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AEROSPACE ENGINEERING

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FLIGHT MECHANICS

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ACHARYA INSTITUTE, B'LORE
AIR - 6

HARIHARAN R
MIT, CHENNAI
AIR - 9

VIGNESH CG
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AIR - 11

ADITYA ANIL KUMAR
IIST TRIVANDRUM
AIR - 17

And Many More ....

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AIR - 2

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AIR - 14

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AMRITA UNIV, COIMBATORE
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AKILESH . G
HITS, CHENNAI
AIR - 7

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AMRITA UNIV, COIMBATORE
AIR - 10

DIPAYAN PARBAT
IIEST, SHIBPUR
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Amrita Univ - Coimbatore

Shashi Kanth M
Sastra Univ - Tanjore

Vagicharla Dinesh
Lovely Professional Univ - Punjab

Anantha Krishan A.G
Amrita Univ - Coimbatore

HAL DT ENGINEER 2022

Fathima J
MIT - Chennai

Mohan Kumar H
MVJCE - Bangalore

HAL DT ENGINEER 2021

Arathy Anilkumar Nair
Amrita Univ - Coimbatore

Sadsivuni Tarun
Sastra Univ - Tanjore

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Ajitha Nishma V
IIST - Trivendrum

Dheeraj Sappa
IIEST - Shibpur

F Jahangir
MIT - Chennai

Goutham
KCG College - Chennai

M Kumar
MVJ College - Bangalore

Mohit Kudal
RTU - Kota

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IIEST - Shibpur

Nitesh Singh
Sandip Univ - Nashik

Ramanathan A
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RAM GOPAL SONI
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Ayush Boral
KIIT - Bhubaneswar

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Sathyabama University - Chennai

Shrenith Suhas
IIEST - Shibpur

Ankur Vats
School Of Aeronautics - Neemrana

9. Flight Mechanics

GATE AE - 2007

One Mark Questions.

1. For maximum range of a glider, which of the following conditions is true?
   (A) lift to drag ratio is maximum
   (B) rate of descent is minimum
   (C) descent angle is maximum
   (D) lift to weight ratio is maximum

2. An airplane with a larger wing as compared to a smaller wing will necessarily have
   (A) more longitudinal static stability
   (B) less longitudinal static stability
   (C) same longitudinal static stability
   (D) more longitudinal static stability for an aft tail airplane if aerodynamic center of the larger wing is behind the center of gravity of the airplane

3. Two airplanes are identical except for the location of the wing. The longitudinal static stability of the airplane with low wing configuration will be
   (A) more than the airplane with high wing configuration
   (B) less than the airplane with high wing configuration
   (C) same as the airplane with high wing configuration
   (D) more if elevator is deflected

4. For a fixed center of gravity location of an airplane, when the propeller is mounted on the nose of the fuselage
   (A) longitudinal static stability increases
   (B) longitudinal static stability decreases
   (C) longitudinal static stability remains same
   (D) longitudinal static stability is maximum

5. Let an airplane in a steady level flight be trimmed at a certain speed. A level and steady flight at a higher speed could be achieved by changing
   (A) engine throttle only
   (B) elevator only
   (C) throttle and elevator together
   (D) rudder only

Two Marks Questions.

6. Two airfoils of the same family are operating at the same angle of attack. The dimensions of one airfoil are twice as large as the other one. The ratio of the minimum pressure coefficient of the larger airfoil to the minimum pressure coefficient of the smaller airfoil is
   (A) 4.0 (C) 1.0
   (B) 2.0 (D) 0.5

7. Wing A has a constant chord c and span b. Wing B is identical but has a span 4b. When both wings are operating at the same geometric angle of attack at subsonic speed, then:
   (A) wings A and B produce the same lift coefficient
   (B) wing A produces a smaller lift coefficient than wing B
   (C) wing A produces a greater lift coefficient than wing B

(D) the freestream Mach number decides which wing produces the greater lift coefficient

8. An airplane model with a symmetric airfoil was tested in a wind tunnel. C_{mo}(C_m at angle of attack, $\alpha = 0$) was estimated to be 0.08 and 0 respectively for elevator settings (δe) of 5 degrees up and 5 degrees down. The estimated value of the elevator control power $\left(\frac{\partial C_m}{\partial \delta e}\right)$ of the model will be

(A) 0.07 per deg
(B) -1.065 per deg
(C) -0.008 per deg
(D) -0.762 per deg

9. The lateral-directional characteristic equation for an airplane gave the following set of roots: $\lambda_1 = -0.6, \lambda_2 = -0.002, \lambda_{3,4} = -0.06 \pm j1.5$, where $j = \sqrt{-1}$.
The damping ratio corresponding to the Dutch-roll mode will be

(A) 0.04
(B) 0.66
(C) 0.35
(D) 0.18

10. An airplane is flying at an altitude of 10km above the sea level. Outside air temperature and density at 10km altitude are 223 K and 0.413 kg/m^3 respectively. The airspeed indicator of the airplane indicates a speed of 60 m/s. Density of air at sea level is 1.225 kg/m^3 and value of the gas constant R is 288 J/kg/K. The stagnation pressure (P_0) measured by the Pitot tube mounted on the wing tip of the airplane will be of magnitude

(A) $3.5 \times 10^4 N/m^2$
(B) $2.0 \times 10^4 N/m^2$
(C) $2.87 \times 10^4 N/m^2$
(D) $0.6 \times 10^4 N/m^2$

11. If the center of gravity of an airplane is moved forward towards the nose of the airplane, the C_{Lmax} (maximum value of the lift coefficient) value for which the airplane can be trimmed ($C_m = 0$) will

(A) decrease
(B) increase
(C) remain same
(D) depend upon rudder deflection

12. If the contribution of only the horizontal tail of an airplane was considered for estimating $\frac{\partial C_m}{\partial \alpha}$, and if the tail moment arm l_t, was doubled, then how many times the original value would the new $\frac{\partial C_m}{\partial \alpha}$ become?

(A) two times
(B) three times
(C) 1.414 times
(D) 1.732 times

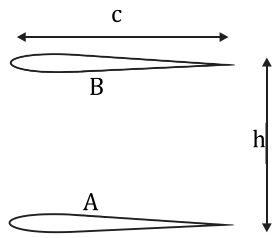
13. If the vertical tail of an airplane is inverted and put below the horizontal tail, then the contribution to roll derivative, $\frac{\partial C_l}{\partial \beta}$, will be

(A) negative
(B) positive
(C) zero
(D) imaginary

14. If horizontal tail area is increased while the elevator to horizontal tail area ratio is kept same, then

(A) both longitudinal static stability and elevator control power will increase
(B) only longitudinal static stability will increase
(C) only elevator control power will increase
(D) neither stability nor control power changes

15. An airfoil section is known to generate lift when placed in a uniform stream of speed U_∞ at an incidence α. A biplane consisting of two such sections of identical chord c, separated by a distance h is shown in the following figure:



With regard to this biplane, which of the following statements is true?

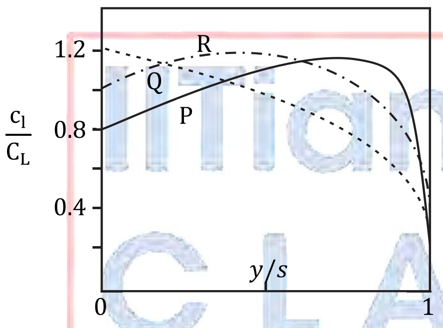
(A) Both the airfoils experience an upwash and an increased approach velocity

(B) Both the airfoils experience a downwash and a decreased approach velocity

(C) Both the airfoils experience an upwash and airfoil A experiences a decreased approach velocity while airfoil B experiences an increased approach velocity

(D) The incidence for the individual sections of the biplane is not altered

16. The span-wise lift distribution for three wings is shown in the following figure:



In the above figure, c_l refers to the section lift coefficient, C_L refers to the lift coefficient of the wing, y is the coordinate along the span and s is the span of the wing. A designer prefers to use a wing for which the stall begins at the root. Which of the wings will he choose?

(A) P (C) R

(B) Q (D) None

Common data for Questions 17, 18 and 19:

An airplane designer wants to keep longitudinal static stability margin (SM) within 5% to 15% of mean aerodynamic chord. A wind tunnel test of the model showed that for $\bar{X}_{CG} = 0.3, \frac{dC_m}{dC_L} = -0.1$. Note that the distance from the wing leading edge to the center of the gravity (X_{CG}) has been non-dimensionalized by dividing it with mean aerodynamic chord, $\bar{c}$, such that $\bar{X}_{CG} = X_{CG}/\bar{c}$. Note also that the relation $\frac{dC_m}{dC_L} = -SM$ holds true for this airplane.

17. The most forward location of the airplane center of gravity permitted to fulfill the designer's requirement on longitudinal static stability margin is

(A) $0.35\,\bar{c}$ (C) $0.15\,\bar{c}$

(B) $0.25\,\bar{c}$ (D) $0.52\,\bar{c}$

18. The most aft location of the airplane center of gravity permitted to fulfill designer's requirement on longitudinal static stability is

(A) $0.35\bar{c}$ (C) $0.52\,\bar{c}$

(B) $0.45\,\bar{c}$ (D) $0.67\,\bar{c}$

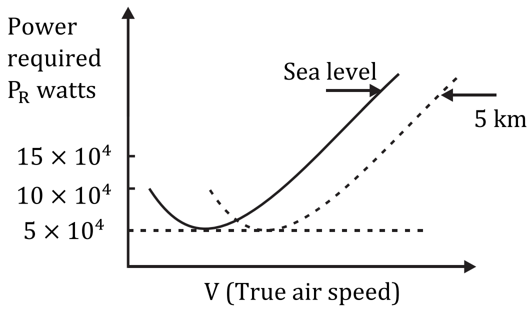
19. The center of gravity location to have $\frac{d\delta e}{dC_L} = 0$ is

(A) $0.35\,\bar{c}$ (C) $0.5\,\bar{c}$

(B) $0.45\,\bar{c}$ (D) $0.4\,\bar{c}$

Statement for Linked Answer Qns 20 & 21:

For a piston propeller airplane weighing 20000 N, the flight testing at 5 km pressure altitude in standard atmosphere gave the variation of power required versus true air speed as shown in figure below. The student forgot to label the air speed axis. The maximum climb rate at sea level was calculated to be 4 m/s. Assume shaft power available to be independent of speed of flight. For piston propeller airplane, it can be assumed that the shaft power available is proportional to ambient density. Values of air density at sea level and at 5 km pressure altitude are 1.225 kg/m^3 and 0.74 kg/m^3, respectively.



