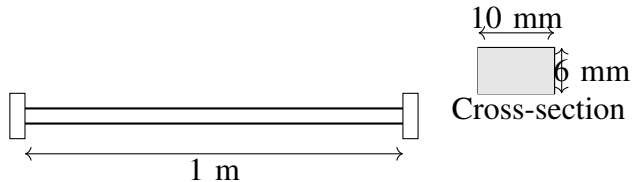


2014-AE-'40-52'

AI24BTECH11006 - Bugada Roopansha

- 40) A structural member of rectangular cross-section $10 \text{ mm} \times 6 \text{ mm}$ and length 1 m is made of steel (Young's modulus is 200 GPa) (coefficient of thermal expansion is $12 \times 10^{-6}/^\circ\text{C}$).

It is rigidly fixed at both ends and then subjected to a gradual increase in temperature. Ignoring the three-dimensional effects, the structural member will buckle if the temperature is increased by ΔT $^\circ\text{C}$, which is

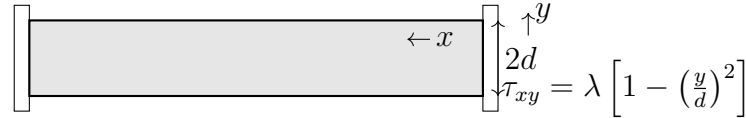


- a) 19.74
- b) 9.87
- c) 78.96
- d) 39.48

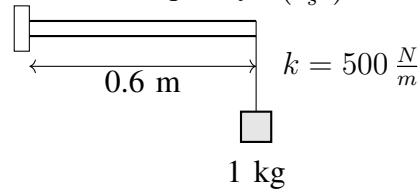
- 41) A gas cylinder (closed thin-walled cylindrical pressure vessel) of diameter 30 cm and wall thickness 1 mm is subjected to a design maximum internal pressure of 5 bar (0.5 MPa). The material used for manufacturing this cylinder has a failure stress of 260 MPa . Assuming von Mises failure criterion, the factor of safety (with respect to maximum allowable stress) for this cylinder is

- a) 2.8
- b) 2.0
- c) 6.9
- d) 4.0

- 42) A cantilevered beam is subjected to a parabolic distribution of shear traction at the right edge while the top and bottom surfaces are traction-free. To solve this problem, the following Airy's stress function is proposed: $\phi = C_1xy + C_2xy^3 + C_3x^2y^2 + C_4x^3y$. This is an admissible Airy's function that would satisfy the bi-harmonic equation as well as the boundary conditions if and only if



- a) $C_1 = 0, C_2 = \lambda, C_3 = 0, C_4 = \frac{\lambda}{3d^2}$
 - b) $C_1 = \lambda, C_2 = \frac{\lambda}{3d^2}, C_3 = 0, C_4 = 0$
 - c) $C_1 = 0, C_2 = 0, C_3 = \lambda, C_4 = -\frac{\lambda}{3d^2}$
 - d) $C_1 = \lambda, C_2 = -\frac{\lambda}{3d^2}, C_3 = 0, C_4 = 0$
- 43) A 1 kg mass is hanging from a spring with stiffness 500 N/m attached to a massless, symmetric beam of length 0.6 m , moment of inertia about the bending axis $I = 8.33 \times 10^{-10} \text{ m}^4$, and Young's modulus $E = 210 \text{ GPa}$ as shown in the figure. The fundamental natural frequency ($\frac{\text{rad}}{\text{s}}$) of the system is



- a) 3.24
 - b) 20.36
 - c) 22.36
 - d) 3.56
- 44) A single degree of freedom system is vibrating with an initial (first cycle) amplitude of 5 cm . The viscous damping factor associated with the vibrating system is 2% . The vibration amplitude of the fifth cycle (in cm) is
- a) 1.65
 - b) 4.41
 - c) 2.67
 - d) 3.02
- 45) A cruise missile with an ideal ramjet engine is flying at Mach 4.0 at an altitude where the ambient temperature is 100 K . Consider the ratio of specific heats $\gamma = 1.4$ and specific gas constant $R = 287 \text{ J/kg K}$. If the stagnation temperature in the combustion chamber is equal to 2310 K , the speed of the exhaust gases is ...

- 46) A gas turbine engine is operating under the following conditions:
- Stagnation temperature at turbine inlet: 1350 K
 - Stagnation pressure at turbine inlet: 10 bar
 - Static temperature at turbine exit: 800 K
 - Velocity at turbine exit: $200 \frac{m}{s}$
 - Total-to-total efficiency of turbine: 0.96
 - γ (ratio of specific heats): 1.33
 - C_p (specific heat at constant pressure): $1.147 \frac{kJ}{kgK}$
- The stagnation pressure (in bar) in the nozzle (considering an isentropic nozzle) is equal to ...
- 47) Air at a stagnation temperature of 300 K (ratio of specific heats, $\gamma = 1.4$) and (specific gas constant $R = 287 \frac{J}{kgK}$) enters the impeller of a centrifugal compressor in axial direction. The stagnation pressure ratio between the diffuser outlet and impeller inlet is 4.0. The impeller blade radius is 0.3 m and it is rotating at 15000 rev/min. If the slip factor σ ratio of tangential component of air velocity at the blade tip to the blade tip speed is 0.88, the overall efficiency (total-to-total) of the compressor (in%) is
- 48) A stationary two-stage rocket with an initial mass of 16000 kg, carrying a payload of 1000 kg, is fired in a vertical trajectory from the surface of the earth. Both stages of the rocket have the same specific impulse, I_p , of 300 s and the same structural coefficient of 0.14. The acceleration due to gravity is $9.8 \frac{m}{s^2}$. Neglecting drag and gravity effects and considering both stages with the same payload ratio, the terminal velocity attained by the payload in m/s is
- 49) An aircraft is flying at Mach 3.0 at an altitude where the ambient pressure and temperature are 50 kPa and 200 K, respectively. If the converging-diverging diffuser of the engine (considered isentropic with a ratio of specific heats, $\gamma = 1.4$) and (specific gas constant $R = 287 \frac{J}{kgK}$) has a throat area of $0.05 m^2$, the mass flow rate through the engine in $\frac{kg}{s}$ is
- 197
 - 232
 - 790
 - 157
- 50) A cryogenic rocket has a specific impulse of 455 s and a characteristic velocity of $2386 \frac{m}{s}$. The value of the thrust coefficient for this rocket is
- 1.78
 - 1.73
 - 1.87
 - 1.95
- 51) For a given airplane with a given wing loading executing a turn in the vertical plane, under what conditions will the turn radius be minimum and the turn rate be maximum?
- Highest possible C_L and lowest possible load factor
 - Lowest possible C_L and lowest possible load factor
 - Lowest possible C_L and highest possible load factor
 - Highest possible C_L and highest possible load factor
- 52) Lift-off distance for a given aircraft of weight W is S_{LO} . If the take-off weight is reduced by 10%, then the magnitude of percentage change in the lift-off distance (assuming all other parameters to remain constant) is