(Answer ALL questions)

56. A structural member supports loads, which produce at a particular point, a state of pure shear stress of 50 N/mm² . At what angles are the principal planes oriented with respect to the plane of pure shear?

   1. $\pi/6$ and $2\pi/3$
   2. $\pi/4$ and $3\pi/4$
   3. $\pi/4$ and $\pi/2$
   4. $\pi/2$ and π

57. A cantilever with thin-walled channel cross-section is subjected to a lateral force at its shear centre. The cantilever undergoes

   1. Bending without twisting
   2. Bending and twisting
   3. Neither bending nor twisting
   4. Twisting without bending

58. A certain material fractured in a simple tensile test at a stress level of 600 MPa. The same material when used as a part of a loaded structure must have a principal stress of 600, 400 and −200 MPa. Determine the factor of safety at this load based on maximum shear stress theory. Take Poisson's ratio as 0.28.

   1. 1.1
   2. 2.1
   3. 1.5
   4. 2.5

59. A brass bar of 24 mm diameter and 400 cm long when it is subjected to a steady tensile load of 10 kN. Young's modulus of the material is given as 102 kN/mm². The total strain energy of the member is given by

   1. 453.5 N.cm
   2. 453.3 N.cm
   3. 433.5 N.cm
   4. 443.3 N.cm

60. A mild steel column with pinned ends is subjected to an axial compressive force? Find the slenderness ratio for which Euler formula is applicable.

   1. 92.54
   2. 90.64
   3. 93.44
   4. 91.64

61. Lift on a delta wing is

   1. calculated from Prandtl-Lanchester lifting line theory
   2. calculated from high angle of attack lifting line theory
   3. computed from empirical formula
   4. calculated from Polhamus's suction analogy

62. Downwash along the span of a wing having elliptical lift distribution

   1. Increases with increase in span
   2. Increases with increase in wing area
   3. Does not change
   4. Decreases with increase in velocity

63. Streamlined body is one for which

   1. Pressure drag is more than skin friction drag
   2. Induced drag is more than profile drag
   3. Skin friction drag is more than pressure drag
   4. None of the above

64. Lifting flow over circular cylinder is obtained by the combination of

   1. Uniform flow + source + vortex
   2. Uniform flow + sink + vortex
   3. Source + Sink + uniform flow
   4. Uniform flow + doublet + vortex

65. The induced drag is minimum for the planform which is

   1. Rectangular
   2. Elliptic
   3. Parabolic
   4. Square

NG 16 (GROUP B)

66. What will be the safe working pressure if the permissible tensile stress (longitudinal or circumferential) is 5 kN/cm², the diameter being 40 times of thickness?
    1. 500 N/cm²
    2. 250 N/cm²
    3. 300 N/cm²
    4. 350 N/cm²

67. Find the values of maximum slope and deflection of a cantilever beam bent in the form of an arc of a circle.
    1. ML/EI and ML²/2EI respectively
    2. 2ML/EI and 2ML²/EI respectively
    3. ML/2EI and 2ML²/EI respectively
    4. 2ML/EI and ML²/2EI respectively

68. A cube made of a linear elastic isotropic material is subjected to a uniform hydrostatic pressure of 100 N/mm² . Under this load, the volume of the cube shrinks by 0.05%. The Young's modulus of the material, E = 300 GPa. The Poisson's ratio of the material is
    1. 0.22 to 0.24
    2. 0.30 to 0.33
    3. 0.28 to 0.31
    4. 0.24 to 0.26

69. The simply supported beam 'A' of length l carries a central point load W. Another beam 'B' is loaded with a uniformly distributed load such that the total load on the beam is W. The ratio of maximum deflections between beams A and B is
    1. 5/8
    2. 8/5
    3. 5/4
    4. 4/5

70. A vertical column has two moments of inertia (i.e. I_{xx} and I_{yy}). The column will tend to buckle in the direction of the
    1. axis of the load
    2. perpendicular to the axis of the load
    3. maximum moment of inertia
    4. minimum moment of inertia.

