EPFL

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microtechnique
microengineering
section

Illustration Image

Guide and Microsoft Word Template for Scientific reports

LATEK reports should follow the same recommendations in terms of structure and content

(Semester and Master Projects)

Student full name
Master program

Location, Date:
Lab name

Assistants: Professor:
xx   name of Prof or MER
yy

INTRODUCTION

The purpose of this guide and template is to help you, the student, with writing good reports.

We emphasise that these are only guidelines. As a consequence these rules should be applied with intelligence. These guidelines are based on a manual of many years ago by teachers in Holland with additions from other sources and updated with input from a number of people at EPFL. For further reference, you may consult the recommendations by M. Whitesides [1] or the ANSI/NISO Norm Z39.18-1995 [2]. Suggestions for improvements, from teachers and students, are always welcome.

The template includes some recommendations for your semester/master thesis project reports' layout. The aim is to provide guidelines for a well readable report layout so that you can begin writing your report without loss of time for layout issues.

1   THE AIMS OF A REPORT

The purpose of a report is to transmit **coherent information** on a subject to the target readers.
Reports at the EPFL are usually technical and should be based on verifiable facts or experiments.
It is not a chronological description of your work.
Obviously, the requirements of your readers (and tutors especially) must be taken into account: what information is requested, how much does the reader know already, what interests him/her?

Write your report in such a way that your fellow students will be able to understand it and can put the contained information to use.
Semester and master reports may be part of a larger project. The success of the project may be influenced by the quality of the report. A clear and critical problem description and a well-motivated solution form an important contribution to the goal to be reached. A report is often the starting point for a next phase in the project. Therefore, a thorough description of the experiments and results are important, as well as clearly formulated conclusions.

Note: copying someone else's work is not allowed! If you cite work/results from other sources, it is mandatory to cite them properly with a reference or footnote.

2 HOW TO STRUCTURE A REPORT

2.1 The basis

It starts with clear and complete notes that you take during your work. You should keep a well-organized notebook in which you put all information that relates to your project: study, notes, designs, discussion notes, measurements, calculations, failures, graphs etc.

During this time you should already work out and discuss some of your material for inclusion in your report, and plan on how you will present your work.

2.2 Realisation

There are many ways to do it, but what follows is, we think, a useful suggestion of how you can do it.

a. **First phase: inventory.**

   Write on a large piece of paper or in your word processor all main items that you must include in your report. Check the project description and your notes to see if you forgot something.

b. **Second phase: order and selection (see next).**

   Make a draft chapter division. Try to include all the main items in these chapters, and adapt them if needed. Order the chapters and items in a logical way. Do not hesitate to put at the beginning what you did at the end if it makes more sense.

c. **Third phase: write your report (see the next chapters for details).**

d. **Fourth phase: checking**

   Read your report from start to end. You can also ask someone else to examine it and comment on it.

3 STRUCTURING YOUR REPORT

Your report is meant to transmit relevant information, understanding and know-how that you developed during the project. Present it in a coherent, scientific way. In practice there is not much difference between semester and master reports. Typical layout:

- Title
- Summary (Project description for the section)
- Table of Contents
- Introduction
- Body of the report, with for example:
    - theory
    - design and motivation
    - design realisation
    - measurement set-up
    - results and discussion
- Conclusions
- List of symbols
- Literature list
- Appendices (may be put ahead of "Literature")

It is difficult to give a strict limitation to the size of the report and the number of pages. As mentioned above, the report should "transmit relevant information, understanding and know-how that you developed during the project. Present it in a coherent, scientific way."
We can reasonably expect that a semester project should not exceed 40 pages without appendix, and a Master thesis without appendix should be limited to 60 pages.

Some clarifications:

3.1 Title

A title like "Silicon microfluidics" is insufficient. "Silicon microfluidic sensors" is better but lacks information on what has been done. Again better is for example "Fabrication and test of silicon microfluidic sensors". And "Realisation and test of a novel microfluidic sensor" is more appealing.
On the title page belong as well:
- Name of writer
- Master program affiliation
- Time period or date
- Institute where the work was done
- Names of professor, assistants

3.2 Summary with Project description

Here you give the description as formulated at the start. Inform the reader about the purpose, used methods and results; give the main conclusions and recommendations. Stress novelty and possible impact.

