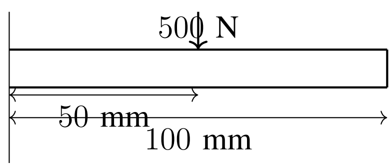
2015-ME-'53-65'

AI24BTECH11006 - Bugada Roopansha

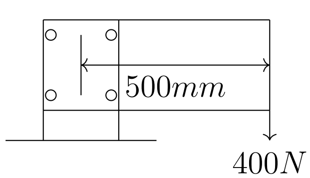
53) A machine element is subjected to the following bi-axial state of stress: $\sigma_1 = 80$ MPa; $\sigma_2 = 20$ MPa; $T_{xy} = 40$ MPa. If the shear strength of the material is 100 MPa, the factor of safety as per Tresca's maximum shear stress theory is
   a) 1.0
   b) 2.0
   c) 2.5
   d) 3.3

54) A cantilever beam with flexural rigidity of 200 Nm is loaded as shown in the figure. The deflection (in mm) at the tip of the beam is $\cdots$



55) A precision instrument package $(m = 1\text{kg})$ needs to be mounted on a surface vibrating at 60 Hz. It is desired that only 5% of the base surface vibration amplitude be transmitted to the instrument. Assume that the isolation is designed with its natural frequency significantly lesser than 60 Hz, so that the effect of damping may be ignored. The stiffness $\left(\text{in}\frac{N}{m}\right)$ of the required mounting pad is$\cdots$

56) A horizontal plate has been joined to a vertical post using four rivets arranged as shown in the figure. The magnitude of the load on the worst-loaded rivet (in N) is $\cdots$



57) For flow through a pipe of radius R, the velocity and temperature distribution are as follows: $u\left(r,x\right) = C_1$, and $T\left(r,x\right) = C_2\left[1-\left(\frac{r}{R}\right)^2\right]$, where C_1 and C_2 are constants. The bulk mean temperature is given by

$$T_m = \frac{2}{U_m R^2}\int_0^R u\left(r,x\right)T\left(r,x\right)r\,dr,$$

with U_m being the mean velocity of flow. The value of T_m is:
   a) $\frac{0.5C_2}{U_m}$
   b) $0.5C_2$
   c) $0.6C_2$
   d) $\frac{0.6C_2}{U_m}$

58) Match the following pairs:

n.o	Equation	Physical Interpretation
P	$V \cdot V = 0$	(I) Incompressible continuity equation
Q	$D\mathbf{V} = 0$	(II) Steady flow
R	$V \cdot \nabla = 0$	(III) Irrotational flow
S	$\frac{\partial a}{\partial t} = 0$	(IV) Zero acceleration of fluid particle

The options are:
   a) (A) P-IV, Q-I, R-II, S-III
   b) (B) P-IV, Q-III, R-I, S-II
   c) (C) P-III, Q-I, R-IV, S-II
   d) (D) P-III, Q-I, R-II, S-IV

59) The velocity field of an incompressible flow is given by $\mathbf{V} = (a_1x+a_2y+a_3z)\mathbf{i}+(b_1x+b_2y+b_2z)\mathbf{j}+(c_1x+c_2y+c_3z)\mathbf{k}$, where $a_1 = 2$ and $c_3 = -4$. The value of b_2 is $\cdots$

60) A 10 mm diameter electrical conductor is covered by an insulation of 2 mm thickness. The conductivity of the insulation is $0.08\frac{W}{mK}$, and the convection coefficient at the insulation surface is $10\frac{W}{m^2K}$. The addition of further insulation of the same material will:
   a) increase heat loss continuously

b) decrease heat loss continuously
c) increase heat loss to a maximum and then decrease heat loss
d) decrease heat loss to a minimum and then increase heat loss

61) The temperature of nitrogen in a vessel of volume $2\,\text{m}^3$ is $288\,\text{K}$. A U-tube manometer connected to the vessel shows a reading of $70\,\text{cm}$ of mercury (level higher in the end open to atmosphere). The universal gas constant is $8314\,\frac{J}{kmol-K}$, atmospheric pressure is $1.01325\,\text{bar}$, acceleration due to gravity is $9.81\,\frac{m}{s^2}$, and the density of mercury is $13600\,\frac{kg}{m^3}$. The mass of nitrogen (in kg) in the vessel is$\cdots$

62) Air $\left(\rho = 1.2\,\frac{kg}{m^3}\text{and kinematic viscosity,}\nu = 2\times10^{-5}\,\frac{m^2}{s}\right)$ with a velocity of $2\,\frac{m}{s}$ flows over the top surface of a flat plate of length $2.5\,\text{m}$. If the average value of the friction coefficient is given by

$$C_f = \frac{1.328}{Re_x}$$

the total drag force (inN) per unit width of the plate is $\cdots$

63) Water $\left(\rho = 1000\,\frac{kg}{m^3}\right)$ flows through a venturimeter with an inlet diameter of $80\,\text{mm}$ and a throat diameter of $40\,\text{mm}$. The inlet and throat gauge pressures are measured to be $400\,\text{kPa}$ and $130\,\text{kPa}$ respectively. Assuming the venturimeter to be horizontal and neglecting friction, the inlet velocity $\left(\text{in}\frac{m}{s}\right)$ is $\cdots$

64) A well-insulated rigid container of volume $1\,\text{m}^3$ contains $1.0\,\text{kg}$ of an ideal gas $\left[C_v = 1000\,\frac{J}{kgK}\text{and}C_p = 800\,\frac{J}{kgK}\right]$ at a pressure of $10^5\,\text{Pa}$. A stirrer is rotated at constant rpm in the container for 1000 rotations, and the applied torque is $100\,\text{N m}$. The final temperature of the gas (in K) is $\cdots$

65) Steam enters a well-insulated turbine and expands isentropically throughout. At an intermediate pressure, 20% of the mass is extracted for process heating, and the remaining steam expands isentropically to $9\,\text{kPa}$.

Inlet to turbine:
$P = 14\,\text{MPa}$ $T = 560\,°\text{C}$ $h = 3486\,\frac{kJ}{kg}$ $s = 6.6\,\frac{kJ}{kgK}$

Intermediate stage:
$h = 2776\,\frac{kJ}{kg}$

Exit of turbine:
$P = 9\,\text{kPa}$ $h = 174\,\frac{kJ}{kg}$ $h_g = 2574\,\frac{kJ}{kg}$ $s = 0.6\,\frac{kJ}{kgK}$ $s_g = 8.1\,\frac{kJ}{kgK}$

If the flow rate of steam entering the turbine is $100\,\frac{kg}{s}$, then the work output (in MW) is $\cdots$