AERODYNAMICS – I

PART A

1. Write energy equation for a steady incompressible flow and name the terms involved in the equation.
2. Define Circulation.
3. Distinguish between Eulerian approach and Lagrangian approach for fluid flow description.
4. What is Blasius theorem?
5. Distinguish between ideal and real fluids.
6. What is Conformal Transformation?
7. What are the applications of thin airfoil theory?
8. What is "horse shoe vortex"?
9. What is the important feature of Karman-Treftz airfoil profile?
10. What are the limitations of lifting line theory?
11. Write the momentum equation for a steady incompressible flow and name the terms involved.
12. Why is that liquid flows are incompressible?
13. Define Blasius theorem.
14. State the condition for irrotationality for a flow.
15. What is the strength of point vortex?
16. What is the application of Joukowshi's transformation to flow problems with respect to aerofoils?
17. Enumerate the application of thin airfoil theory.
18. Write the general form of energy equation for a two dimensional flow.
19. Define boundary layer.
20. Briefly explain the terms substantial derivative, convective derivative and local derivate.
21. What type of flow can be described by Laplace equation?
22. How streamlines and equipotential lines are related to each other? Prove it.
23. State Kutta conditions.
24. What is meant by complex potential function?
25. State Biot and Savart law.
26. What is meant by Wash-in and Wash-out for wings?
27. Define displacement thickness.
28. What are the assumptions involved in Blasius solution.
29. What is uniform flow? Explain.
30. Write down the significance of continuity condition.
31. What is complex potential? Explain.
32. State Kutta-Zoukowski theorem.
33. List the requirements to classify an airfoil as thin.
34. What is Kutta condition and where is it applied?
35. State Biot-Savarts law and its application.
36. How is horse shoe vortex formed? Explain.
37. What are the applications of Bernoulli's equations in aerodynamics?
38. Give the equations of stream lines and the potential lines when (1) the flows are parallel to X axis (2) flows are parallel to Y axis.

39. Define Doublet? Give the streamline for doublet.
40. Express the algebraic form of Kutta – joukowski theorem and explain the parameters in the equation?
41. For symmetric airfoils aerodynamic center and center of pressure coincides. True/false justify your answer.
42. Consider an airfoil in a flow with a free stream velocity of 45 m/s. The velocity at a given point on the airfoil is 70 m/s. Calculate the pressure co-efficient.
43. Give the applications of lifting line theory?

PART B

1. Derive the general x-momentum equation for an unsteady 3-D inviscid flow in partial differential form using a control volume approach.
2. Define angular velocity, strain rate, vorticity and dilatation of a fluid element.
3. Derive the expressions for stream function and velocity potential function.
4. Explain source, sink, free and forced vortex with neat sketches.
5. What are the characteristics of a vortex flow?
6. State and prove Kutta-Joukowski's theorem.
7. Explain how the Joukowski's transformation is used to obtain a circular as aerofoil.
8. Explain Blasius theorem for a steady two dimensional irrotational flow.
9. Enumerate the limitations and applications of Joukowski's aerofoil.
10. Explain Kutta condition.
11. Derive the fundamental equation for thin airfoil theory and give the assumptions that are made in thin aerofoil theory.
12. Explain Biot-Savart's law with application.
13. Explain starting vortex and horse shoe vortex.
14. Explain lifting line theory and give its limitations.
15. Explain the types of drag produced due to the effects of viscosity.
16. Derive Navier-Stokes equations for an unsteady, compressible, three dimensional viscous flow.
17. What is boundary layer separation?
18. Explain displacement thickness and momentum thickness in boundary layer theory.
19. Derive continuity condition in 3D Cartesian coordinates.
20. Derive Euler's equation for 3D flow.
21. Explain 'ideal' and 'perfect' fluid.
22. Generate velocity potential function and stream function for a free vortex.
23. Derive expressions for the velocity potential ϕ and stream function ψ for a doublet.
24. Clearly explain the method of obtaining the Zoukowski transformation to get a cambered airfoil.
25. What are the short combings of Zoukowski Aerofoils?
26. Indicate the transformation function and the characteristics of modified Zoukowski aerofoils.
27. Briefly explain Karman Treffety, Von mises and Carafoli profiler.
28. In a thin aerofoil the flap chord is 30% and flap deflection angle is b. Calculate the values of C_1, C_m and C_{mo}.

29. Using thin aerofoil theory derive expressions for the C_1, C_{mpe} of a flat plate at an angle of an attack ά.
30. State Biot – Savart's law.
31. Using Biot – Savarts law compute the down wash velocity at a point on the central line of symmetry at a distance h a from the bound vortex in a horse shoe vortex.
32. Explain the terms 'Bound vortex', 'Starting vortex' and 'Horse shoe vortex'.
33. Show that for an elliptical wing loading the induced drag is minimum.
34. Derive Bernoulli's equation for incompressible flow from Newton's second law of motion?
35. Two points on a streamline in the steady flow of air upper and the lower points are 150 m/s and 50m/s respectively. Find the difference in the static pressures between two points taking r = 1.225 kg/m^3.
36. Determine the condition that the velocity Components u = ax+by, v = cx+dy will satisfy the equation of continuity and find the magnitude of vorticity.
37. Derive the temperature equation for an incompressible flow in partial differential form.
38. What is a rankine oval? What combination of flows is required to obtain the Oval?
39. The X and Y velocity components of a fluid flow are given by U=2xy+4y+6x and v=3y+2x^2+6xy. Is the flow irrotational? Is it is a physically possible flow?
40. Show that the combination of doublet flow and the uniform flow is equivalent to a non-lifting flow over a cylinder. Obtain the expression for velocity potential function and stream function for the combination.
41. Explain how a flow over a circular cylinder can be transformed a flow over a flat Plate using joukowski's transformation.
42. Derive Blasius theorem for an incompressible flow over flat plate.
43. A thin airfoil has a mean chamber line is given by y/c = 0.25 [0.8 (x/c) – $(x/c)^2$] for 0 £ x/c £ 0.4 and y/c = 0.11 [0.2 + 0.8(x/c) – $(x/c)^2$] for 0.4 £ x/c £ 1.0 where c is chord of the airfoil, x,y are the axis parallel and perpendicular to the chord respectively.

    Based on thin airfoil theory calculate

    i. α at zero lift
    ii. Moment coefficient at quarter chord point.
44. What are Karman – trefftz and Von-mises airfoils? Explain your answers with neat sketch?
45. What is Kutta condition? Draw flow over an airfoil with G = Gkutta.
46. Derive prantl's lifting line theory?
47. State Biot savart law and derive an expression for the velocity induced by an infinite vortex filament at a point, which is at a distance n from the filament.
48. Write short notes on down wash?