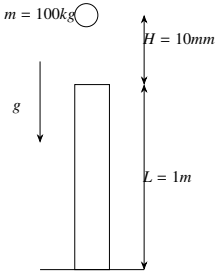
2017-ME-40-52

EE24BTECH11006 - Arnav Mahishi

1) A point mass of 100 kg is dropped onto a massless elastic bar $\left(\text{cross-sectional area} = 100mm^2, \text{length} = 1\text{ m}, \text{Young's modulus} = 100\text{ GPa}\right)$ from a height H of 10 mm as shown (Figure is not to scale). If g = $10\frac{m}{s^2}$, the maximum compression of the elastic bar is _____ mm.

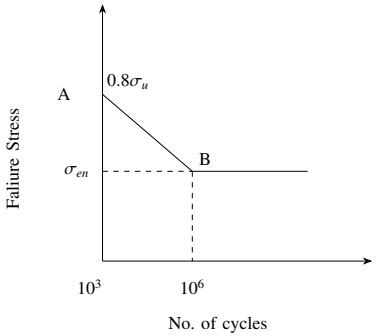


2) Two disks A and B with identical mass (m) and radius (R) are initially at rest. They roll down from the top of identical inclined planes without slipping. Disk A has all of its mass concentrated at the rim, while Disk B has its mass uniformly distributed. At the bottom of the plane, the ratio of velocity of the center of disk A to the velocity of the center of disk B is

a) $\sqrt{\frac{3}{4}}$ b) $\sqrt{\frac{3}{2}}$ c) 1 d) $\sqrt{2}$

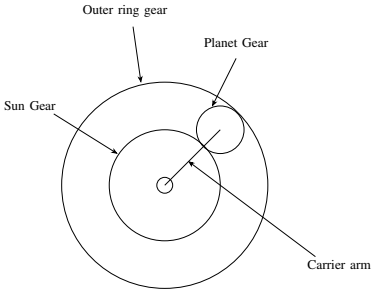
3) A rectangular region in a solid is in a state of plane strain. The (x, y) coordinates of the corners of the undeformed rectangle are given by $P(0,0)$,$Q(4,0)$,$R(4,3)$, $S(0,3)$. The rectangle is subjected to uniform strains:$\epsilon_{xx} = 0.001$, $\epsilon_{yy} = 0.002$, $\gamma_{xy} = 0.003$. The deformed length of the elongated diagonal, up to three decimal places, is _____ units.

4) A machine element has an ultimate strength (σ_u) of $600\frac{N}{mm^2}$ and an endurance limit (σ_{en}) of $250\frac{N}{mm^2}$. The fatigue curve for the element on a log-log plot is shown below. If the element is to be designed for a finite life of 10000 cycles, the maximum amplitude of a completely reversed operating stress is _____ $\frac{N}{mm^2}$ is $\frac{N}{mm^2}$.

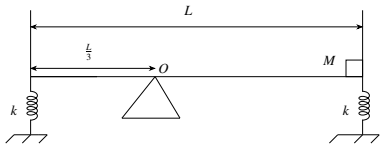


5) A horizontal bar, fixed at one end ($x = 0$), has a length of 1 m and a cross-sectional area of $100mm^2$. Its elastic modulus varies along its length as given by $E(x) = 100e^{-x}GPa$, where x is the length coordinate in m along the axis of the bar. An axial tensile load of 10 kN is applied at the free end ($x = 1$). The axial displacement of the free end is _____ mm.

6) In an epicyclic gear train, shown in the figure, the outer ring gear is fixed, while the sun gear rotates counterclockwise at 100 rpm. Let the number of teeth on the sun, planet and outer gears to be $50, 25$, and 100, respectively. The ratio of magnitudes of angular velocity of the planet gear to the angular velocity of the carrier arm is _____



7) A thin uniform rigid bar of length L and mass M is hinged at point O, located at a distance of $\frac{L}{3}$ from one of its ends. The bar is further supported using springs, each of stiffness k, located at the two ends. A particle of mass $m = \frac{M}{4}$. is fixed at one end of the bar, as shown in the figure. For small rotations of the bar about O, the natural frequency of the system is



a) $\sqrt{\frac{5k}{m}}$ b) $\sqrt{\frac{5k}{2m}}$ c) $\sqrt{\frac{3k}{2m}}$ d) $\sqrt{\frac{3k}{m}}$

