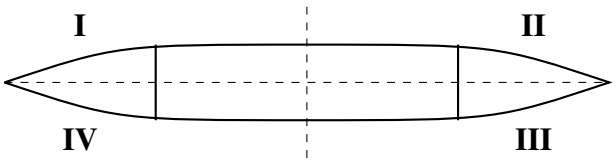
2020-AE-27-39

AI24BTECH11023 - Tarun Reddy Pakala

1) The positive high angle-of-attack condition is obtained in a steady pull-out maneuver at the largest permissible angle-of-attack of the wing. Under this condition, at which of the following regions of the wing does the maximum tension occur?



a) I
b) II
c) III
d) IV

2) The natural frequency of the first mode of a rectangular cross section cantilever aluminum beam is $\omega\frac{rad}{s}$. If the material and cross-section remain the same, but the length of the beam is doubled, the first mode frequency will become
a) $\frac{\omega}{4}\frac{rad}{s}$
b) $4\omega\frac{rad}{s}$
c) $\frac{\omega}{16}\frac{rad}{s}$
d) $16\omega\frac{rad}{s}$

3) Given $A = \begin{pmatrix} \sin\theta & \tan\theta \\ 0 & \cos\theta \end{pmatrix}$, the sum of squares of eigenvalues of A is
a) $\tan^2\theta$
b) 1
c) $\sin^2\theta$
d) $\cos^2\theta$

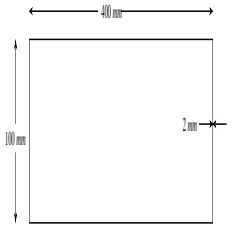
4) Burnout velocity of a space vehicle in a circular orbit at angle 5 degrees above the local horizon around earth is 13.5 $\frac{km}{s}$. Tangential velocity of the space vehicle in the orbit is _____ $\frac{km}{s}$ (*round off to two decimal places*).

5) Velocity of an airplane in the body fixed axes is given as $[100\ -10\ 20]\frac{m}{s}$. The sideslip angle is _____ degrees (*round off to two decimal places*).

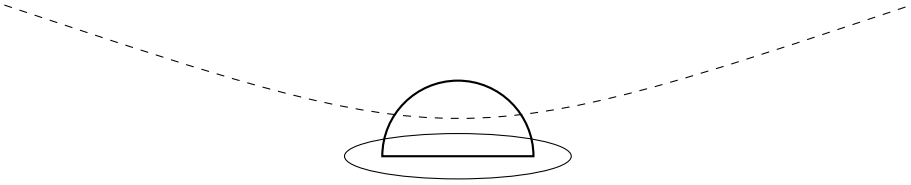
6) The similarity solution for the diffusion equation, $\frac{\partial u}{\partial t} = \alpha\frac{\partial^2 u}{\partial x^2}$ is $u(x,\ t) = u(\eta)$, where similarity variable, $\eta = \frac{x}{\sqrt{\alpha t}}$. If $u(x\ 0) = e^{-x^2}$, the ratio $\frac{u(0,\ 1)}{u(0\ 4)}$ = _____ (*round off to one decimal place*).

7) Air enters the rotor of an axial compressor stage with no pre-whirl ($C_\theta = 0$) and exits the rotor with whirl velocity, $C_\theta = 150\frac{m}{s}$. The velocity of rotor vanes, U is $200\frac{m}{s}$. Assume $C_P = 100\frac{J}{kg\ K}$, the stagnation temperature rise across the rotor is _____ K (*round off to one decimal place*).

8) A thin walled beam of constant thickness shown in the figure is subjected to a torque of 3.2 kNm. If the shear modulus is $25GPa$, the angle of twist per unit length is _____ $\frac{rad}{m}$ (*round off to three decimals*).



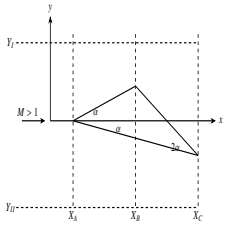
9) An airplane of mass 5000 kg is flying at a constant speed of 360 $\frac{km}{h}$ at the bottom of a vertical circle with a radius of 400 m, as shown in the figure. Assuming that the acceleration due to gravity is 9.8 $\frac{m}{s^2}$, the load factor experienced at the center of gravity of the airplane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



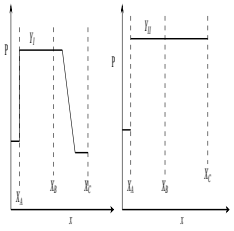
Airplane

10) The equation $x\frac{dx}{dy} + y = c$, where c is a constant, represents a family of
   a) exponential curves
   b) parabolas
   c) circles
   d) hyperbolas

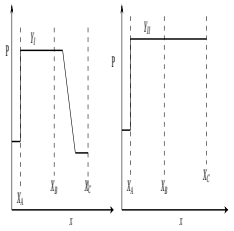
11) A wedge shaped airfoil is placed in a supersonic flow as shown in figure (not to scale). The corners of the wedge are at $x = \mathrm{x}_A$, $x = \mathrm{x}_B$, $x = \mathrm{x}_C$, respectively.



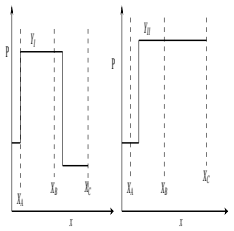
Which one of the following represents the correct static pressure along $y = \mathrm{Y}_I$ and $y = \mathrm{Y}_{II}$?



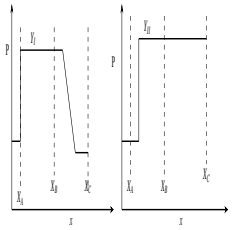
a)



b)



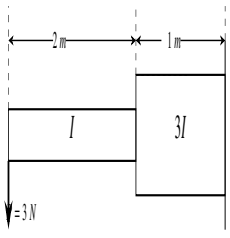
c)



d)

12) The value of Poisson's ratio at which the shear modulus of an isotropic material is equal to the bulk modulus is
   a) $\frac{1}{2}$
   b) $\frac{1}{4}$
   c) $\frac{1}{6}$
   d) $\frac{1}{8}$

13) A load P is applied to the free end of a stepped cantilever beam as shown in the figure. The Young's modulus of the material is E, and the moments of inertia of the two sections of length 2 m and 1 m are I and $3I$, respectively. Ignoring transverse shear and stress concentration effects, the deflection at the point where the load is applied at the free end of the cantilever is



   a) $\frac{23}{243EI}$
   b) $\frac{1}{3EI}$
   c) $\frac{43}{3EI}$
   d) $\frac{23}{3EI}$