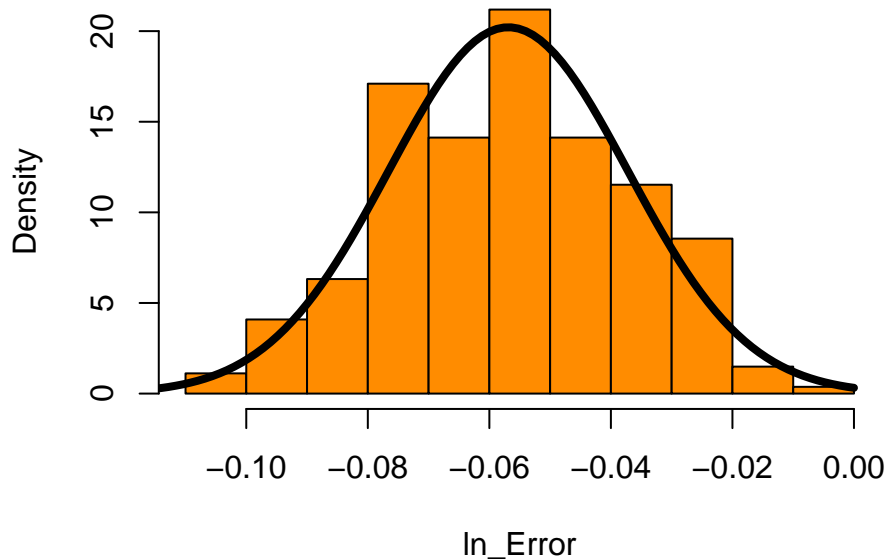


## ESD-FYS - module 4-1 - exercises - suggested answers

Component variation: Capacitor

```
Cap220=read.csv(url("https://asta.math.aau.dk/datasets?file=capacitor_lot_220_nF.txt"))[,1]
ln_Error=log(Cap220/220)
hist(ln_Error,breaks="FD",col="darkorange",prob=TRUE)
s=sd(ln_Error)
m=mean(ln_Error)
curve(dnorm(x,m,s),-.12,0,lwd=4,add=TRUE)
```

**Histogram of ln\_Error**



With the population curve added.

```
t.test(ln_Error)

##
## One Sample t-test
##
## data: ln_Error
## t = -47.278, df = 268, p-value < 2.2e-16
## alternative hypothesis: true mean is not equal to 0
## 95 percent confidence interval:
## -0.05925865 -0.05452044
## sample estimates:
## mean of x
## -0.05688955

load(url("https://asta.math.aau.dk/datasets?file=cap_1pct.RData"))
fit <- lm(log(capacity) ~ log(nomval), data = capDat)
summary(fit)

##
## Call:
## lm(formula = log(capacity) ~ log(nomval), data = capDat)
##
```

```
## Residuals:
##      Min       1Q   Median       3Q      Max
## -0.0064121 -0.0010784  0.0007315  0.0013879  0.0050839
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept) -0.0300145  0.0011907  -25.21  <2e-16 ***
## log(nomval)  1.0002636  0.0002648 3776.74  <2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.003101 on 498 degrees of freedom
## Multiple R-squared: 1, Adjusted R-squared: 1
## F-statistic: 1.426e+07 on 1 and 498 DF, p-value: < 2.2e-16
```

```
ab<-coef(fit) # a vector of the form (intercept,slope)
ab
```

```
## (Intercept) log(nomval)
## -0.03001454  1.00026359
```

```
ln_Error_corrected<-(ln_Error - ab[1])/ab[2]
t.test(ln_Error_corrected)
```

```
##
## One Sample t-test
##
## data:  ln_Error_corrected
## t = -22.335, df = 268, p-value < 2.2e-16
## alternative hypothesis: true mean is not equal to 0
## 95 percent confidence interval:
##  -0.02923641 -0.02449944
## sample estimates:
##  mean of x
## -0.02686793
```

```
s=sd(ln_Error_corrected)
m=mean(ln_Error_corrected)
m+3*c(-1,1)*s
```

```
## [1] -0.08605868  0.03232283
```

