Code No: RR222101 **Set No. 1**

II B.Tech II Semester Supplementary Examinations, November/December 2005
**AERODYNAMICS-I**
**(Aeronautical Engineering)**

**Time: 3 hours** **Max Marks: 80**

**Answer any FIVE Questions**
**All Questions carry equal marks**

⋆ ⋆ ⋆ ⋆ ⋆

1. How does a low speed airfoil and wing differ from a high-speed airfoil and wing. Explain features of both the wings. [16]

2. Consider Pressure distribution over a cambered section in a viscous, incompressible medium. Explain the phenomenon of separation and stalling with $C_p$ plots and sketches of resulting flow patterns. [16]

3. Compare total drag and its components over a circular cylinder with that on a flat plat with its orientation being, along the free stream and normal to it. Which are the dominant components in these test cases. Make use of sketches /plots to illustrate your answer. [16]

4. Show that the Complex Potential function w = $U_z$ + (q/2$\pi$)$L_{nz}$ represents flow about a half body. Sketch the streamlines and equipotential lines. [16]

5. Compare a symmetrical Zhukovsky airfoil with a symmetrical airfoil in use. Present your observations. Are these airfoils useful for practical applications? Hence transform a circle in to an ellipse using the Kutta-Zhukovsky transformation. Make use of sketches and plots to elaborate your answer. [16]

6. An airscrew is required to produce thrust of 5500 Newtons at a speed of 130 m/s at sea level. The diameter of the disc is 2.78 m. Estimate the minimum power to be supplied on the basis of ideal actuator disc. Another propeller is placed in its slipstream such that its disc area is just equal to that of the slipstream. Work out the size ant input power to the second propeller on the basis of Froude momentum theory. [16]

7. An airscrew of diameter 3.4 m dia. has the following characteristics

| J | 1.06 | 1.19 | 1.34 | 1.44 |
|---|---|---|---|---|
| $K_Q$ | 0.0410 | 0.0400 | 0.0378 | 0.0355 |
| $\eta$ | 0.76 | 0.80 | 0.84 | 0.86 |

   Calculate the forward speed at which it will absorb 700 KW AT 1250 rpm at 3000 m
   ($\sigma$ = 0.742) and the thrust under these conditions. Compare the efficiency with that from the ideal actuator disc theory. [16]

8. Describe different variants of multi-rotor helicopters. Explain salient design and operational features of each of these configurations. Make use of sketches / plots to elaborate your answer. [16]

⋆ ⋆ ⋆ ⋆ ⋆

Code No: RR222101 **Set No. 2**

II B.Tech II Semester Supplementary Examinations, November/December 2005

**AERODYNAMICS-I**

**(Aeronautical Engineering)**

**Time: 3 hours** **Max Marks: 80**

**Answer any FIVE Questions**

**All Questions carry equal marks**

⋆ ⋆ ⋆ ⋆ ⋆

1. Describe various types of airfoil sections used in aircraft industry. Describe in details 4 digit and 5 digit series of NACA sections. Make use of sketches and $c_1$-$c_d$-$\alpha$ plots to illustrate your answer. [16]

2. Consider an arbitrary object moving through a fluid medium. How can you develop expressions for forces occurring on this object? [16]

3. An airplane weighing 5,10,000 N, with wing loading of 2820 N/ $m^2$ has its drag polar given by $C_D = 0.021 + 0.042\ C_L^2$ . Plot the thrust vs. velocity curve and obtain lift coefficient for minimum drag. What is the significance of this condition? [16]

4. Show that the Complex Potential function w = (i$\Gamma$x / 2$\pi$)$L_n$ [(z+a) / (z-a)] represents a line vortex near a wall. Sketch the streamlines and equipotential lines. [16]

5. What are the basic principles of conformal transformation? Show that for a transformation of the type $\zeta$ = z + $b^2$/z , ( b is a constant ), the velocity ratio between corresponding points is the inverse of the length ratios. [16]

6. A pair of airscrews is placed in tandem at a stream wise spacing sufficient too eliminate mutual interference. The diameter of the rear screw is just equal to the diameter of the slipstream of the front airscrew. Calculate efficiency of the combination and that of the rear airscrew, on the basis of ideal actuator disc theory. [16]

7. A 3-bladed airscrew is driven at 1560 rpm at a flight speed of 110 m / s at sea level. At 1.25 m radius, the local efficiency is estimated to be 87%, while the L/D ratio of the blade section is 57.3. Calculate the local thrust grading, ignoring rotational interference. [16]

8. How can the plane of a rotary wing be tilted to a desired angle for an operation? Make use of sketches / plots to elaborate your answer. [16]

