Probability And Statistics for Engineers And Scientists (4th Edition)

Chapter 5.2, Problem 4P

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Problem

Recall Problem where metal plate thicknesses are normally distributed with a mean of 4.3 mm and a standard deviation of 0.12 mm.

> (a) If one metal plate is placed on top of another, what is the distribution of their combined thickness?
>
> (b) What is the distribution of the average thickness of 12 metal plates?
>
> (c) What is the smallest number of metal plates required in order for their average thickness to be between 4.25 and 4.35 mm with a probability of at least 99.7%?

Problem

The thicknesses of metal plates made by a particular machine are normally distributed with a mean of 4.3 mm and a standard deviation of 0.12 mm.

> (a) What are the upper and lower quartiles of the metal plate thicknesses?
>
> (b) What is the value of c for which there is 80% probability that a metal plate has a thickness within the interval [4.3 –c, 4.3 + c]?

Step-by-step solution

1. **Step 1 of 4**

   Given information is related to thicknesses of a metal plate.

   Let X a random variable related to thicknesses of a metal plate.

   Given that the random variable X follows normal distribution with mean $\mu = 4.3 \text{ mm}$ and standard deviation $\sigma = 0.12 \text{ mm}$.

   Comment

2. **Step 2 of 4**

   (a)

   Let the random variable X be the distribution of their combined thickness, it is given by

   Therefore, the distribution of their combined thickness is.

   $$X \sim N\left(\mu_1 + \mu_2, \sigma_1^2 + \sigma_2^2\right)$$
   $$X \sim N\left(4.3 + 4.3, 0.12^2 + 0.12^2\right)$$
   $$X \sim N\left(8.6, 0.0288\right)$$

   Comment

   $$\boxed{X \sim N\left(8.6, 0.0288\right)}$$

3. **Step 3 of 4**

   (b)

   The distribution of the individual thicknesses of metal plate is.

   Consequently the average thicknesses of 12 metal plates is distributed as follows:

   $$\boxed{X \sim N\left(4.3, 0.12^2\right)}$$

   Therefore, the distribution of the average thicknesses of 12 metal plates is

   Comment

$$\bar{X} \sim N\left(\mu, \frac{\sigma^2}{n}\right)$$

$$\bar{X} \sim N\left(4.3, \frac{0.12^2}{12}\right)$$

$$\bar{X} \sim N(4.3, 0.0012)$$

$$\boxed{\bar{X} \sim N(4.3, 0.0012)}$$

4. **Step 4 of 4**

(c)

Let n be the smallest number of metal plates.

Calculate the value of n by using the following notation:

$$n \geq 51$$

Therefore, the minimum number of metal plates required should be $\boxed{n \geq 51}$.

$$P(4.25 \leq \bar{X} \leq 4.35) \geq .997$$

$$2(Z_{0.0015} \times \sigma) \leq 1 - 0.99$$

$$2.9677 \times \frac{0.12}{\sqrt{n}} \leq 0.05$$

$$\sqrt{n} \geq \frac{2.9677 \times 0.12}{0.05}$$

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