8) For an inline slider-crank mechanism, the lengths of the crank and connecting rod are 3 m and 4 m, respectively. At the instant when the connecting rod is perpendicular to the crank, if the velocity of the slider is $1\frac{m}{s}$, the magnitude of angular velocity (upto 3 decimal points accuracy) of the crank is _____ $\frac{rad}{s}$.

9) A 10 mm deep cylindrical cup with diameter of 15 mm is drawn from a circular blank. Neglecting the variation in the sheet thickness, the diameter (upto 2 decimal points accuracy) of the blank is _____mm.

10) Circular arc on a part profile is being machined on a vertical CNC milling machine. CNC part program using metric units with abosolute dimensions is listed below:

N60 G01 X 30 Y 55 Z-5 F50
N70 G02 X 50 Y 35 R 20
N80 G01 Z 5

The coordinates of the circular arc are:

a) $(30, 55)$ b) $(50, 55)$ c) $(50, 35)$ d) $(30, 35)$

11) Assume that the surface roughness profile is triangular as shown schematically in the figure. If the peak to valley height is $20\mu m$. The central line average surface roughness R_a (in μm)

a) 5 b) 6.67 c) 10 d) 20

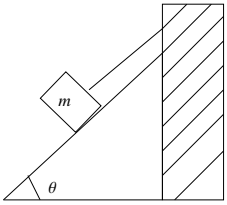
12) Two models, P and Q, of a product earn profits of Rs. 100 and Rs. 80 per piece, respectively. Production times for P and Q are 5 hours and 3 hours, respectively, while the total production time available is 150 hours. For a total batch size of 40, to maximize profit, the number of units of P to be produced is _____

13) Following data refers to the jobs (P, Q, R, S) which have arrived at a machine for scheduling. The shortest possible average flow time is _____ days

Job	Processing Time(days)
P	9
R	22
S	12

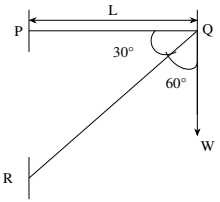
14) A block of mass m rests on an inclined plane and is attached by a string to the wall as shown in the figure. The coefficient of static friction between the plane and the

block is 0.25. The string can withstand a maximum force of 20 N. The maximum value of the mass (m) for which the string will not break and the block will be in static equilibrium is _____kg. Take $\cos\theta = 0.8$ and $\sin\theta = 0.6$.



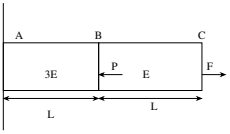
a) 10.2 b) 10.8 c) 9.8 d) 9.2

15) A two-member truss PQR is supporting a load W. The axial forces in members PQ and QR are respectively



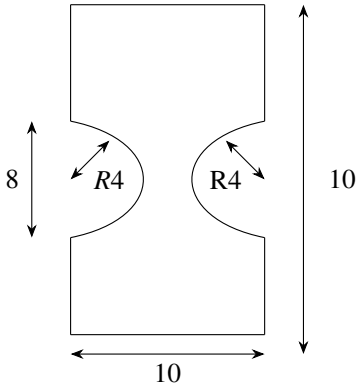
a) 2W tensile and $\sqrt{3}$W compressive
b) $\sqrt{3}$W tensile and 2W compressive
c) $\sqrt{3}$W compressive and 2W compressive
d) 2W compressive and $\sqrt{3}$W tensile

16) A horizontal bar with a constant cross-section is subjected to loading as shown in the figure. The Young's moduli for the sections AB and BC are $3E$ and E, respectively.



For the deflection at C to be zero, the ratio $\frac{P}{F}$ is _____

17) The figure shows cross-section of a beam subjected to bending. The area moment of inertia $\left(\text{in } mm^4\right)$ of this cross-section about its base is _____


8
R4
R4
10
10