20. The maximum rate of climb achievable by this airplane at 5 km altitude will be
   (A) 1.65 m/s (C) 1.43 m/s
   (B) 0.51 m/s (D) 3.65 m/s

21. If during the maximum rate of climb at 5 km altitude, the airplane was flying at an angle of attack of 4 degrees and attitude (pitch) angle of 5 degrees, what was equivalent airspeed of the airplane?
   (A) 40.2 m/s (C) 130.3 m/s
   (B) 63.7 m/s (D) 20.2 m/s

Statement for Linked Answer Qns 22 & 23:
A model wing of rectangular planform has a chord of 0.2 m and a span of 1.2 m. It has a symmetric airfoil section whose lift curve slope is 0.1 per degree. When this wing is mounted at 8 degrees angle of attack in a freestream of 20 m/s it is found to develop 35.3 N lift when the density of air is 1.225 kg/m^3.

22. The lift curve slope of this wing is
   (A) 0.10 per deg (C) 0.075 per deg
   (B) 0.092 per deg (D) 0.050 per deg

23. The span efficiency factor of this wing is
   (A) 1.0 (C) 0.75
   (B) 0.91 (D) 0.63

24. A piston-prop airplane having propeller efficiency, $\eta_P = 0.8$ and weighing 73108 N could achieve maximum climb rate of 15 m/s at flight speed of 50 m/s. The excess Brake Power (BP) at the above flight condition will be
   (A) 1700 kW (C) 1371 kW
   (B) 2100 kW (D) 6125 kW

GATE AE - 2008

One Mark Questions.

25. The service ceiling of a transport aircraft is defined as the altitude
   (A) that is halfway between sea-level and absolute ceiling
   (B) at which it can cruise with one engine operational
   (C) at which its maximum rate of climb is zero
   (D) at which its maximum rate of climb is 0.508 m/s

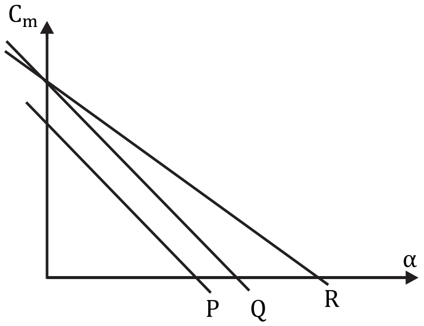
26. The drag of an aircraft in steady climbing flight at a given forward speed is
   (A) inversely proportional to climb angle
   (B) higher than drag in steady level flight at the same forward speed
   (C) lower than drag in steady level flight at the same forward speed
   (D) independent of climb angle

27. In steady, level turning flight of an aircraft at a load factor ‘n’, the ratio of the horizontal component of lift and aircraft weight is
   (A) $\sqrt{n-1}$ (C) $\sqrt{n^2-1}$
   (B) $\sqrt{n+1}$ (D) $\sqrt{n^2+1}$

28. The parameters that remain constant in a cruise-climb of an aircraft are
   (A) equivalent airspeed and lift coefficient
   (B) altitude and lift coefficient
   (C) equivalent airspeed and altitude
   (D) lift coefficient and aircraft mass

Two Marks Questions.

29. The figure below shows the variation of C_m versus α for an aircraft for three combinations of elevator deflections and locations of centre of gravity. In the figure, lines P and Q are parallel, while lines Q and R have the same intercept on the C_m axis.



Which of the following statements is true?

(A) Lines P and Q correspond to the same centre of gravity location.

(B) Lines Q and R correspond to the same centre of gravity location.

(C) Lines P and Q correspond to the same elevator deflection.

(D) Lines P and R correspond to the same centre of gravity location.

30. Which of the following statements is TRUE as the altitude increases in stratosphere of International Standard Atmosphere?

(A) Temperature increases and dynamic viscosity decreases.

(B) Temperature remains constant and pressure increases.

(C) Temperature decreases and sound speed decreases.

(D) Temperature remains constant and density decreases.

31. Which of the following statements is TRUE?

(A) Wing dihedral reduces roll stability while a low wing increases roll stability.

(B) Wing dihedral increases roll stability while a low wing reduces roll stability.

(C) Wing dihedral, as well as low wing reduces roll stability.

(D) Wing dihedral, as well as low wing increases roll stability.

32. An aircraft has a level flight stalling speed of 60 m/s EAS (equivalent air speed). As per the V-n diagram, what is the minimum speed at which it should be designed to withstand the maximum vertical load factor of 9?

(A) 20 m/s (C) 120 m/s

(B) 60 m/s (D) 180 m/s

33. Match each mode of aircraft motion listed in Group I to its corresponding property from Group II.

Group I: Aircraft mode
P: Short period mode
Q: Wing rock
R: Phugoid mode
S: Dutch roll
Group II: Property
1: Coupled roll-yaw oscillations
2: Angle of attack remains constant
3: Roll oscillations
4: Speed remains constant

(A) P-2, Q-1, R-4, S-3

(B) P-4, Q-3, R-2, S-1

(C) P-4, Q-1, R-2, S-3

(D) P-2, Q-3, R-4, S-1

34. An aircraft is cruising at a true air speed (TAS) of 100 m/s under ISA conditions, at an altitude at which the density of free stream is 0.526 kg/m^3. What will be the equivalent air speed (EAS)?

(A) 65.5 m/s (C) 110.5 m/s

(B) 72.5 m/s (D) 152.7 m/s

35. In the definition of the aircraft Euler angles φ (roll), θ(pitch), and ψ(yaw), the correct sequence of rotations required to make the inertial frame coincide with the aircraft body frame is
(A) first ψ about z axis, second θ about y axis, third φ about x axis
(B) first θ about y axis, second φ about x axis, third ψ about z axis
(C) first φ about x axis, second θ about y axis, third ψ about z axis
(D) first ψ about z axis, second φ about x axis, third θ about y axis

36. To maximize range of a jet engine aircraft, it should be flown at a velocity that maximizes
(A) C_L/C_D (C) $C_L^{1.5}/C_D$
(B) $C_L^{0.5}/C_D$ (D) C_L^2/C_D

37. The primary function of the fin in the vertical tail of an aircraft is to provide
(A) yaw control (C) roll damping
(B) yaw stability (D) roll stability

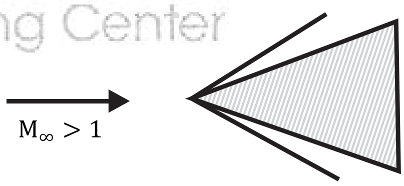
38. An aircraft requires the trailing edge of the elevator to be deflected upwards from its initial position to lower the trim speed. Which of the following statements about the static stick-fixed stability of this aircraft is true?
(A) The aircraft is unstable.
(B) The aircraft is neutrally stable.
(C) The aircraft is stable.
(D) The stability of the aircraft cannot be determined from the given information.

39. Which of the following statements is true for an aircraft flying at a low angle of attack?
(A) Yawing motion generates yawing moment and pitching moment.
(B) Rolling motion generates rolling moment and pitching moment.
(C) Yawing motion generates yawing moment and rolling moment.
(D) Pitching motion generates yawing moment and rolling moment

40. For a free stream Mach number of 0.7 the critical pressure coefficient ($C_{p,cr}$) is -0.78. If the minimum pressure coefficient for a given airfoil in incompressible flow is -0.6, then the flow over the airfoil at a free stream Mach number of 0.7 is
(A) Subsonic and compressible
(B) completely supersonic
(C) incompressible
(D) partly subsonic and partly supersonic

41. The variation of downwash along the span of an untwisted wing of elliptic planform is
(A) sinusoidal (C) elliptic
(B) parabolic (D) constant

42. Consider a 2-D body in supersonic flow with an attached oblique shock as shown below



An increase in free stream Mach number M_∞ will cause the oblique shock wave to
(A) move closer to the body
(B) move away from the body
(C) detach from the body
(D) become a normal shock

43. The geometrical features of a supercritical airfoil are
(A) rounded leading edge, flat upper surface and high camber at the rear

(B) sharp leading edge, curved upper surface and high camber at the rear

(C) rounded leading edge, curved upper surface and no camber at the rear

(D) sharp leading edge, flat upper surface and no camber at the rear

44. Which one of the following high lift device results in higher stalling angle?

(A) split flap

(B) Fowler flap

(C) plain flap

(D) leading edge flap

Statement for Linked Answer Qns 45 & 46:

An aircraft has a zero-lift drag coefficient C_{Do} =0.0223, wing aspect ratio AR_W =10.0, and Oswald's efficiency factor e = 0.7

45. The thrust required for steady level flight will be minimum when the aircraft operates at a lift coefficient of

(A) 0.65 (C) 0.75

(B) 0.70 (D) 0.80

46. The glide angle that results in maximum range in a power-off glide is

(A) 1.82 degrees (C) 3.64 degrees

(B) 2.68 degrees (D) 5.01 degrees

Statement for Linked Answer Qns 47 & 48:

Consider an untwisted wing of elliptical planform in inviscid incompressible irrotational flow at an angle of attack of 4 degrees. The wing aspect ratio is 7 and the zero lift angle of attack is -2 degrees.

47. The wing lift coefficient C_L is

(A) 0.66 (C) 0.44

(B) 0.51 (D) 0.34

48. The induced drag coefficient of the wing C_{Di} is

(A) 0.0053 (C) 0.0118

(B) 0.0087 (D) 0.0197

GATE AE - 2009

One Mark Questions.

49. A conventional altimeter is a

(A) Pressure transducer

(B) Temperature transducer

(C) Density transducer

(D) Velocity transducer

50. The relation between an airplane's true airspeed V_{TAS} and equivalent airspeed V_{EAS} in terms of the density ratio $\left(\sigma = \frac{\rho}{\rho_o}\right)$, where ρ_o is the air density at sea-level and ρ is the air density at the altitude at which the airplane is flying, is given by the formula:

(A) $\frac{V_{EAS}}{V_{TAS}} = \sigma$ (C) $\frac{V_{EAS}}{V_{TAS}} = \sqrt{\sigma}$

(B) $\frac{V_{EAS}}{V_{TAS}} = \sigma^2$ (D) $\frac{V_{EAS}}{V_{TAS}} = \frac{1}{\sqrt{\sigma}}$

51. An unswept fixed-winged aircraft has a large roll stability if the wing is placed

(A) low on the fuselage and has negative dihedral angle

(B) low on the fuselage and has positive dihedral angle

(C) high on the fuselage and has negative dihedral angle

(D) high on the fuselage and has positive dihedral angle

52. Thrust available from a turbojet engine

(A) increases as altitude increases

(B) increases up to the tropopause and then decreases

(C) remains constant at all altitudes

(D) decreases as altitude increases

53. If C_{mCG} is the pitching moment coefficient about the center of gravity of an aircraft, and α is the angle of attack, then $\frac{dC_{mCG}}{d\alpha}$ is

(A) a stability derivative which represents stiffness in pitch

(B) a stability derivative which represents damping in pitch

(C) a control derivative in pitch

(D) positive for an aircraft that is stable in pitch

Two Marks Questions.