3.3 Table of contents

The chapters and sections (and if you like, subsections) are mentioned with their page number.

3.4 Introduction

Indicate in more detail the purpose, background, starting points and limitations. Explain briefly your approach and what is new. Explain and list in details your own contribution vs

the gobal context/work done by others. You can include acknowledgements to the persons involved in the project, or add Acknowledgements before the Introduction.

3.5   Body of the report

This will be split up in several chapters, depending on the work that has been done. Nevertheless, the body should be logical and fluent. Transmit your message in the form of coherent information, which is not necessarily a historical description. In accord with the point of depart as formulated in the introduction, you should build up the subject matter in a logical way. All matter that you feel should be in the report but does not fit with that logic has to go to the appendix. Where appropriate you can refer to that in the text.
Examples of items in the body of the report:

- Theoretical background
- Reasons, motivations for design choices
- Key design or layout
- Simulations / calculations
- Key aspects of realisation
- Choice of measurement method or set-up
- Discussion of results

3.6   Conclusions

This is a very important part of a report. Give all relevant conclusions, even negative. Stress novelty and scientific or industrial impact. Also new insights, outlook and recommendations for improvement should be put here. However, do not introduce results or concepts that belong in the body of the report. Bring structure in your conclusions.

3.7   Symbol list

A report with a large number of symbols benefits from a symbol list. It should have **all** used symbols, preferably in alphabetic sequence (small letters, capital letters, Greek). Indicate both meaning and units. Try to adapt generally used symbols, and avoid the use of the same symbol for different meanings. Also non-standard abbreviations can be added here. Abbreviations are introduced ones at their first appearance and then used later on throughout the text.

3.8   Literature list

See section 5.6

3.9   Appendices

Hereunder fall items that would interrupt the fluidity of the body of the report, such as:
- Long derivations of formulas,
- Calculations that would interrupt the body of the report (keep them compact)
- Large tables with measurements or calculated results
- Large drawings and schemes or layouts, series of pictures
- Part lists and computer simulation print-outs (listings, runs)

The report must be understandable without the appendixes and contain all the important information.

4 THE INSIDE OF A REPORT

4.1 Page Layout

The page layout is based on the DIN A4 format. The side margins allow a good binding of the document on the left side in case it is printed out. A larger margin on the 'glue-bounded' side of the page is therefore used. **The margins in this template are for a printout as single-sided documents**: Left 3.2 cm, Right 2 cm, Top and Bottom 2.5 cm. If you plan to print out your thesis for personal use, we recommend that you use double-sided printing, remember to adjust the margins: on even-numbered pages (left pages), the left margin equals 2 cm and the right 2.7 cm. Odd-numbered pages (right pages) have a 2.7 cm left margin and a 2 cm right margin. You can control the difference in margin size, headers and footers between left and right pages in the Page Setup menu.

4.2 Headers and Footers

Edit the header and footers by either clicking on them or choosing from the Menu 'View – Headers and Footers'. The three tab stops facilitate the alignment on the left, centre and right side.

4.3 Using Styles

A minimum number of styles were used for this template: Heading 1, Heading 2 and Heading 3, corresponding to three heading levels. Additionally Table of Contents Styles, Title, Caption and some more styles for the Abstract Page. You can change them with Format – Styles and Formatting.

4.3.1 Styles and Table of Contents

Using the heading styles allows to insert and update automatically the table of contents from the headings used. Update the table by right-click, then 'Update Field'; Insert – Reference – Index and Tables – Table of Contents.

4.3.2 Inserting a Literature Reference

In this template, the endnote function is used for the references on articles. You can insert an endnote by choosing 'Insert' – 'Reference' – 'Footnote', then choosing the option 'Endnote', as for example done for the article on Magnetic Resonators by Olivier Martin [3].

4.4 Chapters and contents

Start each chapter on a new page. Use large margins (ca. 3 cm left margin, top and bottom). Place pictures near the relevant text. Group the information in paragraphs.

