Gate AE-2010

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1) Isentropic efficiency η_e of a subsonic diffuser is defined as:
(Note: 'a' represents the ambient, '2' represents the exit of the diffuser, and 's' represents an isentropic process.)

a) $\frac{T_{O2s}-T_a}{T_{O2}-T_a}$ b) $\frac{T_{O2s}+T_a}{T_{O2}+T_a}$ c) $\frac{P_{O2s}-P_a}{P_{o2}-P_{a_s}}$ d) $\frac{P_a-P_{O2s}}{P_a-P_{O2}}$

2) Two position vectors are indicated by $\overline{V}_1 = \begin{Bmatrix} x_1 \\ y_1 \end{Bmatrix}$ and $\overline{V}_2 = \begin{Bmatrix} x_2 \\ y_2 \end{Bmatrix}$. If $a^2 + b^2 = 1$, then the operation $\overline{V}_2 = \begin{bmatrix} a & -b \\ b & a \end{bmatrix} \overline{V}_1$ amounts to obtaining the position vector $\overline{V}_2$ from $\overline{V}_1$ by

a) translation
b) rotation
c) magnification
d) combination of translation, rotation, and magnification

3) 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) dependent on the weight of the aircraft

4) In a general case of a homogeneous material under thermo-mechanical loading, the number of distinct components of the state of stress is:

a) 3 b) 4 c) 5 d) 6

5) The linear second-order partial differential equation: $5\frac{\partial^2\phi}{\partial x^2} + 3\frac{\partial^2\phi}{\partial x\partial y} + 2\frac{\partial^2\phi}{\partial y^2} + 9 = 0$ is:

a) Parabolic
b) Hyperbolic
c) Elliptic
d) None of the above

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

a) 15% b) 30% c) 70% d) 105%

7) A vertical slender rod is suspended by a hinge at the top and hangs freely. It is heated until it attains a uniform temperature. Neglecting the effect of gravity, the rod has

a) Stress but no strain
b) Strain but no stress
c) Both stress and strain
d) Neither stress nor strain

8) 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 b) 40.0 m/s c) 56.6 m/s d) 80.0 m/s

9) The eigen-values of a real symmetric matrix are always

a) positive
b) imaginary
c) real
d) complex conjugate pairs

10) The concentrations of a certain chemical species at time t in a chemical reaction is described by the differential equation $\frac{dx}{dt} + kx = 0$, with $x(t = 0) = x_0$. Given that e is the base of the natural logarithms, the concentration x at $t = \frac{1}{k}$

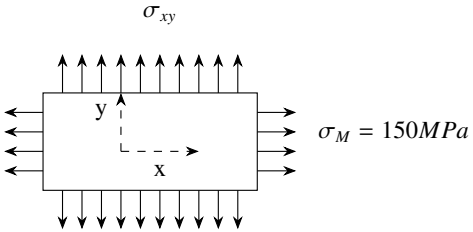
a) falls to the value $0.5x_0$
b) rises to the value $2x_0$
c) falls to the value $\frac{x_0}{e}$
d) rises to the value ex_0

11) The definite integral $\int_{-1}^{+1} \frac{dx}{x^2}$

a) does not exist b) is equal to 2 c) is equal to 0 d) is equal to -2

12) 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

13) A thin rectangular plate made of isotropic material which satisfies the octahedral (i.e., Von Mises/Distortion energy) failure criterion has yield strength of 200 MPa under uniaxial tension. As shown in the figure, if it is loaded with uniform tension of 150 MPa along the x-direction, the maximum uniform tensile stress that can be applied along the y-direction before the plate starts yielding is about



a) 227 MPa b) 77 MPa c) 87 MPa d) 114 MPa