54. An airplane flying at 100 m/s is pitching at the rate of 0.2 deg/s. Due to this pitching, the horizontal tail surface located 4 metres behind the centre-of-mass of the airplane will experience a change in angle of attack, which is
(A) 0.01 deg (C) 0.04 deg
(B) 0.008 deg (D) 0.004 deg

55. The contribution of the horizontal tail to the pitching moment coefficient about the center of gravity (C_{mCG}) of an aircraft is given by $C_{m_{tail}} = 0.2 - 0.0215\,\alpha$, where α is the angle of attack of the aircraft. The contribution of the tail to the aircraft longitudinal stability
(A) is stabilizing
(B) is destabilizing
(C) is nil
(D) cannot be determined from the given information

56. The linearized dynamics of an aircraft (which has no large rotating components) in straight and level flight is governed by the equations
$$\frac{d\vec{x}}{dt} = \begin{bmatrix} [A] & [B] \\ [C] & [D] \end{bmatrix}\vec{x}$$
where $\vec{x} = [u\ w\ q\ \theta\ v\ p\ r\ \phi]^T$, $[\,]^T$ represents the transpose of a matrix, [A], [B], [C] and [D] are 4 × 4 matrices and [0] is the 4 × 4 null matrix. Which of the following is true?
(A) $[A] \neq [0];\ [B] \neq [0]; [C] = [0]; [D] \neq [0];$
(B) $[A] = [0];\ [B] \neq [0]; [C] \neq [0]; [D] = [0];$
(C) $[A] \neq [0];\ [B] = [0]; [C] = [0]; [D] \neq [0];$
(D) $[A] \neq [0];\ [B] = [0]; [C] \neq [0]; [D] = [0];$

57. The velocity vector of an aircraft along its body-fixed axis is given by $\vec{V} = \begin{Bmatrix} u \\ v \\ w \end{Bmatrix}$. If V is the magnitude of $\vec{V}$, α is the angle of attack and β is the angle of sideslip, which of the following set of relations is correct?
(A) $u = V\sin\beta\cos\alpha\,;\ v = V\sin\beta\,;\ w = V\cos\beta\sin\alpha$
(B) $u = V\cos\beta\cos\alpha\,;\ v = V\cos\beta\,;\ w = V\cos\beta\sin\alpha$
(C) $u = V\cos\beta\cos\alpha\,;\ v = V\sin\beta\,;\ w = V\sin\beta\sin\alpha$
(D) $u = V\cos\beta\cos\alpha\,;\ v = V\sin\beta\,;\ w = V\cos\beta\sin\alpha$

58. An aircraft of mass 2500 kg in straight and level flight at a constant speed of 100 m/s has available excess power of 1.0×10^6 W. The steady rate of climb it can attain at that speed is
(A) 100 m/s (C) 40 m/s
(B) 60 m/s (D) 20 m/s

59. A symmetrical airfoil section produces a lift coefficient of 0.53 at an angle of attack of 5 degrees measured from its chord line. An untwisted wing of elliptical planform and aspect ratio 6 is made of this airfoil. At an angle of attack of 5 degrees relative to its chordal plane, this wing would produce a lift coefficient of
(A) 0.53 (C) 0.40
(B) 0.48 (D) 0.36

Common Data for Questions 60 and 61:

The roots of the characteristic equation for the longitudinal dynamics of a certain aircraft are: $\lambda_1 = -0.02 + 0.2i;\ \lambda_2 = -0.02 - 0.2i;\ \lambda_3 = -2.5 + 2.6i,\ \lambda_4 = -2.5 - 2.6i$ where $i = \sqrt{-1}$

60. The pair of eigenvalues that represent the phugoid mode is
(A) λ_1 and λ_3 (C) λ_3 and λ_4
(B) λ_2 and λ_4 (D) λ_1 and λ_2

61. The short period damped frequency is
(A) 2.6 rad/s (C) 2.5 rad/s
(B) 0.2 rad/s (D) 0.02 rad/s

GATE AE - 2010

One Mark Questions.

62. An aircraft is climbing at a constant speed in a straight line at a steep angle of climb. The load factor it sustains during the climb is:

(A) equal to 1.0

(B) greater than 1.0

(C) positive but less than 1.0

(D) dependant on the weight of the aircraft

63. All other factors remaining constant, if the weight of an aircraft increases by 30% then the takeoff distance increases by approximately:

(A) 15%　(C) 70%

(B) 30%　(D) 105%

64. An aircraft stalls at a speed of 40 m/s in straight and level flight. The slowest speed at which this aircraft can execute a level turn at a bank angle of 60 degrees is:

(A) 28.3 m/s　(C) 56.6 m/s

(B) 40.0 m/s　(D) 80.0 m/s

65. The absolute ceiling of an aircraft is the altitude above which it:

(A) can never reach

(B) cannot sustain level flight at a constant speed

(C) can perform accelerated flight as well as straight and level flight at a constant speed

(D) can perform straight and level flight at a constant speed only

Two Marks Questions.

66. A propeller powered aircraft, trimmed to attain maximum range and flying in a straight line, travels a distance R from its take-off point when it has consumed a weight of fuel equal to 20% of its lake-off weight. If the aircraft continues to fly and consumes a total weight of fuel equal to 50% of its take-off weight, the distance between it and its lake-off point becomes:

(A) 2.5 R　(C) 2.1 R

(B) 3.1 R　(D) 3.9 R

67. An aircraft is cruising at an altitude of 9 km. The free-stream static pressure and density at this altitude are $3.08 \times 10^4 \text{N/m}^2$ and 0.467kg/m^3 respectively. A Pitot tube mounted on the wing senses a pressure of $3.31 \times \frac{10^4 \text{N}}{\text{m}^2}$. Ignoring compressibility effects, the cruising speed of the aircraft is approximately

(A) 50 m/s　(C) 150 m/s

(B) 100 m/s　(D) 200 m/s

68. The trim curves of an aircraft are of the form $C_{m_{CG}} = (0.05 - 0.2\delta_e) - 0.1C_L$ where the elevator deflection angle, δ_e is in radians. The static margin of the aircraft is

(A) 0.5　(C) 0.1

(B) 0.2　(D) 0.05

69. The trim curves of an aircraft are of the form $C_{m,CG} = (0.05\text{-}0.2\delta_e)\text{-}0.1C_L$ where the elevator deflection angle, δ_e is in radians. The change in elevator deflection needed to increase the lift coefficient from 0.4 to 0.9 is:

(A) -0.5 radians　(C) 0.25 radians

(B) -0.25 radians　(D) 0.5 radians

Statement for linked Answer Qns 70 and 71:

An aircraft is in straight and level flight at a constant speed v. It is disturbed by a symmetric vertical gust, resulting in a phugoid oscillation of time period T.

70. Assuming that g is the acceleration due to gravity, T is given approximately by:

(A) $v/\pi g$　(C) $v/\sqrt{2}\pi g$

(B) $\pi v/g$　(D) $\sqrt{2}\pi v/g$

71. If v = 200 m/s then the wavelength of the phugoid oscillations, assuming $g = 9.81 \text{ m/s}^2$, is, approximately:

(A) 1.28×10^4m　(C) 1.81×10^4m

(B) 1.30×10^3m　(D) 918 m

GATE AE - 2011

One Mark Questions.

72. In an un-powered glide of an aircraft having weight W, lift L and drag D, the equilibrium glide angle is defined as

(A) $\tan^{-1}\left(\frac{L}{D}\right)$ (C) $\tan^{-1}\left(\frac{L}{W}\right)$

(B) $\tan^{-1}\left(\frac{D}{L}\right)$ (D) $\tan^{-1}\left(\frac{W}{L}\right)$

73. Lift on an aircraft climbing vertically up is
(A) equal to its weight
(B) zero
(C) equal to the drag
(D) equal to the thrust

74. If an aircraft is performing a positive yawing manoeuvre, the side slip angle
(A) is always zero
(B) is never zero
(C) is always negative
(D) could be any value

75. For an airplane to be statically stable, its centre of gravity must always be
(A) ahead of wing aerodynamic centre
(B) aft of the wing aerodynamic centre
(C) ahead of neutral point
(D) aft of neutral point

76. Winglets are used on wings to minimize
(A) skin friction drag
(B) profile drag
(C) wave drag
(D) induced drag

Two Marks Questions.

77. An aircraft is performing a coordinated turn manoeuvre at a bank angle of 30° and forward speed of 100 m/s. Assume g = 9.81 ms^{-2}. The load factor and turn radius respectively are
(A) $(2/\sqrt{3})$ and 1.76 km
(B) $\sqrt{3}$ and 17.6 km
(C) 2 and 0.18 km
(D) $(2/\sqrt{3})$ and 17.6 km

78. An aircraft in a steady level flight at forward speed of 50 m/s suddenly rolls by 180° and becomes inverted. If no other changes are made to the configuration or controls of the aircraft, the nature of the subsequent flight path taken by the aircraft and its characteristic parameter(s) (assume g = 9.81 ms^{-2}) are
(A) straight line path with a speed of 50 m/s
(B) upward circular path with a speed of 50 m/s and radius of 127.4 m
(C) downward circular path with a speed of 50 m/s and radius of 127.4 m
(D) downward circular path with a speed of 25 m/s and radius of 254.8 m

79. An aircraft with a mass of 5000 kg takes off from sea level with a forward speed of 50 m/s and starts to climb with a climb angle of 15°. The rate of climb and excess thrust available at the start of the climb respectively (assume g = 9.81 ms^{-2}) are
(A) 13.40 m/s and 13146.0 N
(B) 12.94 m/s and 12694.1 N
(C) 13.40 m/s and 12694.1 N
(D) 12.94 m/s and 13146.0 N

80. A glider having a mass of 500 kg is taken to an altitude of 1000 m with a jeep moving on ground at 54 kmph. Upon reaching the required altitude in 50 s, the glider is released and starts its descent. Under the assumption of equilibrium glide, the range and endurance of the glider for a constant lift-to-drag ratio of 15 are
(A) 15.0 km and 1002.2 s respectively
(B) 15.0 km and 601.3 s respectively
(C) 1.0 km and 601.3 s respectively
(D) 1.0 km and 50 s respectively

81. An aircraft in level flight encounters a vertical gust, which excites the phugoid mode. The phugoid motion completes 10 cycles in 50 s and its amplitude reduces to half of its maximum value in 25s. The eigenvalues of the phugoid mode are

(A) $-0.05 \pm 0.02i$
(B) $-0.5 \pm 0.2i$
(C) $-0.028 \pm 1.26i$
(D) $0.028 \pm 1.26i$

GATE AE - 2012

One Mark Questions.

82. An aircraft in trimmed condition has zero pitching moment at

(A) its aerodynamic centre.
(B) its centre of gravity.
(C) 25% of its mean aerodynamic chord.
(D) 50% of its wing root chord.

83. In an aircraft, constant roll rate can be produced using ailerons by applying

(A) a step input.
(B) a ramp input.
(C) a sinusoidal input.
(D) an impulse input.

84. The critical Mach number of an airfoil is attained when

(A) the freestream Mach number is sonic.
(B) the freestream Mach number is supersonic.
(C) the Mach number somewhere on the airfoil is unity.
(D) the Mach number everywhere on the airfoil is supersonic.

