

B.E. DEGREE EXAMINATIONS: APRIL / MAY 2009

Fourth Semester

AERONAUTICAL ENGINEERING

U07AR401 Aerodynamics - I

Time: Three Hours

Maximum Marks: 100

Answer ALL the Questions:-

PART A (20 x 1 = 20 Marks)

1. The rate of variation of velocity with space is known as
 - a. Convective acceleration
 - b. Local acceleration
 - c. Substantial acceleration
 - d. Total acceleration

2. For a stream line the velocity vector at any instant is
 - a. Tangential to the stream line
 - b. Radial to the stream line
 - c. Parallel to the stream line
 - d. Perpendicular to the stream line

3. Bernoulli's equation is applicable to any perfect fluid provided
 - a. There is no change of temperature
 - b. There is change of temperature
 - c. There is no transfer of energy from or to the fluid
 - d. There is energy transfer from or to the fluid

4. Dynamic pressure is caused by
 - a. change of momentum of fluid
 - b. rotation of fluid
 - c. circulation of fluid
 - d. vortex formation

5. For a free vortex flow
 - a. discharge of fluid is constant
 - b. circulation of fluid is constant
 - c. velocity of fluid is constant
 - d. density of the fluid is constant

6. For uniform velocity U parallel to x -axis, the stream function is
 - a. Ux
 - b. Uy
 - c. U
 - d. $Ux + Uy$

7. For combination of doublet with uniform flow the stream line of zero stream function is
a. Circle b. Oval c. Ellipse d. Straight line
8. Stream lines are radial lines and potential lines are circle for
a. Source b. Vortex c. Doublet d. Uniform flow
9. Which is sub-critical circulation for cylinder flow
a. $\Gamma < 4\pi aU$ b. $\Gamma = 4\pi aU$ c. $\Gamma > 4\pi aU$ d. $\Gamma = 0$
10. Trailing edge angle of a cuspid Joukowski aerofoil is
a. 0 b. 90 c. 180 d. 360
11. Kutta trailing edge condition is about
a. Shape of the upper camber of aerofoil
b. Shape of lower camber of aerofoil
c. Maximum thickness of the aerofoil
d. Magnitude of circulation around aerofoil
12. Induced drag of an aerofoil is minimum when
a. Aspect ratio is minimum
b. Aspect ratio is maximum
c. Aspect ratio is equal to unity
d. Aspect ratio is zero
13. Modified Joukowski aerofoil profile
a. Modifies the shape of the aerofoil
b. Modifies the angle at the trailing edge
c. Modifies the position of aerodynamic centre
d. Modifies the maximum thickness
14. Theoretical maximum lift curve slope of a flat plate
a. Zero b. Unity c. 2π d. Infinity
15. For symmetrical aerofoil zero lift line coincide with
a. Upper camber b. Lower camber c. Chord line d. Any line
16. A transformation is conformal when
a. The figure is altered in size, position, orientation
b. Alter in shape only
c. Altered in size only
d. Altered in orientation only

17. Within boundary layer

- a. Viscous force are predominant
- b. Viscous force are not predominant
- c. Surface tension is predominant
- d. Surface tension is not predominant

18. The boundary layer thickness on a body depends on

- a. Variation of pressure normal to the body
- b. Variation of velocity normal to the body
- c. Variation of density normal to the body
- d. All the above

19. Pressure gradient in boundary layer formation is due to

- a. Pressure variation across the boundary layer
- b. Pressure variation along the boundary layer
- c. Density variation across the boundary layer
- d. Density variation along the boundary layer

20. Laminar boundary layer thickness on a flat plate is

- a. Directly proportional to distance from the leading edge
- b. Inversely proportional to distance from the leading edge
- c. Directly proportional to the square root of the distance from the leading edge
- d. Inversely proportional to the square root of the distance from the leading edge

PART B (5 x 16 = 80 Marks)

21. (a). (i). Derive 1-D continuity equation in differential form. (8)

(ii). In a flow field the radial component of the velocity $\frac{-\mu \cos \theta}{r^2}$, determine tangential component in case of steady incompressible continuous flow. Also determine resultant velocity. (8)

(OR)

(b). (i). State and prove Bernoulli's equation for compressible flow. (12)

(ii). Free stream velocity for flow is 42.5 m/s. At certain position on the top the aerofoil the local velocity is 33.8 m/s. Estimate the pressure coefficient. (4)

22. (a). (i). In a 2-D flow $u = \frac{y}{b^2}$ and $v = \frac{-x}{a^2}$. Determine whether the flow is possible and also determine the streamline passing through (a, 0). (1)

(ii). Show that for a doublet with uniform flow the dividing streamline is a circle of radius 'a' at origin. (1)

(OR)

(b). State and prove Kutta - Joukowski equation. (1)

23. (a). Establish Joukowski transformation to get a symmetrical aerofoil and obtain an expression for maximum thickness ratio of such aerofoil. (1)

(OR)

(b). Find the pressure drag due to pressure applied on one side of a cylinder in a uniform stream. (1)

24. (a). The mean camber line of NACA 2312 is defined as follows,

Forward of maximum camber

$$y/c = 1/8 [0.8 (x/c) - (x/c)^2]$$

After the maximum camber

$$y/c = 0.055 [0.2 + 0.8 (x/c) - (x/c)^2]$$

Using thin aerofoil theory, calculate zero lift angle. (1)

(OR)

(b). For general lift distribution find the expression for induced angle of attack and induced drag coefficient. (1)

25. (a). Explain nominal thickness, momentum thickness and displacement thickness of boundary layer. (1)

(OR)

(b). Establish the relationship between Reynolds number and momentum thickness, displacement thickness for flat plate boundary layer at zero pressure gradient for the distribution of velocity across the boundary layer

given by $\frac{u}{U} = \frac{y}{\delta}$ (1)