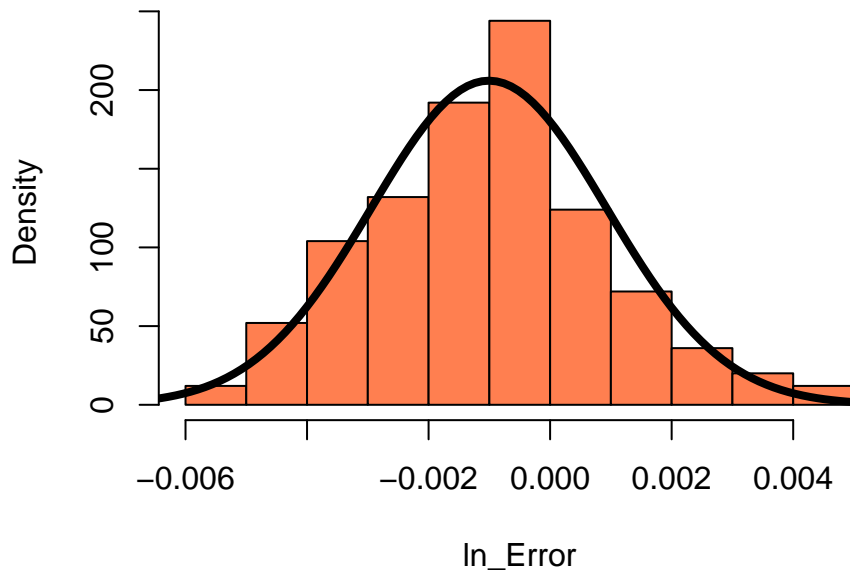
```
cv=sqrt(exp(s^2)-1)
M=exp(m+s^2/2)
M*(1+3*c(-1,1)*cv)-1
```

```
## [1] -0.08395912  0.03131773
```

### Component variation: Resistor

```
R1000=read.csv(url("https://asta.math.aau.dk/datasets?file=0hm.txt"))[,2]
ln_Error=log(R1000/1000)
hist(ln_Error,breaks="FD",col="coral",prob=TRUE)
s=sd(ln_Error)
m=mean(ln_Error)
curve(dnorm(x,m,s),-.007,.005,lwd=4,add=TRUE)
```

## Histogram of ln\_Error



With the population curve added.

```
t.test(ln_Error)
```

```
##  
## One Sample t-test  
##  
## data: ln_Error  
## t = -8.219, df = 249, p-value = 1.133e-14  
## alternative hypothesis: true mean is not equal to 0  
## 95 percent confidence interval:  
## -0.0012482278 -0.0007656399  
## sample estimates:  
## mean of x  
## -0.001006934
```

```
s=sd(ln_Error)  
m=mean(ln_Error)  
m+3*c(-1,1)*s
```

```
## [1] -0.006818238 0.004804371
```

```
cv=sqrt(exp(s^2)-1)  
M=exp(m+s^2/2)  
M*(1+3*c(-1,1)*cv)-1
```

```
## [1] -0.006810025 0.004800919
```

### WMM example 13.7

```
yield=c(9.7,5.6,8.4,7.9,8.2,7.7,8.1,  
10.4,9.6,7.3,6.8,8.8,9.2,7.6,  
15.9,14.4,8.3,12.8,7.9,11.6,9.8,  
8.6,11.1,10.7,7.6,6.4,5.9,8.1,  
9.7,12.8,8.7,13.4,8.3,11.7,10.7)
```

```

batch=factor(rep(1:5,each=7))
data=data.frame(batch=batch,yield=yield)
fit=lm(yield~batch,data=data)
table=anova(fit)
table

## Analysis of Variance Table
##
## Response: yield
##           Df Sum Sq Mean Sq F value    Pr(>F)
## batch      4  72.596   18.149   4.4614 0.006003 **
## Residuals 30 122.040    4.068
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

SSA=table[1,2]
SSE=table[2,2]
k=length(unique(batch))
n=length(yield)/k
s_squared=SSE/k/(n-1)
s_alpha_squared=(SSA/(k-1)-s_squared)/n
s_squared

## [1] 4.068

s_alpha_squared

## [1] 2.011571

```