⋆ ⋆ ⋆ ⋆ ⋆

Code No: RR222101 **Set No. 3**

II B.Tech II Semester Supplementary Examinations, November/December 2005

**AERODYNAMICS-I**

**(Aeronautical Engineering)**

**Time: 3 hours** **Max Marks: 80**

**Answer any FIVE Questions**

**All Questions carry equal marks**

⋆ ⋆ ⋆ ⋆ ⋆

1. Show the effect of sweep, taper and twist on the aerodynamic performance of a wing. What type of wing plan form requires these additional features. Make use of sketches and $c_1$-$c_d$-$\alpha$ plots to illustrate your answer. [16]

2. Following data was obtained from wind tunnel test. The pitching moment coefficients were take about a spindle located 1/3 rd of chord behind the leading edge:

| $C_L$ | 0.2 | 0.4 | 0.6 | 0.8 |
|---|---|---|---|---|
| $C_m$ | -0.02 | 0.00 | 0.02 | 0.04 |

   Find the value of aerodynamic center and $C_{m0}$ . Develop the expression used. [16]

3. Define the term Drag force acting on an airfoil / wing or any moving object. What are the causes and effects of drag? Write down expression for total drag and its components. Hence compare drag of various objects. Make use of sketches /plots to illustrate your answer. [16]

4. Define a complex potential function from the first principle. What is represented by a Complex potential function? Consider a point source placed in a uniform stream. Plot the streamlines and equipotential lines. Make use of sketches and plots to explain your answers. [16]

5. Calculate the velocity just outside the boundary layer at the 0.50 x/c location of a symmetrical Zhukovsky airfoil of t/c ratio of 40 % set at zero incidence in a stream of undisturbed velocity 50 m/s. [16]

6. An airscrew is required to produce thrust of 6000 Newtons at a speed of 125 m/s at sea level. If the diameter of the disc is 2.6 m estimate the minimum power to be supplied on the basis of ideal actuator disc. [16]

7. A 4- bladed airscrew is required to propel an aircraft at 125 m/s at sea level, the rotational speed being 1200 rpm. The blade element at 1.25 m radius has an absolute incidence of $6^0$ and the thrust grading is 2800 N/m per blade. Assuming a reasonable value for the section lift curve slope, calculate the blade chord at 1.25 m radius. Neglect rotational interference, sectional drag and compressibility. [16]

8. What are the possible variants of a rotary wing aircraft? Explain design features and other details with sketches and plots. [16]

⋆ ⋆ ⋆ ⋆ ⋆

Code No: RR222101 **Set No. 4**

II B.Tech II Semester Supplementary Examinations, November/December 2005
**AERODYNAMICS-I**
**(Aeronautical Engineering)**

**Time: 3 hours** **Max Marks: 80**

**Answer any FIVE Questions**
**All Questions carry equal marks**

⋆ ⋆ ⋆ ⋆ ⋆

1. What are the requirements of airfoil section for high-speed applications in airplanes? Should it be symmetrical or cambered? Provide reasons for your answer. Make use of sketches and $c_1$-$c_d$-$\alpha$ plots to illustrate your answer. [16]

2. Given an airfoil at some angle of attack. Elaborate if lift and drag forces on it are different or equal to Normal and axial forces on it. Make use of sketches / plots to explain your answer. [16]

3. Explain the causes of skin friction drag on an airfoil / wing. Can you estimate this component of drag with a theoretical / experimental technique. Elaborate. [16]

4. Sketch the stream line pattern of the flow given by the Complex Potential function w = A $z^2$ , where A is a constant and other symbols have usual meaning. Find the magnitude and direction of the stream at x = 1,y= 2 when A = 10. [16]

5. Apply the Kutta-Zhukovsky transformation to obtain a symmetrical airfoil of thickness ratio 15%. Make use of sketches and plots to elaborate your answer. [16]

6. An airscrew is required to produce thrust of 4500 Newtons at a speed of 125 m/s at sea level. The diameter of the disc is 2.5 m. Estimate the minimum power to be supplied on the basis of ideal actuator disc. Another propeller is placed in its slipstream such that its disc area is just equal to that of the slipstream. Work out the size ant input power to the second propeller on the basis of Froude momentum theory. [16]

7. Define the term torque coefficient. Hence develop an expression for it from dimensional analysis. Hence define Power coefficient, and efficiency of a propeller. [16]

8. Describe with neat sketches / plots a fully articulated rotor system of a helicopter. Explain its action in effecting collective and cyclic pitch as desired by the pilot. [16]

⋆ ⋆ ⋆ ⋆ ⋆