85. During the ground roll manoeuvre of an aircraft, the force(s) acting on it parallel to the direction of motion

(A) is thrust alone.
(B) is drag alone.
(C) are both thrust and drag.
(D) are thrust, drag and a part of both weight and lift.

86. An aircraft in a steady climb suddenly experiences a 10% drop in thrust. After a new equilibrium is reached at the same speed, the new rate of climb is

(A) lower by exactly 10%.
(B) lower by more than 10%.
(C) lower by less than 10%.
(D) an unpredictable quantity.

87. In an aircraft, the dive manoeuvre can be initiated by

(A) reducing the engine thrust alone.
(B) reducing the angle of attack alone.
(C) generating a nose down pitch rate.
(D) increasing the engine thrust alone.

88. In an aircraft, elevator control effectiveness determines

(A) turn radius.
(B) rate of climb.
(C) forward-most location of the centre of gravity.
(D) aft-most location of the centre of gravity.

Two Marks Questions.

89. An aircraft has a steady rate of climb of 300 m/s at sea level and 150 m/s at 2500 m altitude. The time taken (in sec) for this aircraft to climb from 500 m altitude to 3000 m altitude is ____.

90. An airfoil generates a lift of 80 N when operating in a freestream flow of 60 m/s. If the ambient pressure and temperature are 100 kPa and 290 K respectively (specific gas constant is 287 J/kg-K), the circulation on the airfoil in m^2/s is ____.

91. If an aircraft takes off with 10% less fuel in comparison to its standard configuration, its range is

(A) lower by exactly 10%.
(B) lower by more than 10%.
(C) lower by less than 10%.
(D) an unpredictable quantity.

92. An aircraft has an approach speed of 144 kmph with a descent angle of 6.6°. If the aircraft load factor is 1.2 and constant deceleration at touch down is 0.25g ($g = 9.81\ m/s^2$), its total landing distance approximately over a 15 m high obstacle is
(A) 1830 m. (C) 830 m.
(B) 1380 m. (D) 380 m.

93. An aircraft is trimmed straight and level at true air speed (TAS) of 100 m/s at standard sea level (SSL). Further, pull of 5 N holds the speed at 90 m/s without re-trimming at SSL (air density = $1.22\ kg/m^3$). To fly at 3000 m altitude (air density = $0.91\ kg/m^3$) and 120 m/s TAS without re-trimming, the aircraft needs
(A) 1.95 N upward force.
(B) 1.95 N downward force.
(C) 1.85 N upward force.
(D) 1.75 N downward force.

Common Data for Questions 94 and 95:

A wing and tail are geometrically similar, while tail area is one-third of the wing area and distance between two aerodynamic centres is equal to wing semi-span (b/2). In addition, following data is applicable:

$\epsilon_\alpha = 0.3, C_L = 1.0, C_{L_\alpha} = 0.08/\text{deg}.$

$\bar{c} = 2.5\text{m}, b = 30\text{m}, C_{M_{ac}} = 0, \eta_t = 1.$

The symbols have their usual aerodynamic interpretation.

94. The maximum distance that the centre of gravity can be behind aerodynamic centre without destabilizing the wing-tail combination is
(A) 0.4 m (C) 2.4 m
(B) 1.4 m (D) 3.4 m

95. The angle of incidence of tail to trim the wing-tail combination for a 5% static margin is
(A) −1.4° (C) 0.4°
(B) −0.4° (D) 1.4°

GATE AE - 2013

One Mark Questions.

96. Which one of the following is the most stable configuration of an airplane in roll?
(A) Sweep back, anhedral and low wing
(B) Sweep forward, dihedral and low wing
(C) Sweep forward, anhedral and high wing
(D) Sweep back, dihedral and high wing

97. Which one of the following flight instruments is used on an aircraft to determine its attitude in flight?
(A) Vertical speed indicator
(B) Altimeter
(C) Artificial Horizon
(D) Turn-bank indicator

98. A supersonic airplane is expected to fly at both subsonic and supersonic speeds during its whole flight course. Which one of the following statements is TRUE?
(A) Airplane will experience less stability in pitch at supersonic speeds than at subsonic speeds
(B) Airplane will feel no change in pitch stability
(C) Airplane will experience more stability in pitch at supersonic speeds than at subsonic speeds
(D) Pitch stability cannot be inferred from the information given

99. Which one of the following is favorable for an airplane operation?
   (A) Tail wind in cruise and head wind in landing
   (B) Tail wind both in cruise and landing
   (C) Head wind both in cruise and landing
   (D) Head wind in cruise and tail wind in landing

100. Which one of the following is TRUE with respect to Phugoid mode of an aircraft?
   (A) Frequency is directly proportional to flight speed
   (B) Frequency is inversely proportional to flight speed
   (C) Frequency is directly proportional to the square root of flight speed
   (D) Frequency is inversely proportional to the square root of flight speed

Two Marks Questions.

101. A glider is launched from a 500m high hilltop. Following data is available for the glider: Zero lift drag coefficient $C_{D0} = 0.02$, aspect ratio AR =10 and Oswald efficiency factor e = 0.95. The maximum range of the glider in km is ________

102. Which one of the following criteria leads to maximum turn rate and minimum radius in a level turn flight?
   (A) Highest possible load factor and highest possible velocity
   (B) Lowest possible load factor and lowest possible velocity
   (C) Highest possible load factor and lowest possible velocity
   (D) Lowest possible load factor and highest possible velocity

103. Consider an airplane with rectangular straight wing at dihedral angle $\Gamma = 10°$. Lift curve slope of wing airfoil section (constant over the whole span of the wing) is $C_{l\alpha} - 5.4$/rad. The roll stability derivative, $C_{l\beta}$ in per radian is ________

Common Data for Questions 104 and 105:

Data for an airplane are given as follows: weight W = 30kN, thrust available at sea-level $T_0 = 4000$ N, wing planform area $S = 30m^2$, maximum lift coefficient $C_{Lmax} = 1.4$, and drag coefficient $C_D = 0.015 + 0.024C_L^2$ Assume air density at sea-level $\rho_\infty = 1.22\ kg/m^3$.

104. Stall speed of the airplane in m/s is
   (A) 17.36 (B) 34.22 (C) 45.52 (D) 119.46

105. Minimum and maximum speeds of the airplane in level flight condition at sea-level in m/s are respectively
   (A) 17.36 and 180
   (B) 17.36 and 34.22
   (C) 34.22 and 119.46
   (D) 17.36 and 119.46

Statement for Linked Answer Qns 106 & 107:

Circulation theory of lift is assumed for a thin symmetric airfoil at an angle of attack α. Free stream velocity is U.

106. If the circulation at the quarter chord (c/4) of the airfoil is Γ_1, the normal velocity is zero at
   (A) c/4
   (B) c/2
   (C) 3c/4
   (D) all points on the chord

107. A second identical airfoil is placed behind the first one at a distance of c/2 from the trailing edge of the first. The second airfoil has an unknown circulation Γ_2 placed at its quarter

chord. The normal velocity becomes zero at the same chord-wise locations of the respective airfoils as in the previous question. The values of Γ_1 and Γ_2 are respectively

(A) $\frac{4}{3}\pi cU\alpha, \frac{2}{3}\pi cU\alpha$ (C) $\frac{2}{3}\pi cU\alpha, \frac{1}{3}\pi cU\alpha$

(B) $\frac{2}{3}\pi cU\alpha, \frac{2}{3}\pi cU\alpha$ (D) $\frac{4}{3}\pi cU\alpha, \frac{4}{3}\pi cU\alpha$

GATE AE - 2014

One Mark Questions.

108. The moment coefficient measured about the centre of gravity and about aerodynamic centre of a given wing-body combination are 0.0065 and −0.0235 respectively. The aerodynamic centre lies 0.06 chord lengths ahead of the centre of gravity. The lift coefficient for this wing-body is ________.

109. The vertical ground load factor on a stationary aircraft parked in its hangar is:
(E) 0 (G) Not defined
(F) -1 (H) 1

110. Under what condition should a glider be operated to ensure minimum sink rate?
(A) Maximum C_L/C_D
(B) Minimum C_L/C_D
(C) Maximum $C_D/C_L^{3/2}$
(D) Minimum $C_D/C_L^{3/2}$

111. In most airplanes, the Dutch roll mode can be excited by applying
(A) a step input to the elevators
(B) a step input to the rudder
(C) a sinusoidal input to the aileron
(D) an impulse input to the elevators

Two Marks Questions.

112. For a given airplane with a given wing loading executing a turn in the vertical plane, under what conditions will the turn radius be minimum and the turn rate be maximum?
(A) Highest possible C_L and lowest possible load factor
(B) Lowest possible C_L and lowest possible load factor
(C) Lowest possible C_L and highest possible load factor
(D) Highest possible C_L and highest possible load factor

113. Lift-off distance for a given aircraft of weight W is S_{LO}. If the take-off weight is reduced by 10%, then the magnitude of percentage change in the lift-off distance (assume all other parameters to remain constant) is ______.

114. Which of the following design parameters influence the maximum rate-of-climb for a jet propelled airplane?
P. Wing loading
Q. Maximum thrust-to-weight ratio
R. Zero-lift drag coefficient
S. Maximum lift-to-drag ratio
(A) P and Q alone (C) P, Q and S alone
(B) P, Q, R and S (D) Q, R, and S alone

115. Consider the following four statements regarding aircraft longitudinal stability:
(P) $C_{M,cg}$ at zero lift must be positive
(Q) $\partial_{CM,cg}/\partial\alpha_a$ must be negative (α_a is absolute angle of attack)
(R) $C_{M,cg}$ at zero lift must be negative
(S) Slope of C_L versus α_a must be negative
Which of the following combination is the necessary criterion for stick fixed longitudinal balance and static stability?
(A) Q and R only (C) P and Q only
(B) Q, R, and S only (D) Q and S only

116. Data for a light, single-engine, propeller driven aircraft in steady level flight at sea-level is as follows: velocity $V_\infty = 40 m/s$, weight $W = 13000N$, lift coefficient $C_L = 0.65$, drag coefficient $C_D = 0.025 + 0.04C_L^2$ and power available $P_{av} = 100{,}000 J/s$. The rate of climb possible for this aircraft under the given conditions (in m/s) is

(A) 7.20
(B) 5.11
(C) 6.32
(D) 4.23

GATE AE - 2015

One Mark Questions.

117. Consider the density and altitude at the base of an isothermal layer in the standard atmosphere to be ρ_1 and h_1, respectively. The density variation with altitude (ρ versus h) in that layer is governed by (R: specific gas constant, T : temperature, g_o : acceleration due to gravity at sea level)

(A) $\frac{\rho}{\rho_1} = e^{-\left[\frac{g_o}{RT}\right](h-h_1)}$
(B) $\frac{\rho}{\rho_1} = e^{-\left[\frac{g_o}{RT}\right](h_1-h)}$
(C) $\frac{\rho}{\rho_1} = e^{-\left[\frac{RT}{g_o}\right](h-h_1)}$
(D) $\frac{\rho}{\rho_1} = e^{-\left[\frac{RT}{g_o}\right](h_1-h)}$

118. Which one of the following modes of a stable aircraft has non-oscillatory response characteristics?

(A) Short period
(B) Phugoid
(C) Dutch roll
(D) Spiral

119. An aircraft in level and unaccelerated flight with a velocity of $v_\infty = 300$ m/s requires a power of 9×10^6W. If the aircraft weighs 1.5×10^5N, the lift-to-drag ratio $\frac{L}{D}$ is_______.

