

# LABORATORY PRACTICES

## PHYSICS FOUNDATIONS ON COMPUTER SCIENCE

### *2<sup>nd</sup> PRACTICE: ERRORS ON MEASUREMENT*

## 2<sup>nd</sup> Practice: Errors

### Correct expression of errors

- *Two rules:*

1. The number of significant figures of absolute error must be only one (up to two if both figures make up a value < 25).
2. The last significant figure of measurement and absolute error must be of the same decimal order.

Examples:

Incorrect measurements

$48,721 \pm 0,32 \text{ V}$

$4,6 \pm 0,018 \text{ V}$

$563 \pm 30 \text{ cm}$

$872 \cdot 10^{-6} \pm 0,86 \cdot 10^{-4} \text{ N}$

$4,678 \cdot 10^{-8} \pm 4,6 \cdot 10^{-10} \text{ A}$

$0,23 \pm 3 \text{ }^{\circ}\text{C}$

Correct measurements

$48,7 \pm 0,3 \text{ V}$

$4,600 \pm 0,018 \text{ V}$

$560 \pm 30 \text{ cm}$

$8,7 \cdot 10^{-4} \pm 0,9 \cdot 10^{-4} \text{ N}$

$(4,68 \pm 0,05) \cdot 10^{-8} \text{ A}$

$0 \pm 3 \text{ }^{\circ}\text{C}$

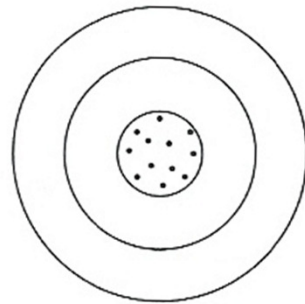
## 2<sup>nd</sup> Practice: Errors

### Random and systematic errors

- *Random errors:*
  - Are due to causes that randomly change measurement.
  - By its random character, can be statistically dealt with.
- *Systematic errors:*
  - Are due to some fault on measurement device or to the measurement method, modifying the result.
  - They are always produced in the same sense, and so can't be statistically dealt with.

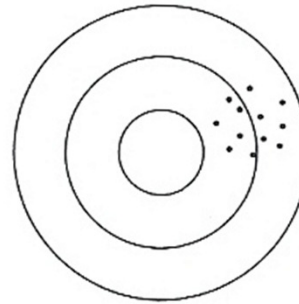
## 2<sup>nd</sup> Practice: Errors

### Random and systematic errors



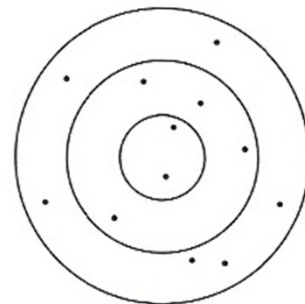
Random: Little  
Systematic: Little

(a)



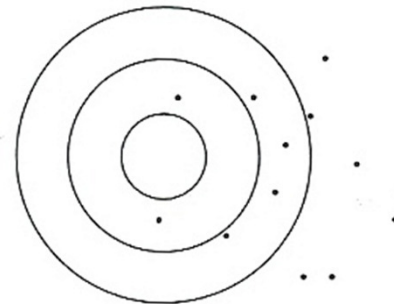
Random: Little  
Systematic: Big

(b)



Random: Big  
Systematic: Little

(c)



Random: Big  
Systematic: Big

(d)

## 2<sup>nd</sup> Practice: Errors

### Random and systematic errors



Random: Little  
Systematic: ?

(a)



Random: Little  
Systematic: ?

(b)



Random: Big  
Systematic: ?

(c)



Random: Big  
Systematic: ?

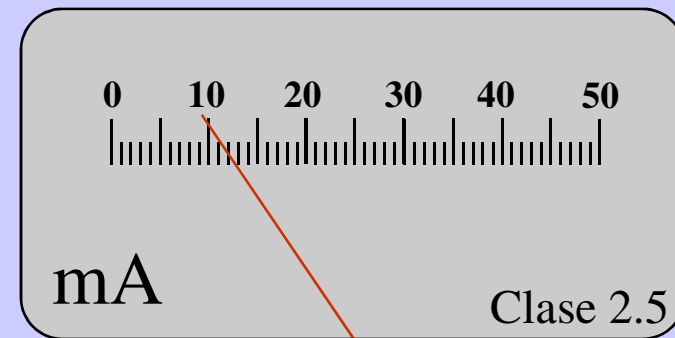
(d)

But if we don't know the true measurement (if we remove the bull's eye), then we can't say anything about the systematic error.

