**CO2**
Q 5	A detached shock wave is formed when a supersonic flow passes over a blunt body. Justify this statement.	**04**	**CO1**

SECTION B

(4Qx10M= 40 Marks)

S. No.		Marks	CO
Q 6	Prove that the following transformations maps an irrotational isentropic flow in compressible space (x, y) to an irrotational, isentropic flow in an incompressible space (ξ, η). $$\xi = x$$ $$\eta = \beta y$$	**10**	**CO4**

	$$\bar{\phi}(\xi,\eta) = \beta\hat{\phi}(x,y)$$		
Q 7	Air flowing at a Mach number of 3.0 is turned through an angle that leads to a drop in pressure by 60%. Estimate the angle by which the flow is turned.	**10**	**CO2**
Q 8	List and discuss five inferences that can be drawn from a *θ-β-M* chart for oblique shock waves. ***OR*** Consider a supersonic flow with Mach number, pressure, and temperature of 2.6, 1 atm and 300 K respectively. The flow is deflected through an angle θ_1=10° by a compression corner at a point A on the lower wall, creating an oblique shock wave emanating from point A. This shock impinges on the upper wall at point B. Also, precisely at point B the upper wall is bent through an angle θ_2 = 4°. The incident shock is reflected at point B, creating a reflected shock wave which propagates downward and to the right. Calculate the Mach number, pressure, and temperature in the region behind the reflected shock wave.	**10**	**CO2**
Q 9	Air is expanded from a large reservoir in which the pressure and temperature are 500 kPa and 35 ^{0}C through a variable area duct. A normal shock occurs at a point in the duct where the Mach number is 2.5. Find the pressure and temperature in the flow just downstream of the shock wave. Downstream of the shock wave, the flow is brought to rest in another large reservoir. Find the pressure and temperature in this reservoir. Assume that the flow is one-dimensional and isentropic everywhere except through the shock wave.	**10**	**CO1**
	SECTION-C **(2Qx20M=40 Marks)**		
Q 10	Linearize the velocity potential equation for a two-dimensional, irrotational, isentropic flow over an airfoil using the small perturbation theory. State clearly, the assumptions made and the limitations of the resulting equation. Hence, deduce an expression for the pressure coefficient in terms of perturbation velocity. ***OR***	**20**	**CO4**

	A two-dimensional wing profile as shown in figure below is placed in a stream of Mach number 2.5 at an incidence of 2^o. Using linear theory, calculate the lift and drag coefficients. 		
Q 11	Using the shock expansion theory, find the lift per meter span for the wedge-shaped airfoil shown in figure below. The Mach number and the pressure ahead of the airfoil are 3.0 and 50 *kPa* respectively. 	**20**	**CO3**