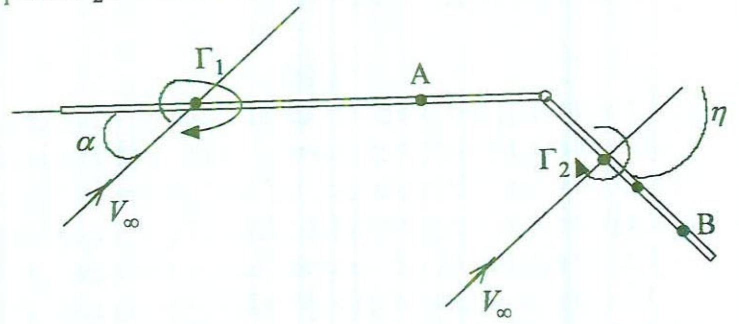
b. Write down the kinematic flow condition as applied to a cambered surface.
An aerofoil with flap is represented by a flat plate at an angle α with the flap part deflected downwards by a small angle η. Representing the plate by a concentrated vortex Γ_1 placed at quarter chord point of the plate, and the deflected flap at the quarter chord point of the flap Γ_2 and satisfying the kinematic flow condition at the three quarter chord points of the respective parts, obtain expressions for Γ_1 and Γ_2 and hence the total lift.



15. a. A wing of finite aspect ratio has elliptic lift distribution along the span given by $\Gamma = \Gamma_o\sqrt{1-(y/s)^2}$ where y is the span wise coordinate and 's' is the semi span. Show that the velocity induced by this vortex distribution is constant along the span.

(OR)

b. The induced angle of attack along the span of a wing due to elliptic lift distribution is given by $\alpha_i = \dfrac{\Gamma o}{4sV\infty}$ where $\Gamma(y) = \Gamma_o\sqrt{1-(y/s)^2}$, y being the span wise coordinate and 's' is the semi span, V_∞ = free stream velocity. Determine the induced drag of the wing.

* * * *

Reg. No.										

B.Tech. DEGREE EXAMINATION, NOVEMBER 2012

Fourth Semester

AS0202 – AERODYNAMICS - I

(For the candidates admitted from the year 2007-2008 onwards)

Use Galauert's integral wherever required $\int_0^{\pi} \dfrac{\cos^n\theta}{\cos\theta - \cos\Psi} = -\pi\dfrac{\sin n\Psi}{\sin\Psi}$

Take standard air properties: P = 100 kPa, t = 288 K and ρ = 1.25 kg/m^3

Time: Three hours Max. Marks: 100

Answer **ALL** Questions

PART – A (10 × 2 = 20 Marks)

1. Define: Stream line and write down its properties.
2. Define: Rotation of a fluid element. Illustrate an irrotational motion.
3. Explain what is meant by 'Stalling' of an aerofoil?
4. Define: Aerodynamic centre and Centre of pressure.
5. Explain the mechanism of formation of starting vortex behind an aerofoil.
6. Write down Kelvin's theorem on vortex motion.
7. Why are low speed aerofoils have well rounded leading edge?
8. Explain what is meant by Kutta's trailing edge condition?
9. Explain the concept of induced drag.
10. Why is sweep applied to a wing?

PART – B (5 × 16 = 80 Marks)

11. a. Write down the stream functions for a uniform flow parallel to the x-axis and the stream function for a doublet flow with its axis along negative x-axis. Combining the above flows, obtain the stream function for the flow past a circular cylinder. Show that the velocity at $\theta = 90°$ is twice the free stream velocity.
A circulation of $\Gamma = 1000\ m^2/s$ is superimposed on a circular cylinder of radius 1 m when a uniform flow of velocity 50 m/s is passing over it. Determine the velocity and pressure at $\theta = \pm 90°$.

(OR)

b. State and prove Kutta Joukowski theorem on lift. A circular cylinder of radius 1 m spins in a uniform flow of velocity 100 m/s. The rate of spin is 100 rps. Calculate the force on the cylinder. The density of fluid is 1 kg/m^3.

12. a. Define centre of pressure and aerodynamic centre for an aerofoil and obtain expressions for the same. The following results were obtained from wind tunnel tests on an aerofoil for different angles of attack.

α	0°	4°	8°	12°
C_L	0.303	0.709	1.114	1.518
C_M (c/2)	−0.277	−0.582	−0.886	−1.188

Determine the aerodynamic centre of the aerofoil.

(OR)

b. The stream function for a two-dimensional flow is given by $\Psi = ar^n \sin(n\theta)$, where a and n are constants. For n = 3/2 and n = 1/2. Determine

(i) The stream lines for which $\psi = 0$ and ψ = constant
(ii) Velocity and pressure at any point in the flow
(iii) Stagnation point if there is any

13. a. Consider a stream tube of circular cross section with wing span as diameter. Assuming this stream tube is affected by the wing, obtain expressions for coefficient of lift, coefficient of induced drag. Show that the induced angle of attack $\alpha_i = \frac{C_L}{\pi A}$ and the induced drag $C_{Di} = \frac{C_L^2}{\pi A}$ where A is the aspect ratio of the wing.

(OR)

b. Considering the propeller as an actuator disk and applying the linear momentum theory, show that the increment in velocity for downstream of the propeller is twice the increment in velocity in the plane of the propeller.
The propeller of an aircraft has a diameter of 5 m and develops a thrust of 30 kN while the aircraft flies with a velocity of 540 kmph. Determine the efficiency of propulsion and the energy lost in the slip stream.

14. a. A flat plate of chord 'C' is kept at a small angle of attack α to the free stream and develops a circulation $\gamma(x)$ given by

$$\gamma(x) = 2V_\infty \alpha \frac{x}{\sqrt{(c-x)x}} = 2V_\infty \alpha \tan\frac{\theta}{2}$$

$$where\ \frac{x}{c} = \frac{1}{2}(1+\cos\theta)\ \ or$$

$\gamma(\theta) = 2V_\infty \alpha \cot\frac{\theta}{2}$ $where\ \frac{x}{c} = \frac{1}{2}(1-\cos\theta)$ where x is measured from the leading edge. Determine

(1) Lift coefficient (2) Pitching moment coefficient
(3) Induced velocity along the chord

(OR)