Review from lecture 1 — Monday, Sep 28, 2015

- Definition of Mechanical Design
- Uncertainty => 220 MPa
  220 ± 10 MPa
  220 ± 5% MPa

- Design Factor
- Safety Factor (Factor of Safety)

Selection of Design Factor

- subjective
- follow industry Standards

Factor of safety → Design Factor

Depends on:

- degree of uncertainty about loading
- degree of uncertainty about material strength and structure
- consequences of failure → human safety, economics
- cost of providing a high safety factor

reliability method of design

stochastic method

distributions strength and stress

reliability, R

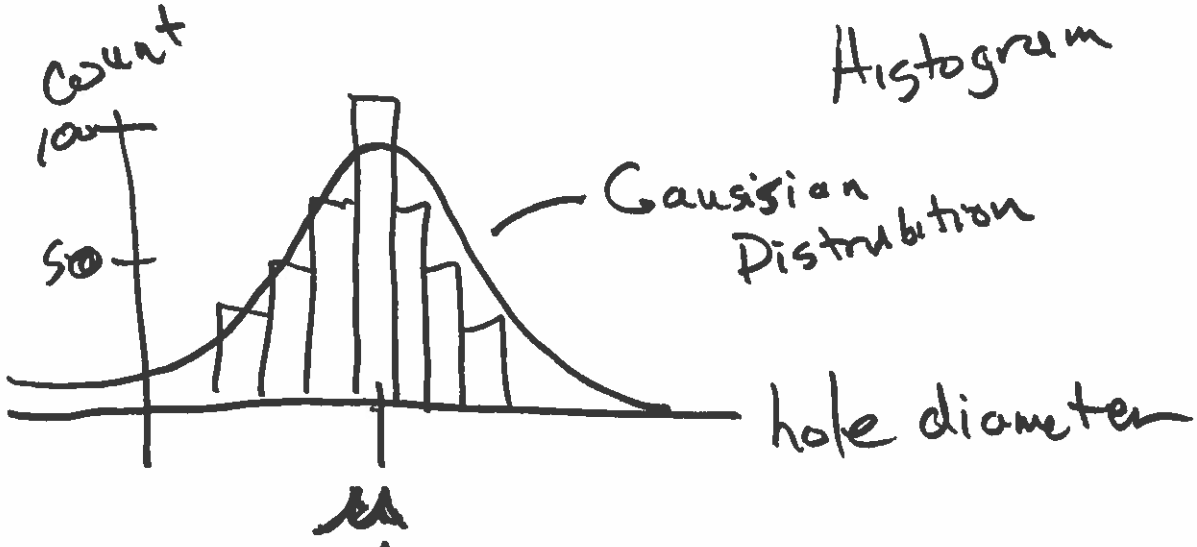
statistical measure

probability that something won't fail

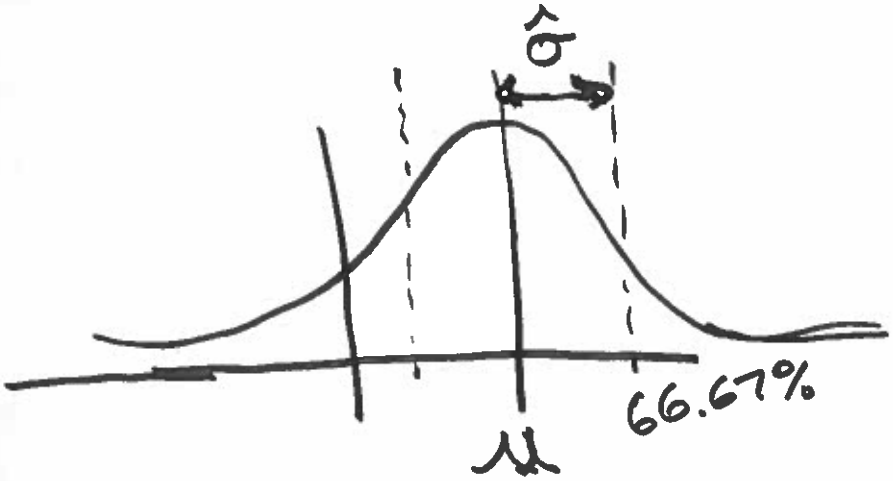
probability of failure, P_f

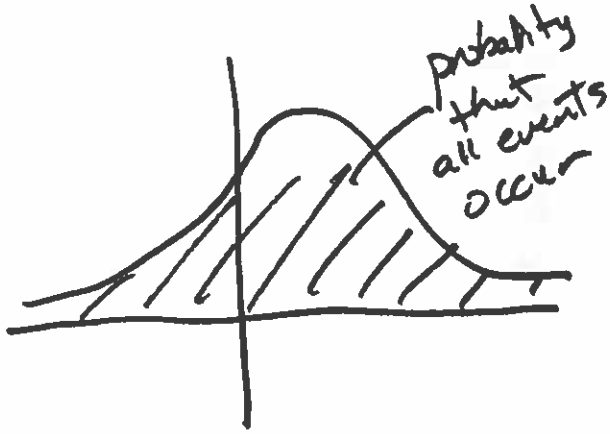
probability that something will fail

