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Booklet No. :

# AS - 16

# Aerospace Engineering

Duration of Test : 2 Hours

Max. Marks : 120

Hall Ticket No. | | | | | | | | |

Name of the Candidate : ____________________

Date of Examination : ________________ OMR Answer Sheet No. : ________________

Signature of the Candidate

Signature of the Invigilator

## INSTRUCTIONS

1. This Question Booklet consists of **120** multiple choice objective type questions to be answered in **120** minutes.
2. Every question in this booklet has 4 choices marked (A), (B), (C) and (D) for its answer.
3. Each question carries **one** mark. There are no negative marks for wrong answers.
4. This Booklet consists of **16** pages. Any discrepancy or any defect is found, the same may be informed to the Invigilator for replacement of Booklet.
5. Answer all the questions on the OMR Answer Sheet using **Blue/Black ball point pen only.**
6. Before answering the questions on the OMR Answer Sheet, please read the instructions printed on the OMR sheet carefully.
7. OMR Answer Sheet should be handed over to the Invigilator before leaving the Examination Hall.
8. Calculators, Pagers, Mobile Phones, etc., are not allowed into the Examination Hall.
9. No part of the Booklet should be detached under any circumstances.
10. The seal of the Booklet should be opened only after signal/bell is given.

1. If 1, 1 and 5 are eigen values of $A = \begin{bmatrix} 2 & 2 & 1 \\ 1 & 3 & 1 \\ 1 & 2 & 2 \end{bmatrix}$, then the eigen values of $A^{-1}$ are

(A) (1,−1,5) (B) (1,1,1/5) (C) (1,1,5) (D) (−1,1,1/5)

2. The system of equations $x+5y+3z=0$, $5x+y-1=0$, $x+2y+p=0$ has a nontrivial solution if $p=$

(A) 0 (B) 1 (C) 1 (D) ½

3. If $f(x)=x-x^3$ satisfy Lagrange Mean Value theorem in [−2,1] at c, then

(A) $c=-1$ (B) $c=1$ (C) $c=0$ (D) $c=2$

4. If $u=\frac{yz}{x}$, $v=\frac{zx}{y}$, $w=\frac{xy}{z}$, then $\frac{\partial(u,v,w)}{\partial(x,y,z)}=$

(A) 4 (B) 1 (C) 2 (D) 3

5. The differential equation $y\frac{dy}{dx}+2=y$, $y(0)=1$ has

(A) no solution (B) two solutions
(C) many solutions (D) unique solution

6. The integrating factor of the differential equation $\frac{dy}{dx}+y\sin x=\frac{\sin 2x}{x}$ is

(A) $e^{\sin x}$ (B) $e^{-\cos x}$ (C) $e^{-\sin x}$ (D) $e^{\sin x^2}$

7. The steady state solution of the heat equation $\frac{\partial u}{\partial t}=\frac{\partial^2 u}{\partial x^2}$ with boundary conditions u(0,t) = 5°C and u(10,t) = 20°C is

(A) $20x-5$ (B) $15x+20$ (C) $10x+5$ (D) $1.5x+5$

8. The steady state solution of the heat equation $\frac{\partial u}{\partial t}=\frac{\partial^2 u}{\partial x^2}$, $u(0,t)=10$ and $u(5,t)=15$ is

(A) $u(x)=15+10x$ (B) $u(x)=10+x$
(C) $u(x)=2-1.5x$ (D) $5+10x$

9. Which of these methods is not a step method to solve ordinary differential equation ?
   (A) Runge Kutta method (B) Euler method
   (C) Taylor's method (D) Milne method

10. The order of convergence of bisection method is
   (A) Linear (B) quadratic (C) cubic (D) None

11. In reversible adiabatic process of a perfect gas
   (A) Stagnation pressure and stagnation temperature are constant.
   (B) Only Stagnation temperature is constant.
   (C) Only stagnation pressure is constant.
   (D) Stagnation pressure and stagnation temperature are not constant

12. Entropy of perfect gas increases with
   (A) Stagnation Pressure Loss (B) Velocity change
   (C) Static pressure change (D) Stagnation temperature change

13. For a normal shock with the upstream Mach number tends to infinity, the resulting downstream Mach number for perfect gas with specific heat ratio 1.4 is
   (A) 1 (B) 0 (C) 0.378 (D) Infinity