120. The percentage change in the lift-off distance for a 20 % increase in aircraft weight is _____.

121. A statically stable trimmed aircraft experiences a gust, and the angle of attack reduces momentarily.
As a result, the center of pressure of the aircraft

(A) shifts forward
(B) shifts rearward
(C) does not shift
(D) coincides with the neutral point

Two Marks Questions.

122. An aircraft, with a wing loading $\frac{W}{S} = 500\ N/m^2$, is gliding at $\left(\frac{L}{D}\right)_{max} = 10$ and $C_L = 0.69$.
Considering the free stream density $\rho_\infty = 0.9\ kg/m^3$. the equilibrium glide speed (in m/s) is _____.

123. Determine the correctness or otherwise of the following assertion [a] and reason [r]:
Assertion [a]: Aircraft directional static stability can be improved by moving the vertical tail rearward.
Reason [r]: Moving the vertical tail rearward increases the moment arm from the tail aerodynamic center to the aircraft center of gravity.

(A) Both [a] and [r] are true and [r] is the correct reason for [a]
(B) Both [a] and [r] are true but [r] is not the correct reason for [a]
(C) Both [a] and [r] are false
(D) [a] is true and [r] is false

124. For a level flight at cruise altitude, $C_D = 0.018$ with drag coefficient at zero lift, $C_{D,0} = 0.015$, For a 30° climb at the same altitude and speed, $C_D =$ _______$\times 10^{-3}$.

125. An aircraft is flying with inertial ground and wind speeds of $\vec{V}_g^b = (100,5,5)$m/s and $\vec{V}_w^b = (0,-5,-10)$m/s, respectively, as expressed in

the body frame. The corresponding sideslip angle (in degrees) is

(A) 0 (C) 8.49
(B) 5.65 (D) 9.54

GATE AE - 2016

One Mark Questions.

126. The damping ratio in phugoid motion for gliders is usually less compared to powered aircraft because
(A) gliders are unpowered.
(B) gliders are light.
(C) lift to drag ratio is higher for gliders.
(D) gliders fly at low speed.

127. During an aircraft cruising flight, the altitude above the ground is usually measured using
(A) dynamic pressure.
(B) static pressure.
(C) radar.
(D) laser range finder.

128. Indicated airspeed is used by a pilot during
(A) take-off.
(B) navigation.
(C) setting the engine RPM.
(D) setting the elevator angle.

129. The pitch angle and the angle of attack for a fixed wing aircraft are equal during
(A) wings level constant altitude flight.
(B) unaccelerated climb.
(C) unaccelerated descent.
(D) landing.

130. The load factor of an aircraft turning at a constant altitude is 2. The coefficient of lift required for turning flight as compared to level flight at the same speed will be
(A) same (C) double
(B) half (D) four times

Two Marks Questions.

131. An aircraft is flying level in the North direction at a velocity of 55 m/s under cross wind from East to West of 5 m/s. For the given aircraft $C_{n\beta}$ = 0.012/deg and $C_{n\delta r}$ = – 0.0072/deg, where δr is the rudder deflection and β is the side slip angle. The rudder deflection exerted by pilot is ________ degrees.

132. An aircraft weighing 10000 N is flying level at 100 m/s and it is powered by a jet engine. The thrust required for level flight is 1000 N. The maximum possible thrust produced by the jet engine is 5000 N. The minimum time required to climb 1000 m, when flight speed is 100 m/s, is _______s.

133. The aircraft velocity (m/s) components in body axes are given as [u, v, w] = [100, 10, 10]. The air velocity (m/s), angle of attack (deg) and sideslip angle (deg) in that order are
(A) [120, 0.1, 0.1]
(B) [100, 0.1, 0.1]
(C) [100.995, 0.1, 5.73]
(D) [100.995, 5.71, 5.68]

134. The Dutch roll motion of the aircraft is described by following relationship

$$\begin{bmatrix}\Delta\dot{\beta}\\ \Delta\dot{r}\end{bmatrix} = \begin{bmatrix}-0.26 & -1\\ 4.49 & -0.76\end{bmatrix}\begin{bmatrix}\Delta\beta\\ \Delta r\end{bmatrix}$$

The undamped natural frequency (rad/s) and damping ratio for the Dutch roll motion in that order are:
(A) 4.68, 1.02 (C) 2.165, 0.235
(B) 4.49, 1.02 (D) 2.165, 1.02

135. A glider weighing 3300 N is flying at 1000 m above sea level. The wing area is 14.1 m^2 and the air density is 1.23 kg/m^3. Under zero wind conditions, the velocity for maximum range is ________ m/s.

α (deg)	C_L	C_D	C_L/C_D
11	1.46	0.0865	16.9
9	1.36	0.0675	20.1
7	1.23	0.0535	22.9
5	1.08	0.0440	24.5
3	0.90	0.0350	25.7
1	0.70	0.0275	25.4
-1	0.49	0.0220	22.2
-3	0.25	0.0180	13.8

GATE AE - 2017

One Mark Questions.

136. To ensure only the longitudinal static stability (and not the condition for equilibrium) of a low speed aircraft, the aircraft components must be designed to satisfy which one of the following conditions:

(A) $\frac{\partial C_m}{\partial \alpha} < 0$ and $C_{m0} > 0$

(B) $\frac{\partial C_m}{\partial \alpha} < 0$

(C) $\frac{\partial C_m}{\partial C_L} < 0$ and $C_{m0} < 0$

(D) $\frac{\partial C_m}{\partial C_L} = 0.0$

137. Let $\bar{N}_m$ and $\bar{N}_o$ be respectively the non-dimensional locations of the stick-fixed maneuver point and stick-fixed neutral point of a low speed conventional aircraft. These distances are measured with respect to the nose of the fuselage. The numerical value of $\bar{N}_m - \bar{N}_o$

(A) will always be negative

(B) will always be positive

(C) will always be zero

(D) can have any value depending on the location of the center of gravity of the aircraft

138. The phenomenon of rudder lock in conventional low speed aircraft is primarily due to

(A) large value of directional derivative, $C_{n\beta}$

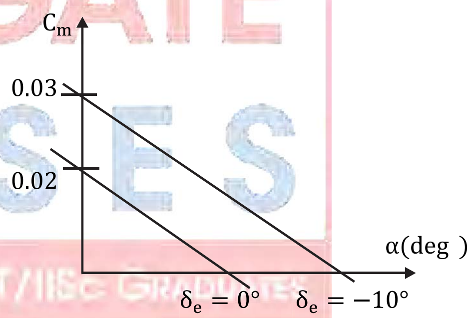
(B) the sidewash due to fuselage on the vertical stabilizer

(C) the tendency of rudder to float rapidly at high angles of side-slip

(D) the sidewash due to wing on the vertical stabilizer

Two Marks Questions.

139. An aircraft model was tested in a low speed wind-tunnel (Reynolds number $= 2 \times 10^6$ based on wing mean chord). The variation of pitching moment coefficient (C_m) with angle of attack (α) for two elevator deflections (δ_e) as recorded during this test is presented below.



Based on the result presented in the figure above, the value of elevator control power ($C_{m\delta e}$) in per radian will be _______(in three decimal place).

140. A pilot was flying a single engine propeller aircraft and maintaining a steady level flight at a lift coefficient, $C_L = 0.5$ at an altitude of 500 m. Due to some emergency, at the same altitude (500 m), the pilot had to fully deploy the landing gear. If the pilot wants to maintain steady level flight at the same $C_L = 0.5$ and at the same altitude, which of the following control actions should the pilot undertake:

(A) move the elevator up, and decrease the throttle

(B) move the elevator up, and increase the throttle

(C) move the elevator down, and decrease the throttle

(D) move the elevator down, and increase the throttle

141. A conventional low speed aircraft had the following aerodynamic characteristics:

$C_{D0} = 0.020, e = 1.0$ (Oswald efficiency).

The aircraft was flown to maintain a steady level flight and for minimum thrust required, at a lift coefficient of $C_L = 0.8$. The numerical value of the aspect ratio of the wing is_____ (in three decimal places).

142. The roots obtained by solving longitudinal characteristic equations of motion for a statically stable aircraft are given below:

$\lambda_{1,2} = -0.02 \pm 0.30i, \lambda_{3,4} = -2.00 \pm 2.50i,$

where $i = \sqrt{-1}$

The undamped short-period longitudinal natural frequency (radians/sec) and damping ratio, in that order, are close to

(A) 3.40, 0.73 (C) 3.83, 0.56

(B) 3.36, 0.65 (D) 3.20, 0.63

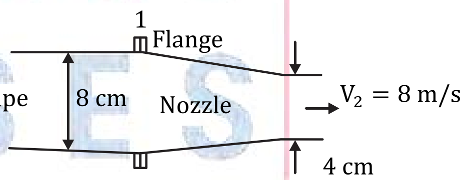
143. An aircraft is to be designed to ensure that it has enough excess power to achieve steady climb at flight path angle, $\gamma = 10$ degrees, maintaining $\frac{C_L}{C_D} = 10.0$. The numerical value of the thrust to weight ratio of the complete aircraft to meet the above requirement under standard atmospheric condition will be______(in three decimal place).

144. A conventional aircraft was analyzed to estimate the contribution of wing towards $C_{m0}(C_m \text{at } \alpha = 0)$ of the whole aircraft. The wing was installed with zero setting angle along the fuselage reference line. Further, the wing was laid such that $\bar{X}_{ac,w} = 0.3$, and $\bar{X}_{cg,aircraft} = 0.4$. $\bar{X}_{ac,w}$ and $\bar{X}_{cg,aircraft}$ are the non-dimensional distances, from the leading edge of the wing, of the aerodynamic center of the wing and center of gravity of the aircraft respectively. The wing had the following aerodynamic characteristics:

$C_{L0} = 0.20$, and $C_{mac,wing} = -0.02$

The numerical value of $C_{m0,w}$ (contribution of the wing to C_{m0}) about the CG of the aircraft is _______ (in two decimal places).

145. In the figure below, water exits from a nozzle into atmospheric pressure of 101 kPa. If the exit velocity is $V_2 = 8 m/s$ and friction is neglected, the magnitude of the axial force on the flange at location 1 required to keep the nozzle attached to the pipe is _______ N (round to nearest integer)



GATE AE - 2018

One Mark Questions.

146. A jet aircraft is initially flying steady and level at its maximum endurance condition. For the aircraft to fly steady and level, but faster at the same altitude, the pilot should

(A) increase thrust alone.

