CODE NO: R09222101

R09

SET No - 1

II B.TECH - II SEMESTER EXAMINATIONS, APRIL/MAY, 2011
AERODYNAMICS
(AERONAUTICAL ENGINEERING)

Time: 3hours **Max. Marks: 75**

Answer any FIVE questions
All Questions Carry Equal Marks
- - -

1.a) Derive the momentum equation for a fluid flow in the integral form.
b) Based on this, derive the expression for the x-component of the momentum equation in differential form. [10+5]

2. Write short notes on
a) Vorticity and circulation
b) Real flow over a circular cylinder
c) Velocity potential for a flow with uniform velocity. [5+5+5]

3.a) Distinguish between laminar and turbulent flows.
b) Compare, with the help of sketches, the laminar and turbulent boundary layers.
c) Discuss flow separation. [5+5+5]

4. Write short notes on
a) Zero-lift angle of attack
b) Vortex filament and vortex sheet
c) Kelvin's circulation theorem. [5+5+5]

5. Explain
a) Vortex filament
b) Biot-Savart Law
c) Induced drag coefficient. [5+5+5]

6.a) Discuss the Laplace equation in the context of fluid flows.
b) Derive the expressions for the velocity components and velocity potentials for three dimensional source, sink and doublet. [5+10]

7. Write short notes on
a) Variation of lift coefficient of an airfoil with angle of attack.
b) Variation of Reynolds number on the lift coefficient
c) Super critical airfoil. [5+5+5]

8. Write short note on
a) Geometric pitch, mean pitch and effective angle of attack of blades of a helicopter
b) Articulation of the blades
c) Compressibility effects on blades. [5+5+5]

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CODE NO: R09222101 | R09 | SET No - 2

II B.TECH - II SEMESTER EXAMINATIONS, APRIL/MAY, 2011
AERODYNAMICS
(AERONAUTICAL ENGINEERING)

Time: 3hours **Max. Marks: 75**

Answer any FIVE questions
All Questions Carry Equal Marks
- - -

1.a) State and explain divergence theorem for a vector field.
b) Derive the continuity equation for a fluid flow in the form of a partial differential equation. [5+10]

2.a) Define a doublet and derive the expression for the stream function in a doublet flow.
b) Derive the expression for non-lifting flow over a circular cylinder. [5+10]

3.a) Derive the expression for the momentum thickness in a boundary layer.
b) Define thermal boundary layer and with the help of sketches, explain the temperature variations in the boundary layer.
c) Show schematically the pressure variation over an airfoil at a high angle of attach (say, 25 degrees) and explain the causes. [5+5+5]

4. Derive the fundamental equation of thin airfoil theory. [15]

5. Write short notes on
a) Biot – Savart Law
b) Helmholtz theorem
c) vortex induced drag. [5+5+5]

6.a) Compare the inviscid, incompressible flows over a cylinder and a sphere.
b) Discuss asymmetric loads over a fuselage. [8+7]

7. Explain
a) drag polar of an airfoil
b) effect of airfoil geometry on the lift coefficient
c) laminar flow control over the airfoil. [5+5+5]

8. Write short notes on
a) Geometry of the propeller of a helicopter
b) effect of geometric pitch on the performance of the rotor.
c) vortex system of the rotor for different flight conditions of the helicopter. [5+5+5]

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CODE NO: R09222101

R09

SET No - 3

II B.TECH - II SEMESTER EXAMINATIONS, APRIL/MAY, 2011
AERODYNAMICS
(AERONAUTICAL ENGINEERING)

Time: 3hours **Max. Marks: 75**

Answer any FIVE questions
All Questions Carry Equal Marks

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1.a) Derive the energy equation for a fluid flow in the integral form.
b) Based on this derive the energy equation for a steady, inviscid, adiabatic fluid flow without any body forces, in the differential form. [10+5]