14. Estimate the Mach number for an aircraft flying in the air at a speed of 1000 kmph, at standard sea level temperature 15°C.
   (A) 1.0 (B) 0.817 (C) 0.917 (D) 1.917

15. Air at a stagnation state of 3 atm and 300 K is accelerated to 200 m/s. Determine the Mach number of the flow.
   (A) 0.596 (B) 0.317 (C) 1.0 (D) 0.0

16. Consider a flow through convergent-divergent nozzle, if the exit pressure is less than the back pressure, the nozzle is said to be
   (A) Under expanded (B) Over expanded
   (C) Correctly expanded (D) Choked

17. A convergent-divergent nozzle is designed to operate with exit Mach number of 1.75. The nozzle is supplied from an air reservoir at $68 \times 10^5$ N/m$^2$ (abs). The exit to throat area ratio is 1.386. The exit Mach number when the nozzle just chokes is 0.48. What is the maximum back pressure to choke the nozzle ?
   (A) 68 atm (B) 58 atm (C) 48 atm (D) 38 atm

18. A Mach number 2.0 nozzle is run by a settling chamber with air maintained at 300 K. The air is discharging to an environment at atmospheric pressure. Determine the settling chamber pressure required to run nozzle at correctly expanded state.
   (A) 7.82 atm (B) 2.24 atm (C) 1.42 atm (D) 5.28 atm

19. The coefficient of pressure at a stagnation point in the compressible flow with freestream Mach number as M is

(A) 1 (B) $1+M^2/4+M^4/40$

(C) $M^2/2$ (D) $M^2/2+M$

20. For an airfoil at 12° angle of attack, the normal and axial force coefficients are 1.2 and 0.03, respectively. The lift and drag coefficients respectively are

(A) 1.18 and 0.279 (B) 1.18 and –0.279

(C) –1.18 and –0.279 (D) 0.0 and 0.0

21. Irrotational, incompressible flow has both velocity potential and stream function that should satisfy

(A) Euler equation (B) Laplace equation

(C) Bernoulli equation (D) Energy equation

22. Circulation around any closed curve in a uniform flow is

(A) Unity (B) Finite (C) Zero (D) Infinity

23. For source flow, the velocity potential lines are

(A) Radial lines (B) Circles (C) Straight lines (D) Elliptical

24. For what bodies the skin friction drag accounts for the major portion of the total drag and the wake drag is very small ?

(A) Bluff body (B) Automobiles

(C) Streamlined body (D) Pipes

25. An aircraft of mass 1500 kg in a steady level flight. If the wing incidence with respect to the freestream flow is 3 deg, what could be the aerodynamic efficiency of the aircraft ?

(A) 99 (B) 59 (C) 19 (D) 29

26. The semi-span of a rectangular wing of planform area 8.4 $m^2$ is 3.5 m. What could be the aspect ratio of wing ?

(A) 10.83 (B) 8.83 (C) 3.85 (D) 5.83

27. For 2D wedge shaped body in supersonic flow with an attached oblique shock, an increase in freestream Mach number will cause the oblique shock wave

(A) To move away from the body (B) To move closer to the body

(C) To remain unaffected (D) To become normal shock wave

28. At a given point on the surface of an airfoil, the pressure coefficient is –0.3 at very low speeds. If the freestream Mach number is 0.6, calculate the pressure coefficient at this point.

(A) –0.375 (B) 0.375 (C) 2.67 (D) –2.67

29. What is the value of lift coefficient for thin symmetrical airfoil at small angle of attack (α), if free stream Mach number is 0.7?

(A) 8.8α (B) 6.28α (C) 0.7α (D) 0.12 α

30. Consider a potential flow with freestream velocity 100 m/s over a finite elliptical wing. Circulation at the origin is 100$m^2$/s. The span length of the wing is 4 m. What could be the induced angle of attack?

(A) 0.125 radians (B) 0.4 radians

(C) 1.0 radians (D) 8 radians

31. Consider a polar coordinate system with a source of strength Λ located at the origin. Superimpose on this flow a uniform stream with velocity V. The value of stream function of the streamline that goes through the stagnation point of the resulting flow pattern is

(A) Λ/2 (B) 2Λ (C) Zero (D) Λ

32. The strength of the vortex at the trailing vortex for both the finite angle and cusped trailing edge according to the Kutta condition is

(A) Unity (B) Infinity (C) Zero (D) Finite

33. A 2D source of volume flow rate is 2.5 $m^2$/s is located in a uniform flow of 2 m/s. Determine the radial location of stagnation point from the source.