## 2<sup>nd</sup> Practice: Errors

### Computation of random error on electrical measurement devices

- *a) Analogic devices:*



- Absolut error = Class error + Reading error

- *b) Digital devices:*



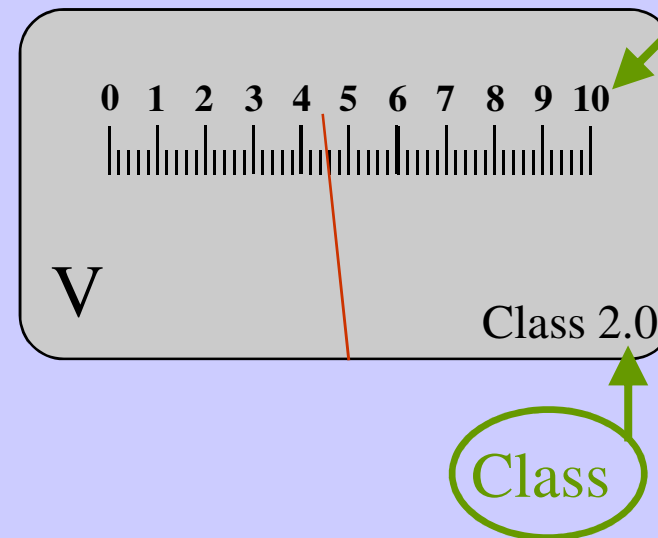
- Absolut error = Accuracy error + Reading error

## 2<sup>nd</sup> Practice: Errors

### Computation of random error on analogic devices

- *Analogic devices:*

- Class = 2
- Range/Full scale = 10 V
- 1 division = 0.2 V
- Reading = 4.6 V
- Class error =  $\text{Range} \times \text{Class} / 100 = 10 \times 0.02 = 0.2 \text{ V}$
- Reading error = 1 division = 0.2 V
- Absolut error = Class error + Reading error =  $0.2 + 0.2 = 0.4 \text{ V}$



**MEASUREMENT:  $4.6 \pm 0.4 \text{ V}$**

## 2<sup>nd</sup> Practice: Errors

### Computation of random error on digital devices

- *To know the error on digital devices, on first we must look at the technical data sheet of the device.*
- *On web site/Practices/Practice 2 you'll find technical data sheet of measurement devices.*



## 2<sup>nd</sup> Practice: Errors

### Computation of random error on digital devices

- *Digital devices:*

- Accuracy = 0.05 %
- Reading error = 3d
- Reading = 4.285 mA
- Accuracy error =  $\text{Accuracy} \times \text{Reading} / 100 = 0.05 \times 4.285 / 100 = 0.0021425 \text{ mA}$
- Reading error =  $3 \times 0.001 = 0.003 \text{ mA}$
- Absolut error =  $\text{Accuracy error} + \text{Reading error} = 0.0051425 = 0.005 \text{ mA}$



**MEASUREMENT:  $4.285 \pm 0.005 \text{ mA}$**

## 2<sup>nd</sup> Practice: Errors

### Computation of absolute error of a linear fitting on Excel

- When you perform a linear fitting with Excel spreadsheet, the error of linear fitting can be got by using the function “*Estimacion.lineal*” on Excel.
- Instructions to handle this function can be found on document “Errors with Excel”, on website/Practices/Practice 2.

## 2<sup>nd</sup> Practice: Errors

### Carrying out and report

- On practice guide you'll find the task to be done and the instructions for the report. Remember to send me the report on time. One report each group (two tables)

## NEXT PRACTICE:

### 3<sup>d</sup> Practice: The Oscilloscope

BEFORE COMING TO NEXT LAB SESSION YOU HAVE TO:

- See the videos about handling of function generator and digital oscilloscope.
- See the video with the slides and experimental assembly.
- Read the practice guide (the first part contains the matter of video) and prepare the carrying out of lab session (second part of guide).