2009 ME 1-12

AI24BTECH11031 - Shivram S

1) For a matrix $\mathbf{M} = \begin{pmatrix} \frac{3}{5} & \frac{4}{5} \\ x & \frac{3}{5} \end{pmatrix}$, the transpose of the matrix is equal to the inverse of the matrix, $\mathbf{M}^\top = \mathbf{M}^{-1}$. The value of x is given by

a) $-\frac{4}{5}$ b) $-\frac{3}{5}$ c) $\frac{3}{5}$ d) $\frac{4}{5}$

2) The divergence of the vector field $3xz\hat{i} + 2xy\hat{j} - yz^2\hat{k}$ at a point $(1, 1, 1)$ is equal to

a) 7 b) 4 c) 3 d) 0

3) The inverse Laplace transform of $\frac{1}{(s^2+s)}$ is

a) $1 + e^t$ b) $1 - e^t$ c) $1 - e^{-t}$ d) $1 + e^{-t}$

4) If three coins are tossed simultaneously, the probability of getting at least one head is

a) $\frac{1}{8}$ b) $\frac{3}{8}$ c) $\frac{1}{2}$ d) $\frac{7}{8}$

5) If a closed system is undergoing an irreversible process, the entropy of the system
   a) must increase
   b) always remains constant
   c) must decrease
   d) can increase, decrease or remain constant

6) A coolant fluid at $30°C$ flows over a heated flat plate maintained at a constant temperature of $100°C$. The boundary layer temperature distribution at a given location on the plate may be approximated as $T = 30 + 70\exp(-y)$ where y (in m) is the distance normal to the plate and T is in $°C$. If thermal conductivity of the fluid is 1.0 $\frac{W}{mK}$, the local convective heat transfer coefficient (in $\frac{W}{m^2K}$) at that location will be

a) 0.2 b) 1 c) 5 d) 10

7) A frictionless piston-cylinder device contains a gas initially at 0.8 MPa and 0.015 m^3. It expands quasi-statically at constant temperature to a final volume of 0.030 m^3. The work output (in kJ) during this process will be

a) 8.32 b) 12.00 c) 554.67 d) 8320.00

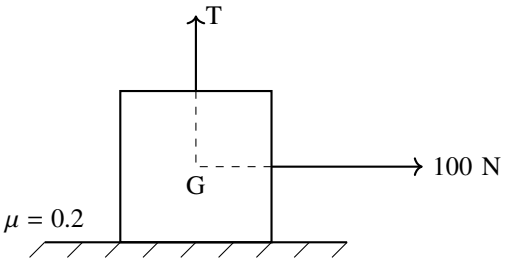
8) In an ideal vapour compression refrigeration cycle, the specific enthalpy of refrigerant (in $\frac{kJ}{kg}$) at the following states is given as:
Inlet of condenser: 283
Exit of condenser: 116
Exit of evaporator: 232
The COP of this cycle is

a) 2.27 b) 2.75 c) 3.27 d) 3.75

9) A compressor undergoes a reversible, steady flow process. The gas at inlet and outlet of the compressor is designated as state 1 and state 2 respectively. Potential and kinetic energy changes are to be ignored. The following notations are used:
v = specific volume and P = pressure of the gas.
The specific work required to be supplied to the compressor for this gas compression process is

a) $\int_1^2 Pdv$ b) $\int_1^2 vdP$ c) $v_1(P_2 - P_1)$ d) $-P_2(v_1 - v_2)$

10) A block weighing 981 N is resting on a horizontal surface. The coefficient of friction between the block and the horizontal surface is $\mu = 0.2$. A vertical cable attached to the block provides partial support as shown. A man can pull horizontally with a force of 100 N. What will be the tension, T (in N), in the cable if the man is just able to move the block to the right?

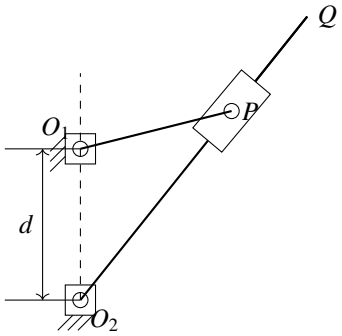


a) 176.2 b) 196.0 c) 481.0 d) 981.0

11) If the principal stresses in a plane stress problem are $\sigma_1 = 100$ MPa, $\sigma_2 = 40$ MPa, the magnitude of the maximum shear stress (in MPa) will be

a) 60 b) 50 c) 30 d) 20

12) A simple quick return mechanism is shown in the figure. The forward to return ratio of the quick return mechanism is 2 : 1. If the radius of the crank O_1P is 125 mm, then the distance d (in mm) between the crank center to lever pivot center point should be



a) 144.3 b) 216.5 c) 240.0 d) 250.0