(A) –0.2 m (B) 0.2 m (C) 1 m (D) 2 m

34. What is the value of stream function of stagnation the streamline for Rankine oval ?

(A) 3.14 (B) Zero (C) 90 (D) 180

35. Consider the nonlifting flow over circular cylinder. Calculate the locations on the surface of the cylinder where the coefficient of pressure ($C_p$) is zero.

(A) 0, 60, 90, 120 degrees (B) 30, 150, 210, 330 degrees

(C) 180, 270, 360 degrees (D) 0 and 180 degrees

36. For Brayton cycle, the cycle efficiency η depends

(A) Only on pressure ratio

(B) Only on nature of the gas

(C) On both pressure ratio and nature of the gas

(D) None of the above

37. Under static conditions i.e., when intake velocity is zero

(A) Thrust is maximum (B) Propulsive efficiency is maximum

(C) Thrust is minimum (D) None of the above

38. If the initial mass of the rocket=200kg, mass after rocket operation=130kg and non propulsive structure=110kg, find the propellant mass fraction ($\xi$)

(A) 0.35 (B) 0.778 (C) 0.45 (D) 0.05

39. For heat exchange cycle the decrease in pressure ratio will cause the efficiency to

(A) Increase (B) Decrease
(C) Independent of pressure ratio (D) None of the above

40. Slip factor in the centrifugal compressor

(A) Increase with number of vanes
(B) Decrease with number of vanes
(C) Independent of the number of vanes
(D) None of the above

41. For a typical subsonic compressor cascade at zero incidence the values of the critical mach number ($M_{cr}$) is in the range of

(A) 0.2 – 0.5 (B) 0.7 – 0.85
(C) 1 – 1.5 (D) 0 – 0.1

42. Burning rate modifiers are used in solid propellants to

(A) Accelerate or decelerate the combustion rate
(B) Improve the elongation of the propellant at low temperatures
(C) Provides the structural matrix to hold the propellant together
(D) None of the above

43. Stay time ($t_s$) of the propellant gases is given by

(A) $t_s = \frac{V_c}{\dot{m} v}$ (B) $t_s = \frac{V_c \rho}{\dot{m}}$
(C) both (A) and (B) (D) only (A) is correct

Where,
$V_c$ – chamber volume, $v$-Specific volume of propellant gas
$\rho$, $\dot{m}$-density and mass flow rate of the propellant

44. The combustion chamber pressure loss is mainly due to

(A) skin friction and turbulence (B) rise in temperature
(C) both (A) and (B) (D) None of the above

45. Centrifugal stresses in the blades of turbine are proportional to

(A) $N^2$ (B) $N^3$
(C) $1/N^2$ (D) None of the above

where N is the rotational speed.

46. Froude's efficiency ($\eta_p$) is the ratio of

(A) Useful propulsive energy to the sum of that energy and unused kinetic energy of the jet.

(B) Useful kinetic energy for propulsion to the rate of energy supplied in the fuel.

(C) Useful work done in overcoming drag to the energy in the fuel supplied.

(D) input energy to the engine output.

47. Which of the following thrust relation is true ?

(A) $F = C_F A_t P$ (B) $F = C_F \dot{m} C^*$

(C) Both (A) and (B) (D) None of the above

$C_F$ – optimum thrust coefficient
$C^*$ - characteristic velocity
P – Chamber pressure
$A_t$ – Throat area

48. The typical values of critical pressure ratio for nozzle is in the range of

(A) 0.12 – 0.40 (B) 0.53 – 0.57

(C) 0.80 – 0.88 (D) 0.6 – 0.8

49. Which of the following statements is true ?

(A) Under expanded nozzle – exit area is too small for an optimum area ratio

(B) Over expanded nozzle – exit area is too small for an optimum area ratio.