(B) increase thrust and increase angle of attack.

(C) increase thrust and reduce angle of attack.

(D) reduce angle of attack alone.

147. The pilot of a conventional airplane that is flying steady and level at some altitude, deflects the port side aileron up and the starboard aileron down. The aircraft will then

(A) pitch, nose up.
(B) roll with the starboard wing up.
(C) pitch, nose down.
(D) roll with the port wing up.

148. A NACA 0012 airfoil has a trailing edge flap. The airfoil is operating at an angle of attack of 5 degrees with un-deflected flap. If the flap is now deflected by 5 degrees downwards, the C_L versus α curve
(A) shifts right and slope increases.
(B) shifts left and slope increases.
(C) shifts left and slope stays the same.
(D) shifts right and slope stays the same.

149. An airplane requires a longer ground roll to lift-off on hot summer days because
(A) the thrust is directly proportional to free-stream density.
(B) the thrust is directly proportional to weight of the aircraft.
(C) the lift-off distance is directly proportional to free-stream density.
(D) the runway friction is high on hot summer days.

150. The highest limit load factor experienced by a civil transport aircraft is in the range
(A) 0.0 – 2.0 (C) 5.0 – 8.0
(B) 2.0 – 5.0 (D) 8.0 – 10.0

Two Marks Questions.

151. An aircraft with a turboprop engine produces a thrust of 500 N and flies at 100 m/s. If the propeller efficiency is 0.5, the shaft power produced by the engine is
(A) 50 kW (C) 125 kW
(B) 100 kW (D) 500 kW

152. Assuming ISA standard sea level conditions (288.16 K, density of 1.225 kg/m^3, g = 9.81 m/s^2, R = 287 J/(kg-K)), the density (in kg/m^3) of air at Leh, which is at an altitude of 3500 m above mean sea level is _______ (accurate to two decimal places).

153. An aircraft with mass of 400,000 kg cruises at 240 m/s at an altitude of 10 km. Its lift to drag ratio at cruise is 15. Assuming g as 9.81 m/s^2, the power (in MW) needed for it to cruise is ______ (accurate to two decimal places).

154. A statically-stable aircraft has a $C_{L_\alpha} = 5$ (where the angle of attack, α, is measured in radians). The coefficient of moment of the aircraft about the center of gravity is given as $C_{M,c.g} = 0.05 - 4\alpha$. The mean aerodynamic chord of the aircraft wing is 1 m. The location (positive towards the nose) of the neutral point of the aircraft from the center of gravity is _____ (in m, accurate to two decimal places).

155. An aircraft with a gross weight of 2000 kg, has a speed of 130 m/s at sea level, where the conditions are: 1 atmosphere (pressure), 288 K (temperature), and 1.23 kg/m^3 (density). The speed (in m/s) required by the aircraft at an altitude of 9000 m, where the conditions are: 0.31 atmosphere, 230 K, and 0.47 kg/m^3, to maintain a steady, level flight is _______ (accurate to two decimal places).

156. Gross weight of an airplane is 7000 N, wing area is 16 m^2, and the maximum lift coefficient is 2.0. Assuming density at the altitude as 1.23 kg/m^3, the stall speed (in m/s) of the aircraft is ________ (accurate to two decimal places).

157. An aircraft wind tunnel model, having a pitch axis mass moment of inertia (I_{yy}) of 0.014 kg-m^2, is mounted in such a manner that it has pure pitching motion about its centre of gravity, where it is supported through a frictionless hinge. If the pitching moment (M)

derivative with respect to angle of attack (α), denoted by 'M_α', is -0.504 N-m/rad and the pitching moment (M) derivative with respect to pitch rate (q), denoted by 'M_q', is −0.0336 N-m/(rad/s), the damping ratio of the resulting motion due to an initial disturbance in pitch angle is approximately _______ (accurate to three decimal places).

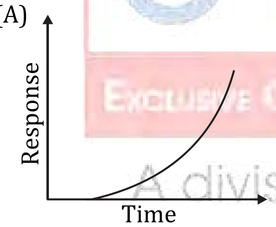
GATE AE - 2019

One Mark Questions.

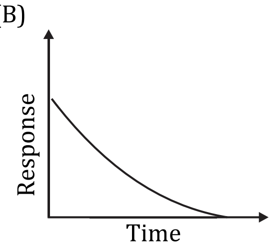
158. When a propeller airplane in ground-roll during take-off experiences headwind, which of the following statements is FALSE?
(A) The drag on the airplane increases.
(B) The thrust from the propellers decreases.
(C) The wing lift increases.
(D) The ground-roll distance increases.

159. Which of the following graphs represents the response of a dynamically unstable airplane?

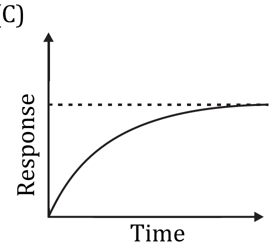
(A)



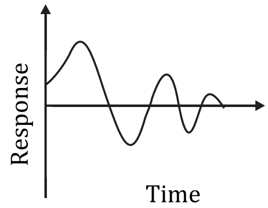
(B)



(C)



(D)



160. The power-off glide range for an airplane with a maximum Lift to Drag ratio of 18, when the glide starts at an altitude of 4 km, is ________ km (round off to the nearest integer).

161. For an airplane flying in a vertical plane, the angle of attack is 3°, the horizontal and vertical components of velocity in wind axis are 300 km/h and 15.72 km/h, respectively. The pitch attitude of the airplane is ________ degrees (round off to 2 decimal places).

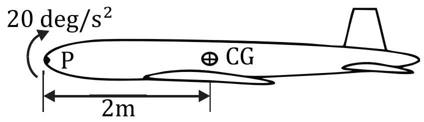
Two Marks Questions.

162. Which of the following statements about adverse yaw of an airplane is/are correct?
P. It is caused by flow separation resulting from large rudder deflection.
Q. It is caused by dissimilar drag forces acting on the two halves of the wing resulting from aileron deflections of same magnitude.
R. It can be eliminated by ensuring that the upward deflection of one aileron is greater than the downward deflection of the opposite aileron.

(A) P only (C) P and R
(B) Q only (D) Q and R

163. The airplane shown in figure starts executing a symmetric pull-up maneuver from steady level attitude with a constant nose-up pitch acceleration of 20 deg/s^2. The vertical load factor measured at this instant at the centre of gravity (CG) is 2. Given that the acceleration due to gravity is 9.81 m/s^2, the vertical load factor measured at point P on the nose of the

airplane, which is 2 m ahead of the CG, is _______ (round off to 2 decimal places).



164. Consider an airplane with a weight of 8000 N, wing area of 16 m^2, wing zero-lift drag coefficient of 0.02, Oswald's efficiency factor of 0.8, and wing aspect ratio of 6, in steady level flight with wing lift coefficient of 0.375. Considering the same flight speed and ambient density, the ratio of the induced drag coefficient during steady level flight to that during a 30° climb is _______ (round off to 2 decimal places).

165. A propeller driven airplane has a gross take-off weight of 4905 N with a wing area of 6.84 m^2. Assume that the wings are operating at the maximum $C_L^{3/2}/C_D$ of 13, the propeller efficiency is 0.9 and the specific fuel consumption of the engine is 0.76 kg/kW-hr. Given that the density of ah at sea level is 1.225 kg/m^3 and the acceleration due to gravity is 9.81 m/s^2, the weight of the fuel required for an endurance of 18 hours at sea level is ________ N. (round off to the nearest integer).

166. The design of an airplane is modified to increase the vertical tail area by 20% and decrease the moment arm from the aerodynamic centre of the vertical tail to the airplane centre of gravity by 20%. Assuming all other factors remain unchanged, the ratio of the modified to the original directional static stability (C_{N_β} due to tail fin) is _______ (round off to 2 decimal places).

GATE AE - 2020

One Mark Questions.

167. For convectional airplanes, which one of the following is true regrading roll control derivative $\left(C_{l\delta_r} = \frac{\partial C_l}{\partial \delta_r}\right)$ and yaw control derivative $\left(C_{n\delta_r} = \frac{\partial C_n}{\partial \delta_r}\right)$, where δ_r is rudder deflection?

(A) $C_{l\delta_r} > 0$ and $C_{n\delta_r} < 0$

(B) $C_{l\delta_r} < 0$ and $C_{n\delta_r} > 0$

(C) $C_{l\delta_r} < 0$ and $C_{n\delta_r} < 0$

(D) $C_{l\delta_r} > 0$ and $C_{n\delta_r} > 0$

168. Velocity of an airplane in the body fixed axes is given as [100 -10 20] m/s. The sideslip angle is _____ degrees (round off to two decimal places).

169. An airplane of mass 5000 kg is flying at a constant speed of 360 km/h at the bottom of a vertical circle with a radius of 400 m, as shown in the figure. Assuming that the acceleration due to gravity is 9.8 m/s^2, the load factor experienced at the center of gravity of the airplane is _______ (round off to two decimal places).

Two Marks Questions.

170. For three different airplanes A, B and C, the yawing moment coefficient (C_n) was measured in a wind-tunnel for three settings of sideslip angle β and tabulated as

	Airplane A	Airplane B	Airplane C
$\beta = -5$deg	-0.030	-0.025	0.040
$\beta = 0$deg	0	0	0
$\beta = 5$ deg	0.030	0.025	-0.040

Which one of the following statements is true regarding directional static stability of the airplanes A, B and C?

(A) All three airplanes A, B, and C are stable.

(B) Only airplane C is stable, while both A and B are unstable.

(C) Airplane C is unstable, A and B are stable with A being more stable than B.

(D) Airplane C is unstable, A and B are both stable with A less stable than B.

171. The eigenvalues for phugoid mode of a general aviation airplane at a stable cruise flight condition at low angle of attack are $\lambda_{1,2} = -0.02 \pm i\,0.25$. If the acceleration due to gravity is 9.8 m/s^2, the equilibrium speed of the airplane is m/s _______ (round off to two decimal places).

172. For a general aviation airplane with tail efficiency $\eta = 0.95$. horizontal tail volume ratio $V_H = 0.453$, downwash angle slope $\frac{d\varepsilon}{d\alpha} = 0.35$, wing lift curve slope $C^w_{L\alpha} = 4.8\ rad^{-1}$, horizontal tail lift curve slope $C^t_{L\alpha} = 4.4\ rad^{-1}$, shift in neutral point location as a percentage of mean aerodynamic chord is ______ (round off to two decimal places).

173. A single engine, propeller driven, general aviation airplane is flying in cruise at sea- level condition (density of air at sea-level is 1.225 kg/m^3) with speed to cover maximum range. For drag coefficient $C_D = 0.025 + 0.049\,C_L^2$ and wing loading W/S = 9844 N/m^2, the speed of the airplane is ______ m/s (round off to one decimal place).