4.5 Numbering

4.5.1 Chapters and sections

Preferably use a decimal enumeration system such as in this manual. The summary, appendices, literature list and symbol list are usually not numbered.

4.5.2 Formulas

Essential formulas and formulas that are referred to in other places in the report should be numbered. For example:

$$f = 0.5\sqrt{s/m} \tag{1}$$

If you do not have many formulas (say less than 20), you can use this type of numbering; otherwise you can use (3.1) etc., referring to the chapter that the formula is in.

4.5.3 Tables
Tables should be numbered, and indicated: Table 1, Table 2 (or Table 3.1, Table 3.2).

4.5.4 Figures
All graphics that are placed in-between the text, such as drawings, graphs, pictures are called "figure". The figures are placed close to the related text. You can number them Figure1, Figure 2 etc. (or Fig.3.1, Fig.3.2).

Together with the numbering you include a clear figure caption that should be self-explaining: all the relevant information has to be in the figure and figure caption. State clearly what is shown: "Measured…", "Simulated…", "Theoretical…", "Comparison…",

4.5.5 Appendices
If you have many that can be grouped into types:

        Graph A. First DC current measurement
        Graph B. First AC current measurement
        Mask 1. Back side
        Mask 2. Front side
        Mask 3. Metallisation

You indicate these in the Table of Contents as:
        Graphs
        Mask layouts

4.6 Figures

Indicate graphs, pictures and drawings with "Figure" or "Fig.". Unfortunately, word does not allow different styles for different caption labels, but you can copy-paste the caption for other figures preserving in such a way the formatting.

Examples of a bad presentation (Fig.1) and good presentations (Fig.2 and Figure 1):
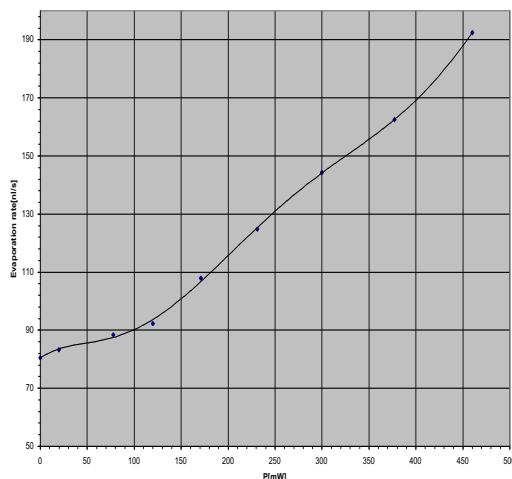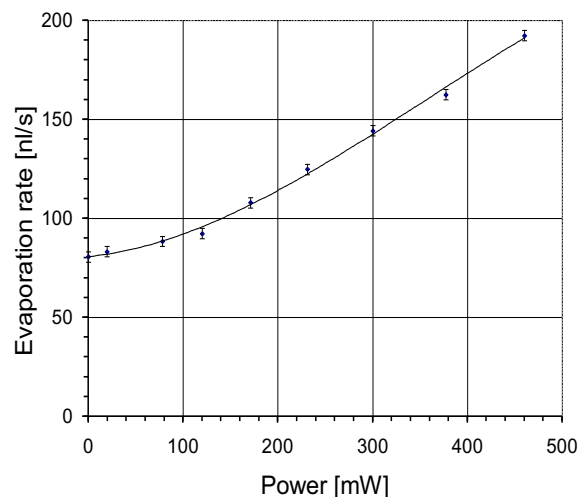