(C) Under expanded nozzle – exit area is too large for an optimum expansion

(D) None of the above

50. What is the effect of divergence angle in conical nozzles?

(A) Small angle gives high specific impulse

(B) Large angle gives better performance

(C) Both (A) and (B)

(D) None of the above

51. The velocity correction factor ($\zeta_v$) is related to energy conversion efficiency (e) by

(A) $e^2$ (B) $1/e$ (C) $\sqrt{e}$ (D) $e^3$

52. The value of discharge correction factor ($\zeta_d$) is usually larger than 1 because,

(A) molecular weight of the gases increase through the nozzle.

(B) heat is transferred to the walls lowering the temperature and thereby increasing the density.

(C) both (A) and (B)

(D) Only (B)

53. The correct relation between mixture ratio (r) and mass flow rate of oxidizer or fuel is given by

(A) $\dot{m}_o = \frac{r\dot{m}}{(r+1)}$ (oxidizer) (B) $\dot{m}_f = \frac{r\dot{m}}{(r+1)}$ (fuel)

(C) both (A) and (B) (D) None of the above

54. The specific impulse of a liquid rocket engine is

(A) Directly proportional to the molecular weight.

(B) Inversely proportional to chamber temperature.

(C) Inversely proportional to molecular weight.

(D) None of the above

55. What are the desirable properties of liquid propellants?

(A) Low freezing point and specific gravity

(B) Low freezing point and high specific gravity

(C) High freezing point and high specific gravity

(D) Low boiling point.

56. The relation among velocity($\zeta_v$), discharge ($\zeta_d$) and thrust ($\zeta_F$) correction factors is given by.

(A) $\zeta_v = \zeta_F \zeta_d$ (B) $\zeta_F = \zeta_v \zeta_d$ (C) $\zeta_d = \zeta_F \zeta_v$ (D) None of the above

57. The burning rate of composite propellants can be increased by.

(A) Decreasing the oxidizer particle size

(B) Increasing oxidizer percentage

(C) Both (A) and (B)

(D) None of the above

58. In the burning rate law given by $r = ap^n$, the value of combustion index(n)

(A) Depends on initial grain temperature

(B) Describes the influence of chamber pressure on the burning rate

(C) Both (A) and (B)

(D) None of the above

59. For an end burning grain the web thickness is

(A) Half of the length of the grain (B) Equal to the length of the grain

(C) Cannot be related to length (D) None of the above

60. The time interval between the initial and final 10% pressure points on the pressure-time trace (in burning solid propellants) is called

(A) Burning time (B) Action time

(C) Deflagration time (D) Delay time

61. The biharmonic equation $\nabla^4 \phi = 0$, in the absence of bodyforces, for 2-D problem in theory of elasticity is derived

(A) by combining equilibrium equation and compatibility condition.
(B) by combining equilibrium equation, stress-strain relation and compatibility condition.
(C) by combining stress-strain relation and compatibility condition.
(D) by combining equilibrium equation and stress-strain relation.

62. The biaxial stress field components are: $\sigma_{xx} = a\,x^2y^2$ , $\sigma_{yy} = b\,y^4$, $\tau_{xy} = x\,y^3$.The values a and b for the stress field to satisfy the equilibrium equations are:

(A) (−3/2) and (−1/4)
(B) (−3/4) and (−1/2)
(C) (−1/2) and (−1/3)
(D) (1/3) and (1/4)

63. The state of pure shear stress is defined by the stress function

(A) $\emptyset = c\,x\,y$
(B) $\emptyset = c\,x^2\,y$
(C) $\emptyset = c\,x\,y^2$
(D) $\emptyset = c\,x^2y^2$

64. The value of c for the following strain field is to be possible one is

$\epsilon_{xx} = c(x^2 + y^2); \epsilon_{yy} = x^2; \gamma_{xy} = 4\,c\,x\,y$

(A) 1
(B) 2
(C) 4
(D) (1/2)

65. The normal stresses with respect to x and y axes are $\sigma_{xx}$ = 55 MPa, $\sigma_{yy}$ = 28 MPa. One of the principal stress values is 66 MPa. What is the value of other principal stress ?