174. An airplane of mass 4000 kg and wing reference area 25 m^2 flying at sea level has a maximum lift coefficient of 1.65. Assume density of air as 1.225 kg/m^3 and acceleration due to gravity as 9.8 m/s^2. Using a factor of safety of 1.25 to account for additional unsteady lift during a sudden pull-up, the speed at which the airplane reaches a load factor of 3.2 is ______ m/s (round off to two decimal places).

175. A Pitot tube mounted on the wing tip of an airplane flying at an altitude of 3 km measures a pressure of 0.72 bar. and the outside air temperature is 268.66 K. Take the sea level conditions as, pressure = 1.01 bar, temperature = 288.16 K, and density = 1.225 kg/m^3. The acceleration due to gravity is 9.8 m/s^2 and the gas constant is 287 J/(kg K). Assuming standard atmosphere, the equivalent airspeed for this airplane is ______ m/s (round off to two decimal place).

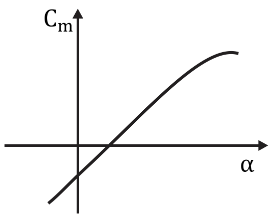
GATE AE - 2021

One Mark Questions.

176. Let V_{TAS} be the true airspeed of an aircraft flying at a certain altitude where the density of air is ρ, and V_{EAS} be the equivalent airspeed. If ρ_0 is the density of air at sea-level, what is the ratio V_{TAS}/V_{EAS} equal to?

(A) ρ/ρ_0
(B) ρ_0/ρ
(C) $\sqrt{\rho_0/\rho}$
(D) $\sqrt{\rho/\rho_0}$

177. $C_m - \alpha$ variation for a certain aircraft is shown in the figure. Which one of the following statements is true for this aircraft?



(A) The aircraft can trim at a positive α and it is stable.

(B) The aircraft can trim at a positive α, but it is unstable.

(C) The aircraft can trim at a negative α and it is stable.

(D) The aircraft can trim at a negative α, but it is unstable.

178. A jet aircraft has the following specifications: wing loading = 1800 N/m^2, wing area = 30 m^2, drag polar $C_D = 0.02 + 0.04C_L^2$, and $C_{L,max}$ = 1.6. Take density of air at sea level as 1.225 kg/m^3. The speed at which the aircraft achieves maximum endurance in a steady and level flight at sea level is ______ m/s (round off to two decimal places).

179. An aircraft with twin jet engines has the following specifications:
Thrust produced (per engine) = 8000 N
Spanwise distance between the two engines = 10 m
Wing area = 50 m^2, Wing span = 10 m
Rudder effectiveness, $C_{n\delta r} = -0.002$ /deg
Density of air at sea level = 1.225 kg/m^3
The rudder deflection, in degrees, required to maintain zero sideslip at 100 m/s in steady and level flight at sea level with a non-functional right engine is ______ (round off to two decimal places)

Two Marks Questions.

180. For a conventional fixed-wing aircraft in a 360° inverted vertical loop maneuver, what is the load factor (n) at the topmost point of the loop? Assume the flight to be steady at the topmost point.

(A) $n = 1$
(B) $n < 1$
(C) $n = -1$
(D) $n > 1$

181. For a conventional fixed-wing aircraft, which of the following statements are true?

(A) Making $C_{m\alpha}$ more negative leads to an increase in the frequency of its short-period mode.
(B) Making c_{mq} more negative leads to a decreased damping of the short-period mode.
(C) The primary contribution towards C_{lp} is from the aircraft wing.
(D) Increasing the size of the vertical fin leads to a higher yaw damping.

182. Which of the following statement(s) is/are true?

(A) Service ceiling is higher than absolute ceiling for a piston-propeller aircraft.
(B) For a given aircraft, the stall speed increases with increase in altitude.
(C) Everything else remaining the same, a tailwind increases the range of an aircraft.
(D) For a jet aircraft constrained to fly at constant altitude, there exists an altitude where its range is maximum.

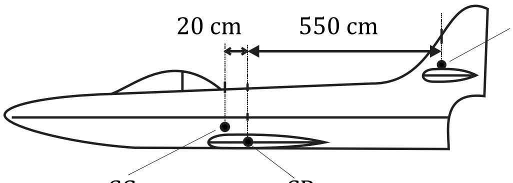
183. A conventional fixed-wing aircraft, with a horizontal tail and vertical fin, in steady and level flight is subjected to small perturbations. Which of the following statement(s) is/are true?

(A) Vertical fin has a stabilizing effect on the lateral stability of the aircraft.
(B) Vertical fin has a destabilizing effect on the directional stability of the aircraft.
(C) Presence of wing anhedral increases the lateral stability of the aircraft.
(D) Horizontal tail has a stabilizing effect on the longitudinal static stability of the aircraft.

184. A finite wing of elliptic planform with aspect ratio 10, whose section is a symmetric airfoil, is placed in a uniform flow at 5 degrees angle of attack. The induced drag coefficient for the wing is _____ (round off to three decimal places).

185. An airplane weighing 5500 kg is in a steady level flight with a speed of 225 m/s. The pilot initiates a steady pull-up maneuver with a

radius of curvature of 775 m. The location of center of gravity (CG), center of pressure on wing (CP) and point of action (T) of tail force are marked in the figure. Use g = 9.81 m/s^2. Neglect drag on the tail and assume that tail force is vertical. Assuming the engine thrust and drag to be equal, opposite and collinear, the tail force is___________ kN (round off to one decimal place).



186. A jet aircraft weighing 10,000 kg has an elliptic wing with a span of 10 m and area 30 m^2. The C_{D0} for the aircraft is 0.025. The maximum speed of the aircraft in steady and level flight at sea level is 100 m/s. The density of air at sea level is 1.225 kg/m^3, and take g= 10 m/s^2. The maximum thrust developed by the engine at sea level is _____ N (round off to two decimal places)

187. Consider a jet transport airplane with the following specifications:

Lift curve slope for wing body $\frac{\partial C_{L,wb}}{\partial \alpha_{wb}} = 0.1/\text{deg}$

Lift curve slope for tail $\frac{\partial C_{L,t}}{\partial \alpha_t} = 0.068/\text{deg}$

Tail area $s_t = 80\ m^2$; Wing area S = 350 m^2

Distance between mean aerodynamic centers of tail and wing-body $\bar{l}_t = 28$ m

Mean aerodynamic chord $\bar{c}$= $9m$

Downwash $\epsilon = 0.4\alpha$

Axial location of the wing-body mean aerodynamic center $x_{ac}/\bar{c} = 0.25$

Axial location of the center of gravity $x_{cg}/\bar{c} = 0.3$

All axial locations are with respect to the leading edge of the root chord and along the body x-axis.

Ignore propulsive effects.

The pitching-moment-coefficient curve slope (C_{m_α}) is __________/deg (round off to three decimal places).

GATE AE - 2022

One Mark Questions.

188. The service ceiling of an airplane is the altitude

(A) at which maximum rate of climb is 100 m/min

(B) beyond which theoretically the airplane cannot sustain level flight

(C) at which maximum power is required for flight

(D) at which maximum rate of climb is 100 ft/min

189. Regarding the horizontal tail of a conventional airplane, which one of the following statements is true?

(A) It contributes to $C_{m_\alpha} < 0$

(B) It makes $C_{m_\alpha} = 0$

(C) It makes $C_{m_\alpha} > 0$

(D) It makes $C_{m0} > 0$ and $C_{m_\alpha} > 0$

190. For International Standard Atmosphere (ISA) up to 11 km, which of the following statement(s) is/are true?

(A) The hydrostatic/ aerostatic equation is used

(B) The temperature lapse rate is taken as -10^{-2}K/m

(C) The sea level conditions are taken as:
pressure, $P_s = 1.01325 \times 10^5$Pa;
temperature, $T_s = 300$ K;
density, $\rho_s = 1.225\ kg/m^3$

(D) Air is treated as a perfect gas

191. An unpowered glider is flying at a glide angle of 10 degrees. Its lift-to-drag ratio is _______ (round off to two decimal places).

Two Marks Questions.

192. Consider a conventional subsonic fixed-wing airplane, *e* is the Oswald efficiency factor and *AR* is the aspect ratio. Corresponding to the minimum $\left(C_D/C_L^{3/2}\right)$, which of the following relations is true?

(A) $\frac{C_D}{C_L^2} = \frac{1}{\pi eAR}$ (C) $\frac{C_D}{C_L} = \frac{1}{\pi eAR}$

(B) $\frac{C_D}{C_L^2} = \frac{4}{3\pi eAR}$ (D) $\frac{C_D}{\sqrt{C_L}} = \frac{1}{\sqrt{\pi eAR}}$

193. For a conventional airplane in straight, level, constant velocity flight condition, which of the following condition(s) is/are possible on Euler angles (ϕ, θ, ψ), angle of attack (α) and the sideslip angle (β)?

(A) $\phi = 0°, \theta = 2°, \psi = 0°, \alpha = 2°, \beta = 0°$

(B) $\phi = 5°, \theta = 0°, \psi = 0°, \alpha = 2°, \beta = 0°$

(C) $\phi = 0°, \theta = 3°, \psi = 0°, \alpha = 3°, \beta = 5°$

(D) $\phi = 0°, \theta = 5°, \psi = 0°, \alpha = 2°, \beta = 5°$

194. A conventional airplane of mass 5000 kg is doing a level turn of radius 1000 m at a constant speed of 100 m/s at sea level. Taking the acceleration due to gravity as 10 m/s^2, the bank angle of the airplane is_______ degrees.

GATE AE - 2023

One Mark Questions.

195. An ideal glider has drag characteristics given by $C_D = C_{D_0} + C_{D_i}$, where $C_{D_i} = KC_L^2$ is the induced drag coefficient, C_L is the lift coefficient, and K is a constant. For maximum range of the glider, the ratio C_{D_0}/C_{D_i} is

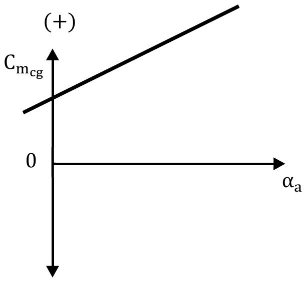
(A) 1 (C) 3

(B) 1/3 (D) 3/2

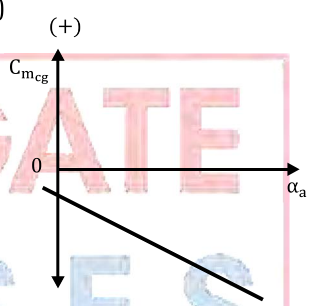
196. For a longitudinally statically stable aircraft, which one of the following represents the relationship between the coefficient of pitching moment about the center of gravity $C_{m_{cg}}$ and absolute angle of attack α_a?

(Note: nose-up moment is positive.)

