15. a. Determine induced drag coefficient for a general lift distribution based on Prandtl's classical lifting line theory.

(OR)

b. i. Explain the concept of induced drag for a wing of finite span. Add sketch if necessary.

ii. A rectangular wing of chord 4 m, span 6 m is kept at a small angle of attack α in a uniform velocity u_∞. The angle α_g = 10° and free stream velocity 100 m/s. Determine the span wise circulation distribution by considering only two terms of the series solution.

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Reg. No.										

B.Tech. DEGREE EXAMINATION, NOVEMBER 2013

Fourth Semester

AS0202 – AERODYNAMICS - I

(For the candidates admitted from the academic year 2007-2008 to 2012-2013)

The following integral may be used wherever necessary.

$$\frac{1}{\pi}\int_0^{\pi}\frac{\cos n\theta_o}{\cos\theta_o-\cos\theta}\,d\theta=-\frac{\sin n\theta_o}{\sin\theta_o}$$

Time: Three hours Max. Marks: 100

Answer **ALL** Questions

PART – A (10 × 2 = 20 Marks)

1. Define Divergence, Curl of a vector field.
2. Define Circulation.
3. Define Aerodynamic center, Center of pressure.
4. Consider an air stream with velocity 25 m/s, produces 20 N of lift per unit span. Determine circulation. Density of air = 1.2 kg/m^3.
5. Distinguish between a potential vortex and a real vortex.
6. Give the important theoretical results for a symmetrical airfoil from thin airfoil theory.
7. Define Effective angle of attack.
8. State Biot-Savart's law.
9. Sketch the section of a blade element of a propeller and indicate the velocities relative the blade and the forces acting on the blade element.
10. Estimate induced drag coefficient for the following data:
    C_L = 0.5; e = 0.9 using span (b) = 8 m, wing area (s) = 10.66 m^2

PART – B ($5 \times 16 = 80$ Marks)

11\. a. Apply the physical principle of conservation mass to a finite control volume fixed in space and derive the continuity equation in integral form.

(OR)

b\. i. A real vortex consists of a core of radius R rotating as a solid body and beyond which it behaves as a potential vortex. Derive expression for the variation of pressure in the core and in the potential region. (10 Marks)

ii\. A real vortex in air has core of radius 1 m rotating at an angular velocity of 50 rad/s. The density of air is 1.225 kg/m^3. Determine the pressure at the center of vortex if the ambient pressure is 10^5 pa. (6 Marks)

12\. a. State and prove Kutta-Joukowshi theorem on lift.

(OR)

b\. The potential and stream function for the flow past a circular cylinder given by $\phi = V_\infty\left(r+\frac{a^2}{r}\right)\cos\theta,\ \psi = V_\infty\left(r-\frac{a^2}{r}\right)\sin\theta$, where 'a' is radius of cylinder. Super impose a potential vortex over this flow. Derive expressions for velocity and pressure over cylinder. Determine position of stagnation point.

13\.a.i Derive an expression for the thrust of a propeller applying the axial momentum principle indicating the assumptions made. (10 Marks)

ii\. A four bladed propeller has a diameter of 4 m and develops a thrust of 8500 N while rotating at 1300 rpm. It absorbs a torque of 8000 N-m for this thrust. Calculate the efficiency of the propeller based on axial momentum theory. (6 Marks)

(OR)

b\. i. Derive the kinematic flow condition as applied to a cambered aerofoil. Obtain the form of equation when the camber is represented by a vortex sheet on the chord.

ii\. The circulation distribution along the chord of camber is given by $r = 2V_\infty \frac{1+\cos\varphi}{\sin\varphi}$, *where* $\frac{x}{c} = \frac{1}{2}(1-\cos\varphi)$. Determine the equation of the cambered surface and sketch its shape.

14\. a. Consider a thin, symmetric airfoil at 1.5° angle of attack. From the results of thin airfoil theory, calculate lift coefficient and the moment coefficient about the leading edge.

(OR)

b\. The following are the data from wind tunnel test on an aerofoil.

α	−4°	0	4	8	12
C_L	−0.44	0.001	0.44	0.877	1.316
C_D	0.006	0.004	0.006	0.082	0.012
$C_{\mu(c/2)}$	−0.141	0	0.1408	0.2806	0.4211

Determine the aerodynamic center and center of pressure for $\alpha = 8°$.