(A) 20 MPa
(B) 17 MPa
(C) 25 MPa
(D) 12 MPa

66. A beam subjected to pure bending has its radius of curvature 3000 cm. The second moment of area of its cross section is 60 $cm^4$ and E = 200 GPa. The bending moment value is

(A) 5000 N-m
(B) 2000 N-m
(C) 4000 N-m
(D) 6000 N

67. Point of contra flexure is

(A) at which shear force is maximum.
(B) at shear force and bending moment are maximum.
(C) at which shear force and bending moment are zero.
(D) at which bending moment is zero.

68. A beam of length L and uniform section is simply supported at its ends and is subjected to a shear force P at its midpoint. In the second case the length of the beam is doubled with load at mid span. The ratio of the maximum bending stress of second case to the first case is

(A) 4
(B) 1
(C) 2
(D) 3

69. A cantilever beam of length L is subjected to load P at its free end. Another identical cantilever beam is subjected moment M at its free end. If the slope at the tip of the beams is to be same, the ratio of M to P is

(A) 2 L (B) L (C) L/2 (D) $L^2$

70. A shaft of length L and rigidity GJ is fixed at left end and free at the other end. A torque T is applied at its midpoint. The twist at the free end is

(A) TL/(2GJ) (B) TL/(GJ) (C) 2TL/(GJ) (D) TL/(4GJ)

71. A solid shaft of diameter d, length L and torsional rigidity GJ is subjected to torque T at its ends. If $\tau$ is the maximum shear stress, the maximum tensile stress is

(A) $\tau/2$ (B) $4\tau$ (C) $\tau$ (D) $3\tau$

72. A solid shaft of length L and diameter d is fixed at its ends. It is subjected to a torque T at point L/4 from left fixed end. The maximum shear stress is

(A) $16T/(\pi d^3)$ (B) $32T/(\pi d^3)$ (C) $8T/(\pi d^3)$ (D) $12T/(\pi d^3)$

73. A shaft of uniform section and diameter d is subjected to torque T. In the second case the diameter of the shaft is doubled with torque remaining same. The ratio of the maximum shear stress of the second case to that in the first case is

(A) 2 (B) 1/2 (C) 1/4 (D) 1/8

74. The cross section of a column is rectangle of width 15 cm and depth 20 cm and cross section is in x-y plane. The width is parallel to x-axis. During buckling the bending will be

(A) about y-axis (B) about diagonal line

(C) about x-axis (D) about z-axis

75. The buckling load for a column with fixed ends is 8000 N. If the end condition of the column is made fixed-free the buckling load is

(A) 16000 N (B) 4000 N (C) 32000 N (D) 500 N

76. A column of length L is hinged at its ends and subjected to axial compressive load P. If another hinge is provided at the midpoint so that the displacement is zero at the midpoint, the buckling load becomes

(A) $\pi^2 EI/4L^2$ (B) $4\pi^2 EI/L^2$ (C) $\pi^2 EI/2L^2$ (D) $\pi^2 EI/L^2$

77. The cross section of a column is circle of diameter 100 mm and length 3 m. The slenderness ratio is

(A) 100 (B) 120 (C) 240 (D) 300

78. The biaxial stress field components are $\sigma_{xx} = 12c$, $\sigma_{yy} = 6c$, $\tau_{xy} = 4c$ (in MPa). The yield stress in simple tension test is 300 MPa. The value of c according to maximum shear stress theory is

(A) 120 (B) 150 (C) 60 (D) 90

79. An idealized thin walled channel section, with area lumped at discrete locations, is subjected to vertical shear force applied at the shear center. The skin is ineffective in resisting the load. The shear flow

(A) varies linearly between the lumped areas
(B) varies parabolically between the lumped areas
(C) is constant between lumped areas
(D) is zero in the flanges of the channel section and constant in the web section

80. A closed thin walled rectangular section of width 10 cm and depth 20 cm is subjected to a constant shear flow of 15 N/cm around the contour. The torque produced by the shear flow is

(A) 3000 N-cm (B) 4000 N-cm (C) 8000 N-cm (D) 6000 N-cm

81. The stiffness of a spring in spring-mass system is k and m is the mass. The stiffness of the spring is doubled and mass is reduced by half. The ratio of the frequency in the second case to that in the first case is

(A) 1 (B) 4 (C) 1/2 (D) 2

82. In a spring-mass system with damper the frequency of oscillation is found to be 90% of its natural frequency. The damping ratio is

