Seat No.: _____ *Enrolment No._____*

GUJARAT TECHNOLOGICAL UNIVERSITY

BE- IVth SEMESTER–EXAMINATION – MAY/JUNE- 2012

Subject code: 140102 **Date: 29/05/2012**

Subject Name: Aerodynamics I

Time: 10:30 am – 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. **Use gas table if required.**

Q.1	**(a)**	Define the following terms. Control Volume, Control Surface, Reynolds Number, Mach Number, Froude Number, Euler Number And Weber Number.	**07**
	(b)	With a neat sketch derive the Navier – Stokes momentum equation in Cartesian coordinates.	**07**
Q.2	**(a)**	Write a short note on vortex flow and show that vortex flow is irrotational except at the center.	**07**
	(b)	Write down the assumptions you considered for Bernoullie's theorem and also with a neat sketch derive the Bernoullie's equation for stream line and with Euler's equation.	**07**
		OR	
	(b)	How the shock waves are generated into the flow field? Differentiate between normal shock wave, oblique shock wave and expansion waves.	**07**
Q.3	**(a)**	State the assumptions for Kutta theorem and prove Kutta-Joukowsky lift theorem.	**07**
	(b)	Define zero lift angle of attack, angle of attack and stall angle with their significance. Draw and explain the $C_L \rightarrow \alpha$ curve.	**07**
		OR	
Q.3	**(a)**	A long right circular cylinder of radius a meters is held with its axis normal to an irrotational in inviscid stream of velocity u m/s. obtain an expression for drag force acting on unit length of cylinder due to pressure exerted on front half body.	**07**
	(b)	With the help of complex potential explain flow past circular cylinder without circulation.	**07**
Q.4	**(a)**	A 2-D incompressible flow is given by velocity field 3yi+2xj. Does this flow satisfy continuity equation? If yes find the stream function and potential function for the same.	**07**
	(b)	A source of strength $10m^2/s$ at point (1,0) and a sink of same strength at point (-1,0) are combined with a uniform flow of 25m/s in X-direction. Determine the size of Rankine body formed by the flow and difference in pressure between a point for upstream in the uniform flow at the point (1, 1).	**07**
		OR	
Q.4	**(a)**	Explain with neat sketches the forces and moments acting on an aircraft.	**07**
	(b)	The pressure and mach number for a normal shock wave at the upstream are 2 bar and 1.5 respectively. Find the rise in static pressure through shock and the total pressure loss across the shock.	**07**

Q.5 **(a)** Explain why shock is always oblique to some angle with respect to upstream flow? For the limiting case of an oblique shock wave, prove that flow downstream to the oblique shock wave is subsonic. **07**

(b) Define the terms aerodynamic center, center of pressure, critical mach number and drag divergence mach number. What is aspect ratio and explain its effect of aspect ratio on the wing. **07**

OR

Q.5 **(a)** Explain the terms bound vortex, trailing vortex and explain why Prandtl's single horse theory failed. **07**

(b) A supersonic flow with $M_1 = 2$, $P_1 = 1$ bar, and $T_1 = 20°C$ is expanded around a sharp corner through deflection angle of 10°. Calculate mach number; change in static properties and stagnation properties downstream the expansion wave. Also find the angles made by Mach lines with respect to the upstream flow direction. **07**

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