# 2023-ME-53-65

AI24BTECH11023 - Tarun Reddy Pakala

53) A part, produced in high volumes, is dimensional as shown. The machining process making this part is known to be statistically in control based on sampling data. The sampling data shows that D_1 follows a normal distribution with a mean of 20 mm and a standard deviation of 0.3 mm, while D_2 follows a normal distribution with a mean of 35 mm and a standard deviation of 0.4 mm. An inspection of dimension C is carried out in a sufficiently large number of parts.
To be considered under six-sigma process control, the upper limit of dimension C should be _____ mm.
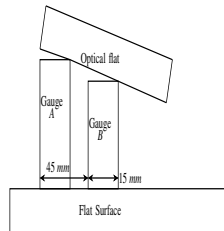(*Rounded off to one decimal place*)
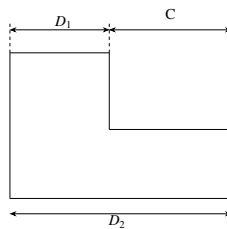
54) A coordinate measuring machine (CMM) is used to determine the distance between Surface SP and Surface SQ of an approximately cuboidal shaped part. Surface SP is declared as the datum as per the engineering drawing used for manufacturing this part. The CMM is used to measure four points P_1, P_2, P_3, P_4 on surface SP, and four points Q_1, Q_2, Q_3, Q_4 on Surface SQ as shown. A regression procedure is used to fit the necessary planes.
The distance between the two fitted planes is _____ mm.
(*Answer in integer*)
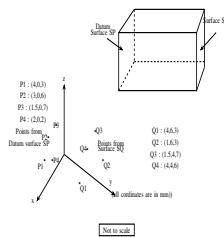
55) A solid part (see figure) of polymer material is to be fabricated by additive manufacturing (AM) in square-shaped layers starting from the bottom of the part working upwards. The nozzle diameter of the AM machine is $\frac{a}{10}$ mm and the nozzle follows a linear serpentine path parallel to the sides of the square layers with a feed rate of $\frac{a}{5}$ $\frac{mm}{min}$.
Ignore any tool path motions other than those involved in adding material, and any other delays between layers or the serpentine scan lines.
The time taken to fabricate this part is _____ minutes.
(*Answer in integer*)
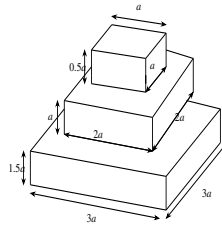
56) An optical flat is used to measure the height difference between a reference slip gauge *A* and a slip gauge *B*. Upon viewing via the optical flat using a monochromatic light of wavelength 0.5 *μm*, 12 fringes were observed over a length of 15 *mm* of gauge *B*. If the gauges are placed 45 *mm* apart, the height difference of the gauge is _____. *μm*.
(*Answer in integer*)

57) Ignoring the small elastic region, the true stress (σ)- true strain (ϵ) variation of a material beyond yielding follows the equation $\sigma = 400\epsilon^{0.3}$ *MPa*. The engineering ultimate tensile strength value of this material is _____ *MPa*.
(*Rounded off to one decimal place*)

58) The area moment of inertia about *y*-axis of a linearly tapered section shown in the figure is _____ m^4.
(*Answer in integer*)
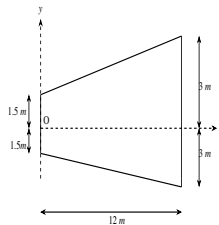
59) A cylindrical bar has a length $L = 5$ *m* and cross section are $S = 10$ m^2. The bar is made of a linear elastic material with a density $\rho = 2700\frac{kg}{m^3}$ and Young's modulus $E = 70$ *GPa*. The bar is suspended as shown in the figure and is in a state of uniaxial tension due to its self-weight.
The elastic strain energy stored in the bars equals _____ *J*.(*Rounded off to two decimal places*)
Take the acceleration due to gravity as $g = 9.8$ $\frac{m}{s^2}$.
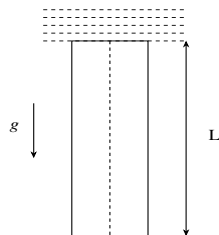
60) A cylinder transmission shaft of length 1.5 *m* and diameter 100 *mm* is made of a linear elastic material with a shear modulus 80 *GPa*. While operating at 500 *rpm*, the angle of twist across its

length is found to be 0.5 degrees.

The power transmitted by the shaft at this speed is _____ kW. (*Rounded off to two decimal places*)
Take $\pi = 3.14$.

61) Consider a mixture of two ideal gases, X and Y, with molar masses $\bar{M}_X = 10 \; \frac{kg}{kmol}$ and $\bar{M}_Y = 20 \; \frac{kg}{kmol}$, respectively, in a container. The total pressure in the container is $100 \; kPa$, the total volume if the container is $10 \; m^3$ and the temperature of the contents of the container is $300 \; K$. If the mass of gas-X in the container is $2 \; kg$, then the mass of the gas-Y in the container is _____ kg.(*Rounded off to one decimal place*)
Assume that the universal gas constant is $8314 \; J \; kmol^{-1}K^{-1}$.

62) The velocity field of a certain two-dimensional flow is given by

$$\mathbf{V}(x, y) = k\left(x\hat{i} - y\hat{j}\right)$$

where $k = 2 \; s^{-1}$. The coordinates x and y are in meters. Assume gravitational effects to be negligible. If the density of the fluid is $1000\frac{kg}{m^3}$ and the pressure at the origin is $100 \; kPa$, the pressure at the location $(2 \; m, \; 2 \; m)$ is _____ kPa.
(*Answer in integer*)

63) Consider a unidirectional fluid flow with the velocity field given by

$$\mathbf{V}(x, y, z, t) = u(x, t) \; \hat{i}$$

where $u(0, t) = 1$. If the spatially homogeneous density field varies with time t as

$$\rho(t) = 1 + 0.2e^{-t}$$

the value of $u(2, 1)$ is _____.(*Rounded off to two decimal places*)
Assume all quantities to be dimensionless.

64) The figure shows two fluids held by a hinged gate. The atmospheric pressure is $P_a = 100 \; kPa$. The moment per unit width about the base of the hing is _____ $\frac{kNm}{m}$.(*Rounded off to one decimal place*)
Take the acceleration due to gravity to be $g = 9.8\frac{m}{s^2}$.
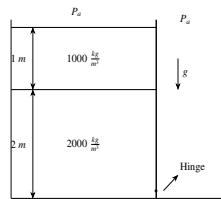
65) An explosion at time $t = 0$ releases energy E at the origin in a space filled with a gas of density ρ. Subsequently, a hemispherical blast wave propagates radially outwards as shown in the figure. Let R denote the radius of the hemisphere blast wave. The radius R follows the relationship $R = kt^a E^b \rho^c$, where k is a dimensionless constant. The value of exponent a is _____.
(*Rounded off to one decimal place*)