71. One engine in operative condition is associated with
    1. Rudder
    2. Elevator
    3. Horizontal tail
    4. None of the above

72. Aileron reversal is associated with
    1. Magnus effect
    2. Kutta condition
    3. Aeroeleastic effect
    4. Biot – Savart law

73. Adverse yaw is associated with
    1. Climbing
    2. Banking
    3. Take off
    4. Landing

74. V-n diagram is a plot of
    1. Velocity Vs normal force
    2. Volumetric flow Vs normal force
    3. Velocity Vs load factor
    4. Volumetric flow Vs load factor

75. NACA 0014 implies the airfoil is
    1. Symmetric
    2. Positively cambered
    3. Negatively cambered
    4. Cusped

76. 1kg mass is hanging from a spring of stiffness 500 N/m attached to a free end of massless, symmetric cantilever beam of length 0.6 m, moment of inertia about the bending axis I = 8.33 × 10⁻¹⁰ m⁴ and Young's modulus E = 210 GPa. The fundamental natural frequency (in rad/s) of the system is
    1. 20.36
    2. 3.56
    3. 22.36
    4. 3.24

77. For a critically damped single degree of freedom spring-mass-damper system with a damping constant C of 4 Ns/m and spring constant k of 16 N/m, the system mass m is
    1. 0.5 kg
    2. 2 kg
    3. 0.25 kg
    4. 4 kg

78. A single degree of freedom system is vibrating with initial (first cycle) amplitude of 5 cm. The viscous damping factor associated with the vibrating system is 2%. Vibration amplitude of the fifth cycle (in cm) is
   1. 1.65
   2. 4.41
   3. 2.67
   4. 3.02

79. A spring-mass damper system with a mass of 1 kg is found to have a damping ratio of 0.2 and a natural frequency of 5 rad/s. The damping of the system is given by
   1. 2 N/s
   2. 2 Ns/m
   3. 0.2 kg/s
   4. 0.2 N/s

80. Kutta-Joukowski theorem gives the dependence of lift per unit span on
   1. Total pressure
   2. Temperature
   3. Circulation
   4. None

81. For a positively cambered airfoil the zero lift angle of attack is
   1. Positive
   2. Negative
   3. Zero
   4. Directly proportional to aspect ratio

82. Aerodynamic center of an airfoil is the point about which
   1. Pitching moment is zero
   2. Pitching moment is constant
   3. Pitching moment is positive
   4. Pitching moment is negative

83. Increasing aspect ratio has the effect of
   1. Increasing lift curve slope
   2. Decreasing lift curve slope
   3. Decreasing coefficient of lift
   4. None

84. The wall heat flux in a jet engine nozzle is the highest at the following location:
   1. nozzle entrance
   2. nozzle exit
   3. at a distance of 2/3 times the nozzle length
   4. nozzle throat

85. Optimum expansion through a rocket nozzle is achieved when the exit pressure
   1. is equal to zero
   2. is equal to ambient pressure
   3. is less than ambient pressure
   4. is more than ambient pressure

86. The operational range of Mach number of ramjet engine is
   1. 0.1 to 0.8
   2. 0.8 to 1.2
   3. 1.2 to 2.0
   4. 2.0 to 5.0

87. Most of the commercial jet transport aircraft use the following type of engine for propulsion
   1. turbojet
   2. turboprop
   3. turbofan
   4. pulse jet

88. The following type of aircraft requires longest runway for take off
   1. the aircraft that uses turboprop
   2. the aircraft that uses turbojet
   3. the aircraft that uses piston engine
   4. the aircraft that uses turbofan

89. A linear mass-spring-dashpot system is over-damped. In free vibration, this system undergoes
   1. non-oscillatory motion
   2. random motion
   3. oscillatory and periodic motion
   4. oscillatory and non-periodic motion

90. Which one of the following features improves the fatigue strength of a metallic material?
   1. Increasing the temperature
   2. Scratching the surface
   3. Overstressing
   4. Understressing

91. A closed coil helical spring is subjected to a torque about its axis. The spring wire would experience a
    1. Bending stress
    2. Direct tensile stress of uniform intensity at its cross-section
    3. Direct shear stress
    4. Torsional shearing stress

92. In a beam of I-section, the maximum shear force is carried by
    1. The upper flange
    2. The web
    3. The lower flange
    4. Any one of the above

93. The state of plane stress at a point is described by $\sigma = \sigma_x = \sigma_y$ and $\tau_{xy} = 0$. The normal stress on the plane inclined at 45° to the X-plane will be
    1. σ
    2. $\sqrt{2}\,\sigma$
    3. $\sqrt{3}\,\sigma$
    4. 2σ

