

# 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,  $\mathbf{M}^T = \mathbf{M}^{-1}$ . 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  $30^\circ\text{C}$  flows over a heated flat plate maintained at a constant temperature of  $100^\circ\text{C}$ . 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  $1.0 \frac{\text{W}}{\text{mK}}$ , the local convective heat transfer coefficient (in  $\frac{\text{W}}{\text{m}^2\text{K}}$ ) 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  $0.015 \text{ m}^3$ . It expands quasi-statically at constant temperature to a final volume of  $0.030 \text{ m}^3$ . 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

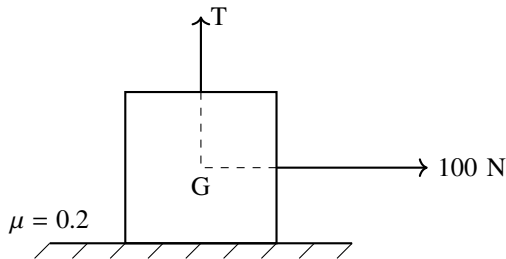
9) A compressor undergoes a reversible, steady flow process. The gas at inlet and outlet of the compressor is designated as state 1 and state 2 respectively. Potential and kinetic energy changes are to be ignored. The following notations are used:

$v$  = 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)  $\int_1^2 P dv$                       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?

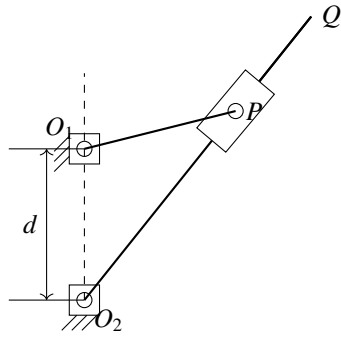


- a) 176.2                      b) 196.0                      c) 481.0                      d) 981.0

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