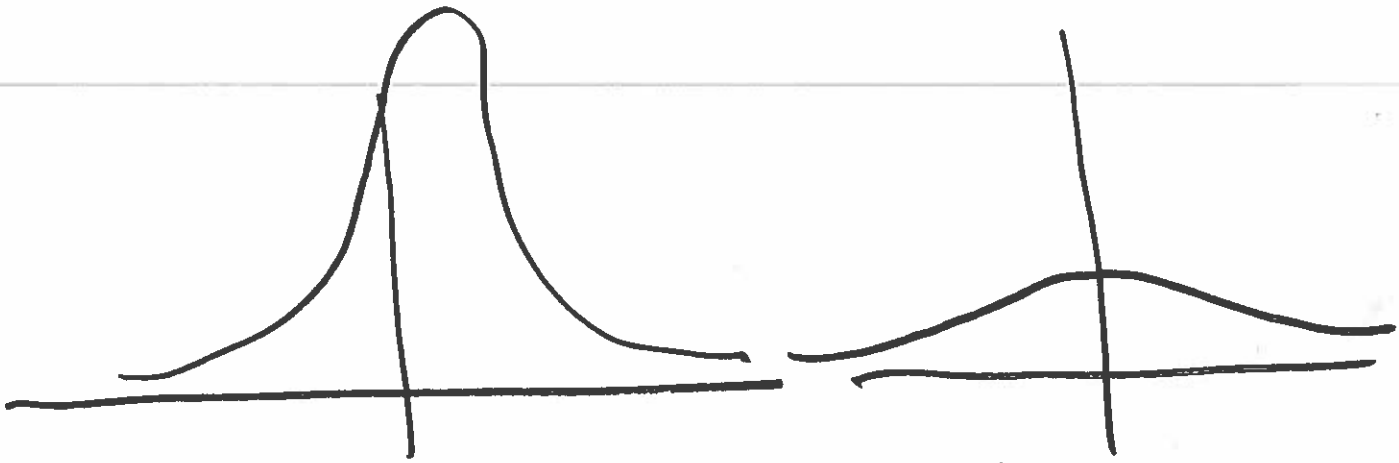
$$1 - R = P_f$$



μ: mean σ: standard deviation







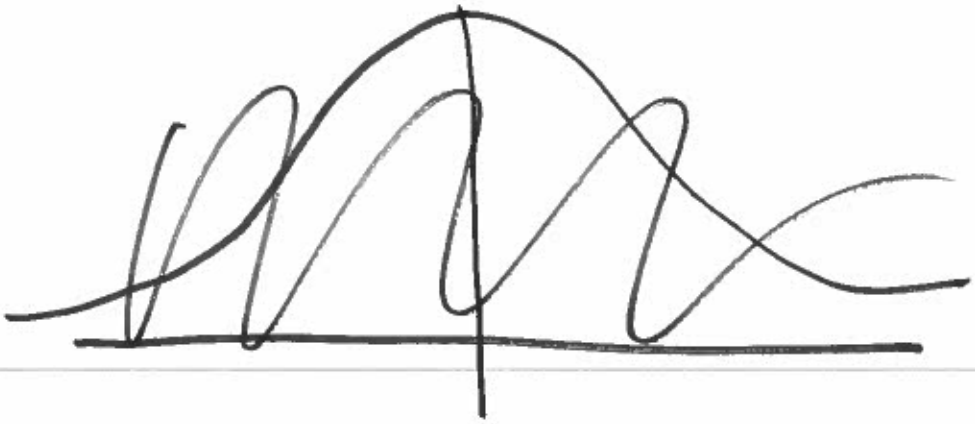
$\hat{\sigma}$ small

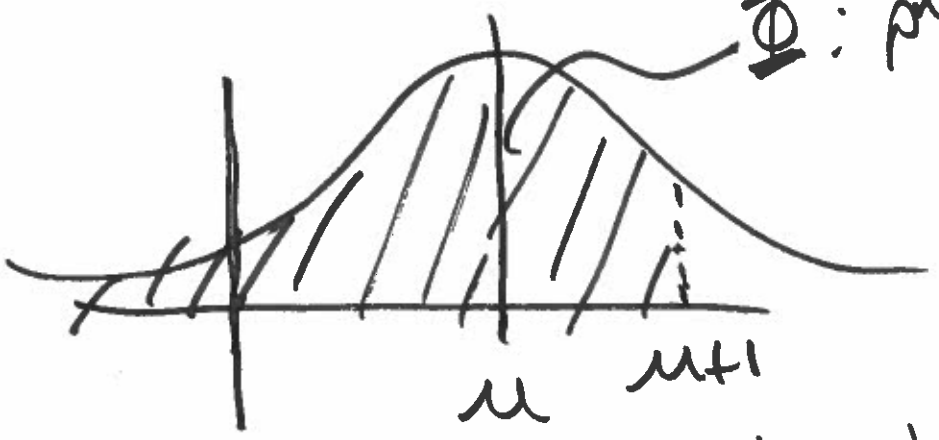
$\hat{\sigma}$ large

Probability Distribution Function

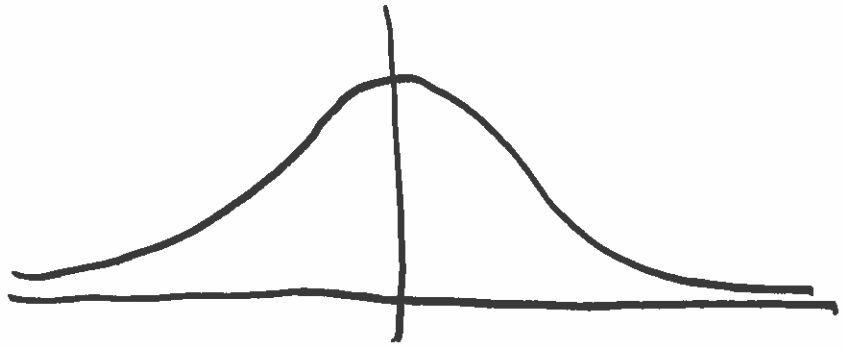
$$f(x) = \frac{1}{\hat{\sigma}\sqrt{2\pi}} e^{\left[-\frac{1}{2}\left(\frac{x-\mu}{\hat{\sigma}}\right)^2\right]}$$

