

- 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, $\mathbf{M}^T = \mathbf{M}^{-1}$. 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 $^\circ\text{C}$. If thermal conductivity of the fluid is 1.0 W/mK , the local convective heat transfer coefficient (in $\text{W/m}^2\text{K}$) 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) 0.2
 - b) 1
 - c) 5
 - d) 10

- 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 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

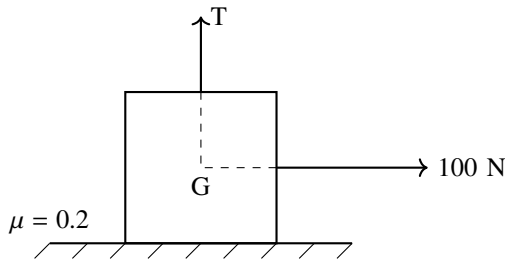
- 9) A compressor undergoes a reversible, steady flow process. The gas at inlet and outlet of the compressor is designated as state 1 and state 2 respectively. Potential and kinetic energy changes are to be ignored. The following notations are used:

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) $\int_1^2 P dv$ b) $\int_1^2 v dP$ 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?

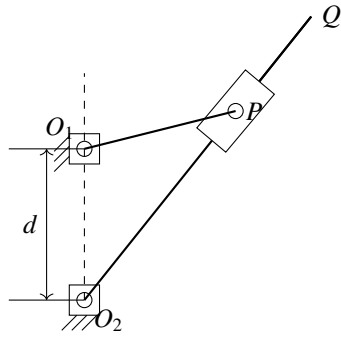


- a) 176.2 b) 196.0 c) 481.0 d) 981.0

- 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