The mean inside diameter of a sample of 250 washers produced by a machine is 5.05 *mm* (millimeters) and the standard deviation is 0.05 *mm* (millimeters). The purpose for which these washers are intended allows a maximum tolerance in the diameter of 4.95 *mm* to 5.10 *mm*, otherwise the washers are considered defective. Determine the percentage of defective washers produced by the machine assuming the diameters are normally distributed.

Solutions

**First Method (Using Table and for attempt in exam)**

Let Inside Diameter of Washers

**Probability of Maximum Tolerance Limit in the diameter**  
(i.e., Minimum inside diameter of a washer should be 4.95 millimeters and maximum inside diameter of a washer should be 5.10 millimeters)

Standardizing with variable with zero mean and unit variance. i.e.,

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **0.00** | 0.01 | 0.02 | 0.03 |
| 0.8 | **0.78814** | 0.79103 | 0.79389 | 0.79673 |
| 0.9 | **0.81594** | 0.81859 | 0.82121 | 0.82381 |
| **1.0** | **0.84134** | **0.84375** | **0.84614** | **0.84849** |
| 1.1 | **0.86433** | 0.86650 | 0.86864 | 0.87076 |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **0.00** | 0.01 | 0.02 | 0.03 |
| 1.8 | **0.96407** | 0.96485 | 0.96562 | 0.96638 |
| 1.9 | **0.97128** | 0.97193 | 0.97257 | 0.97320 |
| **2.0** | **0.97725** | **0.97778** | **0.97831** | **0.97882** |
| 2.1 | **0.98214** | 0.98257 | 0.98300 | 0.98341 |

The washers will be considered defective if the inside diameter of the washers lies outside the tolerance limits. i.e.

**Second Method (Using CASIO)**

Find the probability of washers being defective.

The tolerance range is given as follows

The probability of washers being defective is as follows

**Third Method (Using Definite Integrals)**

1. Direct Method

Tolerance Limit

Probability of washers being defective

1. First, Transform Tolerance Limit into standard normal distribution as already attempted in first method i.e.,

Probability of washers being defective