$$\int_{-\infty}^{\infty} f(x) \Rightarrow 100\% \text{ probability}$$





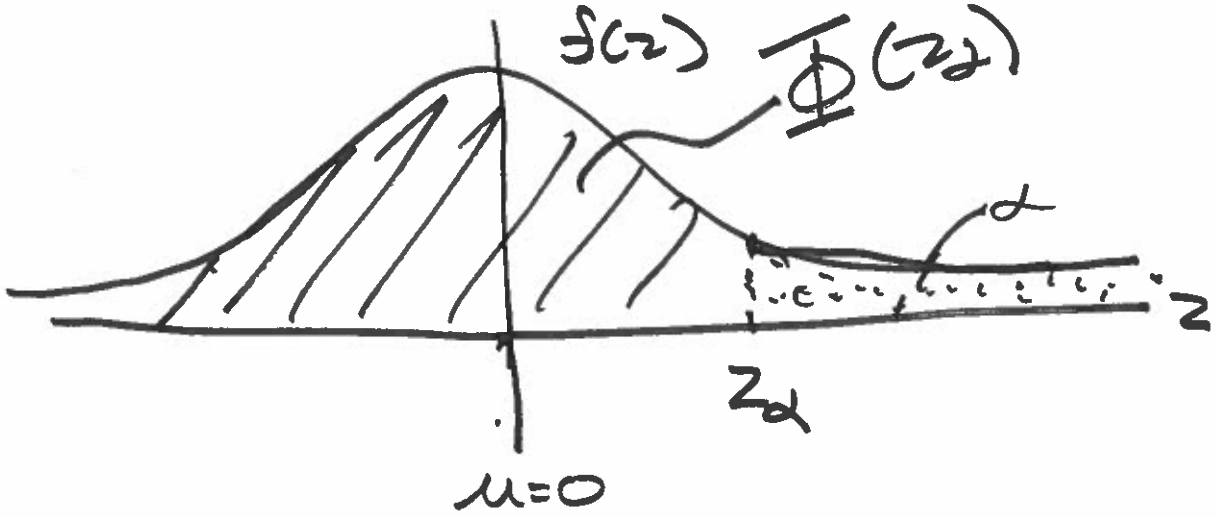
What is the probability that the observation is less than $\mu+1$?