(A) $(0.3)^{0.5}$ (B) $(0.25)^{0.5}$ (C) $(0.19)^{0.5}$ (D) $(0.4)^{0.5}$

83. The mass in spring-mass-damper system is 1 kg and damping ratio is 0.25. The natural frequency of vibration is 8 rad/sec. The damping constant is

(A) 0.2 N-s/m (B) 2 N-s/m (C) 4 N-s/m (D) 3 N-s/m

84. The number of degrees of freedom for a simply supported beam is

(A) 4 (B) 2 (C) infinite (D) 10

85. The rigid body movement is observed in the case of vibration of a beam with

(A) both ends fixed
(B) both ends simply supported
(C) one end fixed and other end hinged
(D) Both ends are free

86. There exists a particular point on the wing about which the moments are independent of angle of attack. This point is known as

(A) Centre of pressure (B) Aerodynamic center
(C) Centre of gravity (D) Stagnation point

87. An airplane in the steady, equilibrium flight at its trim angle of attack has zero pitching moment about

(A) Centre of gravity (B) Centre of pressure
(C) Aerodynamics center (D) Quarter chord point

88. The contribution of wing with positive camber towards longitudinal static stability is
(A) Stable (B) Destabilizing
(C) Negligible (D) None

89. For longitudinal static stability, the centre of gravity of an airplane must always be
(A) ahead of neutral point
(B) behind neutral point
(C) on the neutral point
(D) positioned at 10% of chord length of the wing

90. The airplane trim angle of attack can be controlled by deflecting
(A) Rudder (B) Aileron (C) Elevator (D) Flap

91. The stick forces at trim can be made zero by incorporating ______on either the elevator or rudder
(A) flap (B) trim tab (C) slat (D) aileron

92. The difference between the neutral point and the actual centre of gravity position is called
(A) Static margin (B) Chord
(C) Quarter chord (D) Sideslip

93. The yawing moment created due to rate of roll is called
(A) Weathercock effect (B) Adverse yaw
(C) Dihedral (D) Cross effect

94. The rudder lock can be prevented by adding a small extension at the beginning of the vertical tail. It is called
(A) Dorsal fin (B) Rudder fin
(C) Rudder delta (D) Rudder tip

95. When the tips of the wing are at higher level than the root of the wing, the wing is said to have
(A) Twist (B) Dihedral
(C) Anhedral (D) Taper

96. The yawing moment created due to sideslip is called
(A) Rolling (B) Adverse yaw
(C) Weathercock effect (D) Pullup

97. The rolling moment created due to sideslip is called
(A) Dihedral effect (B) Adverse Yaw
(C) Weathercock effect (D) Pulldown

98. For unpowered gliding flight, the angle 'θ' is determined in terms of Lift force 'L' and Drag force 'D' by

(A) $\tan\theta = L/D$ (B) $\tan\theta = D/L$

(C) $\sin\theta = L/D$ (D) $\cos\theta = L/D$

99. The absolute ceiling of transport aircraft is defined as the altitude

(A) Where maximum rate of climb is 100ft/min

(B) Above service ceiling

(C) Where maximum rate of climb is infinity

(D) Where maximum rate of climb is zero

100. The stall speed of a given airplane at a given altitude is

(A) Proportional to Maximum lift coefficient

(B) Inversely proportional to Maximum lift coefficient

(C) Proportional to lift coefficient

(D) Inversely proportional to lift coefficient

101. Consider for jet propelled aircraft where thrust is constant with velocity. The maximum climb angle $\theta_{max}$ will occur when the

(A) Lift to drag ratio is maximum (B) Lift to drag ratio is minimum

(C) Lift to drag ratio is one (D) Thrust is maximum

102. In the case of a steady level flight, the value of minimum thrust required ______ with altitude.

(A) changes (B) increases

(C) decreases (D) remains constant

103. Identify the TRUE statement from the following choices.

(A) Wing dihedral and high wing reduce roll stability.

(B) Wing dihedral increases roll stability and high wing configuration reduces roll stability.

(C) Wing dihedral and high wing increase roll stability.

(D) Wing dihedral and low wing configuration reduce roll stability.