2.a) Derive the stream functions for uniform flow, source flow and sink flow.
b) Explain the different coefficients of drag over an airfoil and an aircraft.
c) Explain in brief D'Alembert's paradox. [9+4+2]

3.a) Explain, with the help of neat sketches, flows over an airfoil at a low (say, 5 degree) angle of attack and a high (say, 20 degree angle of attack) over a symmetric airfoil. Discuss the causes and effects.
b) State the expressions for boundary layer thickness over a flat plate in laminar and turbulent boundary layers, explaining all the parameters clearly.
c) Discuss thermal boundary layer. [5+5+5]

4. Starting from the fundamental equation of thin airfoil theory,

$$\frac{1}{2\pi}\int_0^c \frac{\gamma(\xi)\,d\xi}{x-\xi} = V_\infty(\alpha - \frac{dz}{dx})$$

$$\frac{1}{2\pi}\int_0^c \frac{\gamma(\xi)d\xi}{x-\xi} = V_\infty\left(\alpha - \frac{dz}{dx}\right)$$

derive the expression for the slope of lift coefficient of a symmetric airfoil. Explain all the symbols used. Also, discuss the result. [15]

5. Write short notes on
a) Down wash and its effect on lift and drag coefficients of a wing
b) Normal velocity induced at any point on the wing by both an element of a lifting surface and the wake. [5+10]

6.a) Define a doublet and obtain an expression for the velocity potential for a three dimensional doublet.
b) Derive expressions for the velocity and pressure coefficients over the surface of a sphere. [5+10]

7. Write short notes on
a) lift augmentation methods for an airfoil
b) variation of drag coefficient with Mach number
c) effect of Reynolds number on skin friction coefficient. [5+5+5]

8.a) Explain cyclic pitch and collective pitch variations and the requirement in a helicopter flight.
b) Derive an expression for the incremental thrust coefficient of an element in the rotor blade using blade element theory. [5+10]

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CODE NO: R09222101

R09

SET No - 4

II B.TECH - II SEMESTER EXAMINATIONS, APRIL/MAY, 2011
AERODYNAMICS
(AERONAUTICAL ENGINEERING)

Time: 3hours **Max. Marks: 75**

Answer any FIVE questions
All Questions Carry Equal Marks
- - -

1.a) State and explain Buckingham's Pi Theorem.
b) Based on this theorem, prove that the lift and drag coefficients of an air foil are functions of only Mach number and Reynolds number while the lift and drag are functions of the free stream velocity, density, coefficient of viscosity, speed of sound in the free stream and the chord of the airfoil. [7+8]

2.a) Define circulation and vorticity. Establish the relationship between the two in a flow.
b) Define 'stream function'. Derive the expressions for stream functions of three elementary flows. [6+9]

3.a) Explain the approximations to the Navier – Stokes equations to the flow in a boundary layer.
b) Explain surface friction drag and form drag. How does the former depend on the Reynolds number?
c) State the momentum – integral equation for two dimensional, incompressible boundary layers and explain all the parameters in the equation. [5+5+5]

4. Write short notes on
a) Kelvin's circulation theorem
b) Effect of surface roughness and boundary layer transition on the aerodynamic forces over an airfoil. [6+9]

5.a) Explain Starting, bound and trailing vortices
b) Derive an expression for the induced drag over a wing. State all the assumptions very clearly. [5+10]

6.a) Compare the inviscid, incompressible flow and real flow over a sphere. Draw neat sketches wherever necessary.
b) Discuss asymmetric vortex shedding by a cylinder in a low velocity flow. What is the effect of Reynold's number on this phenomenon? [7+8]

7. Write short notes on
a) Effect of wing geometry on lift
b) power augmented lift
c) NACA airfoils. [5+5+5]

8.a) Using the Rankine – Froude momentum theory, derive the velocity of air in the far wake of a helicopter in hover in terms of the velocity induced by the rotor.
b) Describe cyclic pitch and its requirement for helicopter flight. [10+5]

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