$\mu = 0$

$\hat{\sigma} = 1$

$$Z = \frac{X - \mu}{\hat{\sigma}}$$

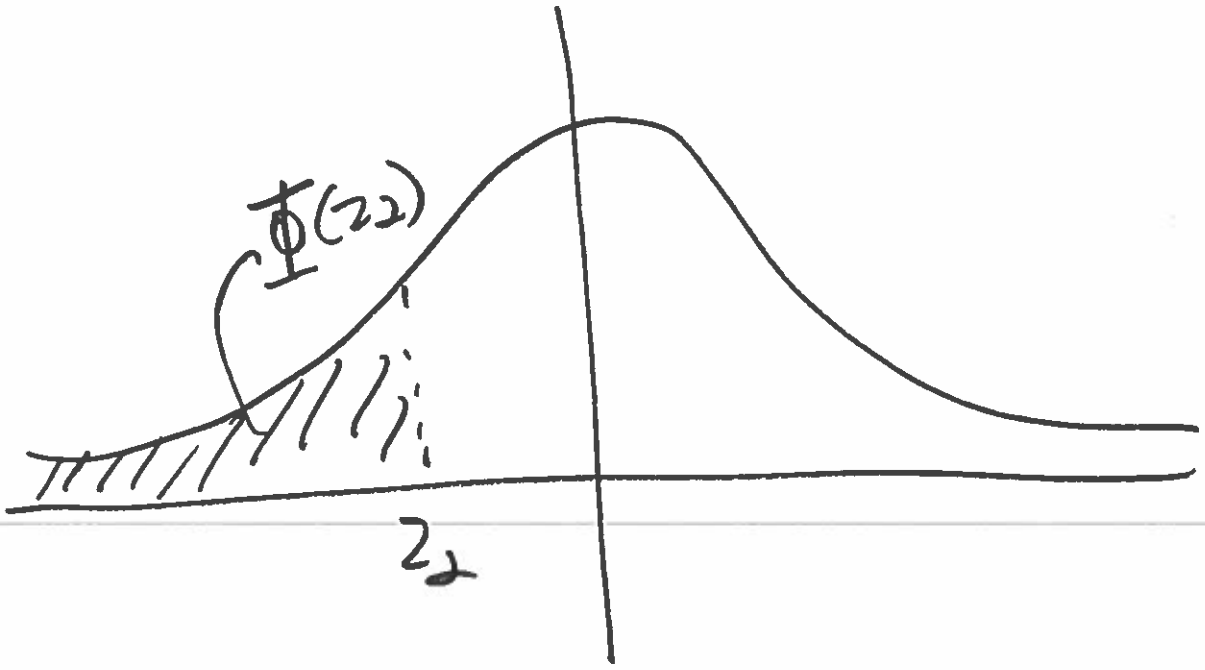


$z_\alpha > 0$

The probability that occurrence is less than z_α

↳ $1 - \Phi(z_\alpha)$

$\alpha =$



$z \leq 0$

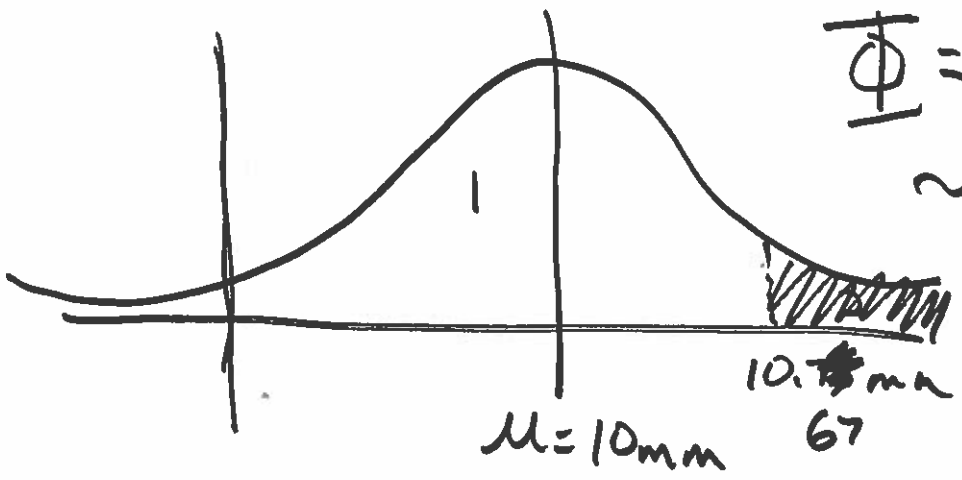
probability $\Phi(z_2)$

1M parts, measure 1000 of them to build a histogram of hole diameters

$\mu_d = 10\,mm$

$\hat{\sigma}_d = 0.5\,mm$

What is the probability that ~~a diameter~~ a randomly chosen part has a diameter $> 10.67\,mm$?



$\Phi = 0.0901$

$\sim 90K > 10.67\,mm$

$$Z = \frac{d - \mu_d}{\hat{\sigma}_d} = \frac{10.67\,mm - 10mm}{0.5\,mm} = 1.34$$

Table A-10

Cummulative Distribution Function of Normal (Gaussian) Distribution

See the "Standard Normal Table" on Wikipedia for equivalent.

What is the probability of occurrence for less than z = -1.23?

A. 0.1151
B. 0.1093
C. 0.8907
D. 0.8849

Tolerances

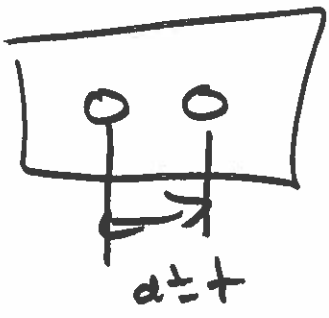
- uncertainty
- bounds (size, shape)

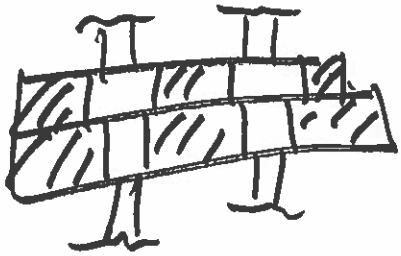
1.000 ± 0.001"

↑ is not ~~$\pm$~~ typically $\hat{\sigma}$

- tight tolerances = highe cost
- loose tolerances in general
- tight tolerance only if necessary

Dimensioning





SI: ~~Eng~~
International System of Units

US: US customary units
Burma, Liberia