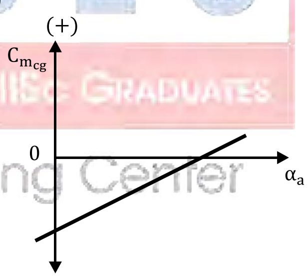
(A)



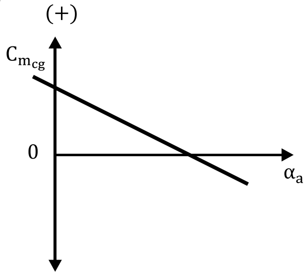
(B)



(C)



(D)

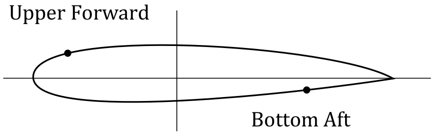


197. Consider the four basic symmetrical flight loading conditions corresponding to the corners of a typical V-n diagram. For one of these flight loading conditions, it is observed that

a. the compressive bending stresses have a maximum value in the bottom aft region (see figure) of the wing cross-section; and

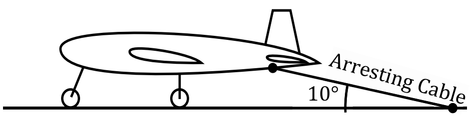
b. the tensile bending stresses are maximum in the upper forward region (see figure) of the wing cross-section.

For the preceding observations, select the corresponding flight loading condition from the options given.



(A) Positive high angle of attack
(B) Positive low angle of attack
(C) Negative high angle of attack
(D) Negative low angle of attack

198. An airplane weighing 40 kN is landing on a horizontal runway during which it is retarded by an arresting cable mechanism. The tension in the arresting cable at a given instant, as shown in the figure, is 100 kN. Assuming that the thrust from the engine continues to balance airplane drag, the magnitude of horizontal load factor is _______. (round off to one decimal place)



Two Marks Questions.

199. Consider a general aviation airplane with weight 10 kN and a wing planform area of 15 m^2. The drag coefficient of the airplane is given as $C_D = C_{D_0} + KC_L^2$ with $C_{D_0} = 0.025$ and $K = 0.05$. For level flight at an altitude where the density is 0.60 kg/m^3 and thrust 1 kN, the maximum cruise speed is____. (Rounded off to the nearest integer)

(A) 87 m/s
(B) 30 m/s
(C) 36 m/s
(D) 101 m/s

200. Consider the International Standard Atmosphere (ISA) with h being the geopotential altitude (in km) and dT/dh being the temperature gradient (in K/m). Which of the following combination(s) of $\left(h, \frac{dT}{dh}\right)$ is/are as per ISA?

(A) $(7, -6.5 \times 10^{-3})$
(B) $(9, 4 \times 10^{-3})$
(C) $(15, 0)$
(D) $(35, 3 \times 10^{-3})$

201. An airplane with wing planform area of 20 m^2 and weight 8 kN is flying straight and level with a speed of 100 m/s. The total drag coefficient is 0.026 and the air density is 0.7 kg/m^3. The total thrust required to introduce a steady climb angle of 0.1 radians is ___ N. (round off to the nearest integer)

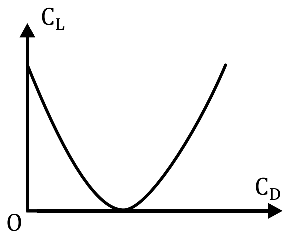
202. The maximum permissible load factor and the maximum lift force coefficient for an airplane is 7 and 2, respectively. For a wing loading of 6500 N/m^2 and air density 1.23 kg/m^3, the speed yielding the highest possible turn rate in the vertical plane is _________ m/s. (round off to the nearest integer)

GATE AE - 2024

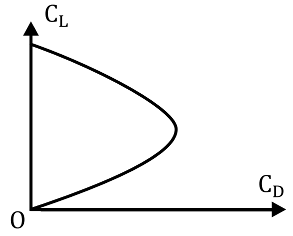
One Mark Questions.

203. Which one of the following figures represents the drag polar of a general aviation aircraft?

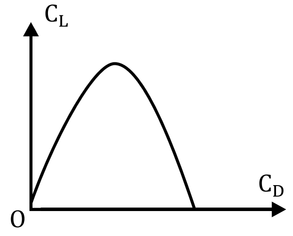
(A)



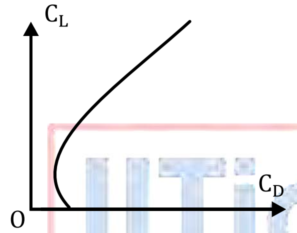
(B)



(C)



(D)



204. In a conventional configuration airplane, the rudder can be used:

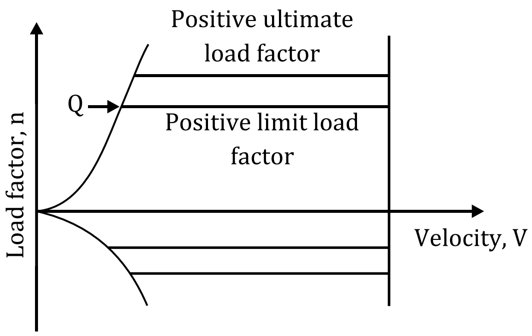
(A) to overcome adverse yaw during a turning maneuver

(B) to overcome yawing moment due to failure of one engine in a multi engine airplane

(C) for landing the airplane in crosswind conditions

(D) for enhancing longitudinal stability

205. Which of the following statements about a general aviation aircraft, while operating at point Q in the V-n diagram, is/are true?



(A) The aircraft has the highest turn rate

(B) The aircraft has the smallest turn radius

(C) The aircraft is flying with minimum drag

(D) The aircraft is operating at $C_{L,max}$

206. An airplane experiences a net vertical ground reaction of 15000 N during landing. The weight of the airplane is 10000 N. The landing vertical load factor, defined as the ratio of inertial load to the weight of the aircraft, is ________ (rounded off to 1 decimal place).

Two Marks Questions.

207. As per the International Standard Atmosphere model, which one of the following options about density variation with increase in altitude in the isothermal layer is correct?

(A) remains constant

(B) increases linearly

(C) decreases linearly

(D) decreases exponentially

208. Which of the following statements about absolute ceiling and service ceiling for a piston-propeller aircraft is/are correct?

(A) The altitude corresponding to absolute ceiling is higher than that for service ceiling

(B) At the absolute ceiling, the power required for cruise equals the maximum power available

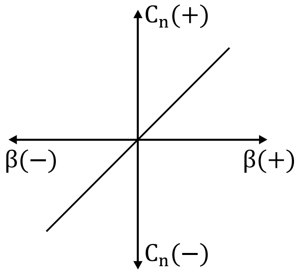
(C) The altitude corresponding to absolute ceiling is lower than that for service ceiling

(D) At the service ceiling, the maximum rate of climb is 50 ft/min

209. For an airplane having directional / weathercock static stability, which of the following options is/are correct?

(A) The airplane when disturbed in yaw, from an equilibrium state, will experience a restoring moment

(B) The variation of yawing moment coefficient (C_n) with sideslip angle (β) for the airplane will look like



(C) The airplane will always tend to point into the relative wind

(D) The airplane when disturbed in yaw will return to equilibrium state in a finite amount of time after removing the disturbance

210. For an aircraft moving at 4 km altitude above mean sea level at a Mach number of 0.2, the ratio of equivalent air speed to true air speed is ______ (rounded off to 2 decimal places).
The density of air at mean sea level is 1.225 kg/m^3 and at 4 km altitude is 0.819 kg/m^3.

211. For a general aviation airplane, one of the complex conjugate pair of eigenvalues for longitudinal dynamics is given by $-0.039 \pm 0.0567\ i$ (in SI units). If the system is disturbed to excite only this mode, the time taken for the amplitude of response to become half in magnitude is ______ s (rounded off to 1 decimal place).

212. An airplane of mass 1000 kg is in a steady level flight with a speed of 50 m/s. The wing has an elliptic planform with a span of 20 m and planform area 31.4 m^2.
Assuming the density of air at that altitude to be 1 kg/m^3 and acceleration due to gravity to be 10 m/s^2, the induced drag on the wing is ________ N (rounded off to 1 decimal place)

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Answer Keys Flight Mechanics

1	A	2	D	3	C	4	B	5	C
6	C	7	A	8	C	9	A	10	C
11	A	12	A	13	B	14	A	15	A
16	C	17	B	18	A	19	D	20	C
21	B	22	C	23	B	24	C	25	D
26	C	27	C	28	A	29	A	30	D
31	B	32	D	33	B	34	A	35	A
36	B	37	B	38	A	39	C	40	D
41	D	42	A	43	A	44	B	45	B
46	C	47	B	48	C	49	A	50	C
51	B	52	D	53	A	54	B	55	A
56	C	57	D	58	C	59	C	60	D
61	A	62	C	63	C	64	C	65	B
66	B	67	B	68	C	69	B	70	D
71	C	72	B	73	B	74	D	75	C
76	D	77	A	78	C	79	B	80	A
81	C	82	B	83	D	84	C	85	D
86	B	87	C	88	C	89	13 to 14	90	1.1 to 1.2
91	C	92	Mark to all	93	B	94	B	95	A
96	D	97	C	98	C	99	A	100	B
101	9 to 10	102	C	103	-0.23 to -0.24	104	B	105	C
106	D	107	C	108	0.45 to 0.55	109	D	110	D
111	B	112	D	113	18 to 20	114	B	115	C
116	B	117	A	118	D	119	4.9 to 5.1	120	43.9 to 44.1
121	A	122	39.5 to 40.5	123	A	124	17.2 to 17.3	125	B
126	C	127	B	128	A	129	A	130	C
131	8.6 to 8.7	132	25.0 to 25.0	133	D	134	C	135	20.0 to 21.0
136	B	137	B	138	C	139	-0.060 to -0.050	140	B
141	10.000 to 10.500	142	D	143	0.270 to 0.280	144	0.00 to 0.00	145	90 to 92
146	C	147	B	148	C	149	A	150	B
151	B	152	0.85 to 0.88	153	62.00 to 63.50	154	-0.81 to -0.79	155	209.00 to 211.00
156	18.80 to 18.90	157	0.195 to 0.205	158	D	159	A	160	72 to 72

161	5.98 to 6.00	162	D	163	2.06 to 2.08	164	1.32 to 1.35	165	1440 to 1490
166	0.96 to 0.96	167	A	168	-5.62 to -5.57	169	3.50 to 3.60	170	C
171	55.20 to 55.33	172	25.60 to 25.70	173	149.0 to 151.0	174	62.95 to 63.08	175	57.10 to 60.00
176	C	177	B	178	64.30 to 64.60	179	6.50 to 6.60	180	D
181	A, C, D	182	B, C, D	183	A; D	184	0.005 to 0.009	185	14.8 to 15.2
186	9735 to 9797	187	-0.025 to -0.023	188	D	189	A	190	A, D
191	5.55 to 5.80	192	B	193	A	194	44 to 46	195	A
196	D	197	D	198	2.4 to 2.6	199	A	200	A, C, D
201	2615 to 2625	202	190 to 195	203	D	204	A, B, C	205	A, B, D
206	1.5 to 1.5	207	D	208	A, B	209	A, B, C	210	0.80 to 0.84
211	17.7 to 17.9	212	63.0 to 64.5