104. In the case of steady level flight, the relation between velocity corresponding to power required minimum ($V_{pr\ min}$) and velocity corresponding to thrust required minimum ($V_{tr\ min}$) is

(A) $V_{pr\ min} = 0.76\ V_{tr\ min}$ (B) $V_{pr\ min} = V_{tr\ min}$

(C) $V_{tr\ min} = 0.76\ V_{pr\ min}$ (D) $V_{pr\ min} = 1.32\ V_{tr\ min}$

105. For critically damped single degree of freedom spring-mass-damper system with a damping constant of 3 Ns/m and spring constant k of 9 N/m, then mass m is

(A) 0.25 kg (B) 1 kg
(C) 3 kg (D) 9 kg

106. An aircraft of mass 2000 kg in steady level flight at a constant speed of 100 m/s has available excess power of $2.0 \times 10^6$ W. The steady rate of climb (approximately) it can attain at that speed is

(A) 100 m/s (B) 150 m/s
(C) 200 m/s (D) 10 m/s

107. The purpose of winglets used on wings is to

(A) Minimize induced drag (B) Minimize wave drag
(C) Minimize skin friction drag (D) Minimize profile drag

108. Identify the TRUE condition for smallest possible turn radius and largest possible turn rate in a level turn flight.

(A) Highest possible load factor and lowest possible velocity.
(B) Lowest possible load factor and highest possible velocity.
(C) Highest possible load factor and highest possible velocity.
(D) Lowest possible load factor and lowest possible velocity.

109. Consider a straight wing of aspect ratio with an NACA 2412 airfoil. For low-speed flow, the lift coefficient at an angle of attack of 6 deg is 0.648. Assume the span efficiency factor is 0.95. Calculate the induced drag coefficient.

(A) 0.234 (B) 0.423
(C) 0.0234 (D) 0.0423

110. The propeller is feathered when an engine failure occurs in flight. This is preferred because it

(A) minimizes drag (B) maximizes lift
(C) maximizes drag (D) minimizes lift

111. For a NACA 2412 airfoil of chord 'c', identify the correct combination from given choices.

(A) Camber is 0.02c located at 0.4c from the leading edge.
(B) Camber is 0.2c located at 0.04c from the leading edge.
(C) Camber is 0.04c located at 0.2c from the leading edge.
(D) Camber is 0.4c located at 0.02c from the leading edge.

112. The main function of swept back wings of subsonic aircraft is
(A) to increase the drag divergence Mach number
(B) to decrease the drag divergence Mach number
(C) to increase the lift
(D) to increase the strength

113. What are the necessary criteria for longitudinal balance and static stability ? $C_{M,cg}$ is coefficient of pitching moment about center of gravity and $\alpha_a$ is absolute angle of attack
(A) $C_{M,cg}$ at zero lift must be positive, $\partial C_{M,cg}/\partial \alpha_a$ must be negative.
(B) $C_{M,cg}$ at zero lift must be negative, $\partial C_{M,cg}/\partial \alpha_a$ must be negative.
(C) $C_{M,cg}$ at zero lift must be positive, $\partial C_{M,cg}/\partial \alpha_a$ must be positive.
(D) $C_{M,cg}$ at zero lift must be zero, $\partial C_{M,cg}/\partial \alpha_a$ must be zero

114. An airplane requires longer ground roll to get off the ground during
(A) summer
(B) winter
(C) cross-winds
(D) rainy day

115. The amount of time that an airplane can stay in the air on one load of fuel is called ---
(A) Range
(B) Endurance
(C) Load factor
(D) Time to climb

116. In an elliptical orbit at which point the radial component of velocity is zero
(A) Perigee
(B) Every point in the trajectory
(C) Apogee
(D) both perigee and apogee

117. Which of the following is always conserved in an orbit?
(A) Kinetic Energy
(B) Potential Energy
(C) Potential and Kinetic Energy
(D) Angular Velocity

118. The ratio of escape velocity to orbital velocity at the point in a circular orbit is equal to
(A) 1.414
(B) 0.707
(C) 1
(D) 2

119. The total energy of an orbit is equal to zero in
(A) Circular Orbit
(B) Hyperbolic Orbit
(C) Elliptic Orbit
(D) Parabolic Orbit

120. The ratio of change in velocity required to change the orbital plane inclination to 90 degrees without changing velocity to the orbital velocity in circular orbit is equal to
(A) 1.414
(B) 1
(C) 2
(D) 0.707

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