94. A solid circular shaft is subjected to a maximum shearing stress of 140 MPa. The magnitude of the maximum normal stress developed in the shaft is
    1. 140 MPa
    2. 80 MPa
    3. 70 MPa
    4. 60 MPa

95. In a turbofan engine
    1. Increasing bypass ratio improves Specific Fuel Consumption (SFC) at the expense of significant reduction in specific thrust
    2. Increasing bypass ratio improves SFC with significant increase in specific thrust
    3. Increasing bypass ratio increases Specific Fuel Consumption (SFC) at the expense of significant reduction in specific thrust
    4. None of the above

96. Stalling in an axial flow compressor occurs due to
    1. Airflow sonic speed
    2. High temperatures in the compressor
    3. Reverse airflow
    4. Flying at high altitude

97. Sonic velocity of a fluid depends on the molecular weight of the fluid, when the temperature is kept constant
    1. Sonic velocity increases with increase in molecular weight
    2. Sonic velocity remains constant with increase in molecular weight
    3. Sonic velocity decreases with increase in molecular weight
    4. Sonic velocity does not depend upon molecular weight

98. It is desired that liquid propellant has
    1. High vapour pressure and high density
    2. High vapour pressure and low density
    3. Low vapour pressure and high density
    4. Low vapour pressure and low density

99. An over-expanded supersonic nozzle is one, in which
    1. the nozzle exit pressure is greater than the ambient pressure
    2. the nozzle exit pressure is equal to the ambient pressure
    3. the nozzle exit pressure is lower than the ambient pressure
    4. the nozzle throat pressure is greater than the ambient pressure

100. When a moving fluid particle is brought to rest adiabatically
    1. and are both conserved
    2. is conserved but is not conserved
    3. is not conserved but is conserved
    4. and are both not conserved

101. The entropy rise across a normal shock wave is a function of
    1. pressure and temperature
    2. temperature and velocity
    3. pressure and velocity
    4. none of the above

102. CFL criterion is used for
    1. round-off error estimation
    2. numerical stability
    3. discretization error estimation
    4. convergence test

103. Substantial derivative includes the effects of
    1. convection only
    2. time varying quantities
    3. both convection and unsteadiness
    4. both unsteadiness and source terms

104. The component of a transonic airplane for which transonic area rule applied is
    1. Nose
    2. Wing
    3. Tail
    4. Fuselage

105. Induced drag of an airplane can be reduced by
    1. Boundary layer fence
    2. Spoilers
    3. Winglets
    4. Decreasing aspect ratio

106. Prandtl – Glauret rule gives the relation between
    1. Viscous and inviscid flow
    2. Compressible and incompressible flow
    3. Transonic and subsonic flow
    4. Transonic and supersonic flow

107. The component of airplane whose size and geometric parameters are very critical to lateral stability is
    1. Wing
    2. Aileron
    3. Horizontal stabilizer
    4. Rudder

108. The critical Mach number can be increased by
    1. Increasing aspect ratio
    2. Increasing thickness to chord ratio
    3. Increasing sweep back
    4. Decreasing sweep back

109. Service ceiling of an airplane is altitude at which maximum rate of climb is
    1. 180 ft/min
    2. 100 ft/min
    3. 30 m/s
    4. 80 ft/s

110. In a thin airfoil with cubic camber it is
    1. possible to have = 0
    2. not possible to have = 0
    3. possible to have > 0
    4. not possible to have < 0

111. The value of cross flow pressure gradient for a boundary layer can be considered as
    1. −1
    2. 1
    3. 0
    4. $\frac{1}{2}$

112. The typical value of by pass ratio of a modern turbofan engine lies in the range of
    1. 0.1 to 0.5
    2. 0.8 to 1.2
    3. 5 to 9
    4. 14 to 21

113. In an aircraft gas turbine engine with a 16 stage axial flow compressor, air tapping for turbine blade cooling is done typically from the following stages of compressor:
    1. First stage
    2. 16th stage
    3. Between 8th and 10th stages
    4. Between 4th and 5th stages

114. The increase in mass flow rate through an axial flow jet engine has the following effect on the engine:
    1. Jet engine drag decreases
    2. Engine thrust increases
    3. Engine heat losses decrease
    4. Engine combustion chamber temperature increases

115. The phenomenon rotating stall is observed in
    1. centrifugal compressor
    2. axial flow compressor
    3. supersonic diffuser
    4. reciprocating compressor