Fig.1. First results

Fig.2. Measurement of evaporation rate as function of input power (third order fit).
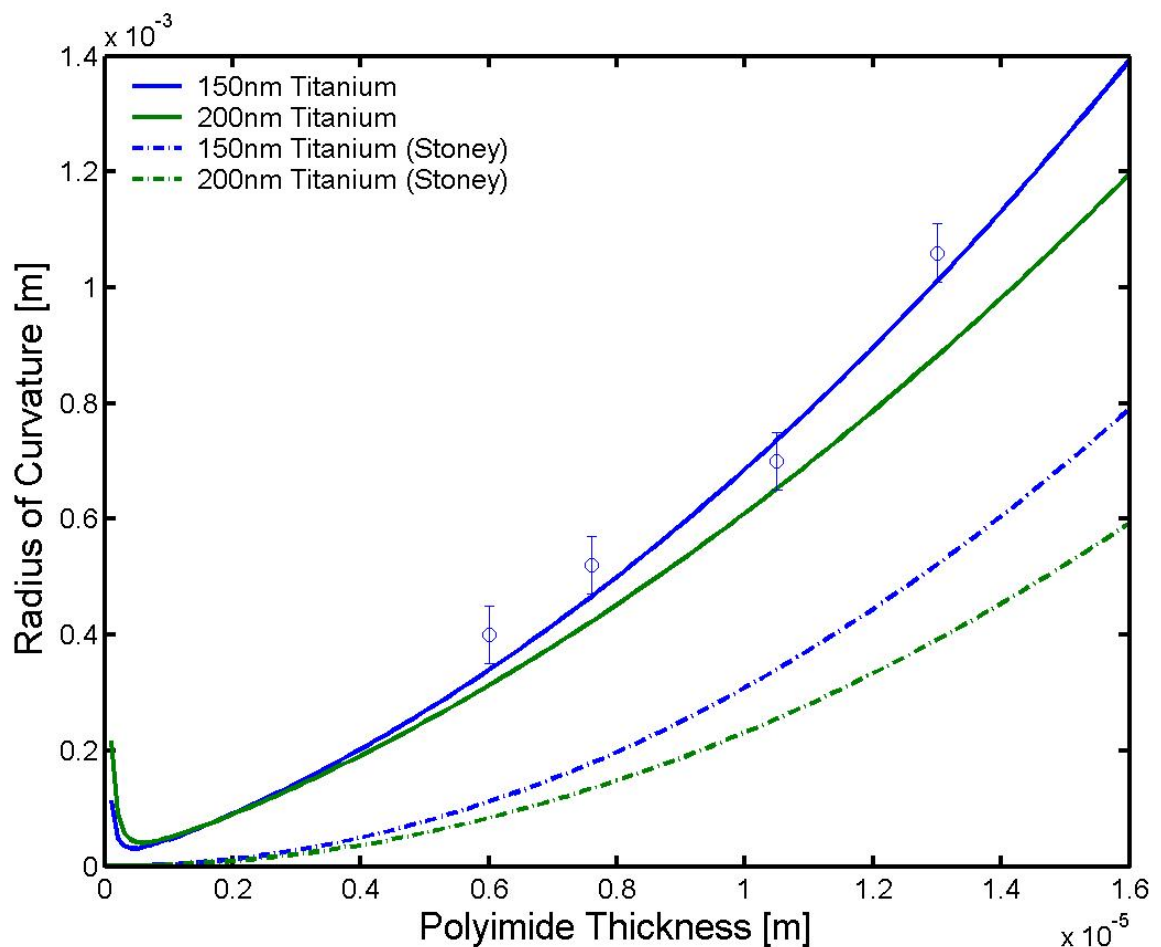
Figure 3 *– Radius of curvature measured as a function of the polyimide thickness for bimorph structures using a polyimide PI2525 layer and a titanium layer. The measurements are represented as dots with their respective measurement incertitude. For comparison, the complete analytic formula is represented in solid lines and the approximate Stoney formula in dashed lines for a titanium thickness of 150 nm and 200 nm respectively.*

4.6.1 Axes

a. **Horizontally** (x) you put the **independent variable** (the cause) and **vertically** (y) the **dependent variable** (the result). For example, if you measure the resistance as function of the temperature: then you put the resistance on the vertical axis. But if you measure the temperature as function of a heater resistance, you put the temperature on the vertical axis.

b. Divisions on the axes:

   o   The space should be used efficiently.

   o   Divide the axes in multiples of 1, 2, 5, 10 (etc.) units ("ticks") in a readable way.

   o   Consider the use of logarithmic divisions; realise what is useful and/or common.

   o   Usually the axes go preferably through the origin (0,0).

   o   Use exactly the same layout for two results that you want to compare (identical axes).

- o Near the axes you indicate the variable (preferably a symbol) and the units: e.g. I [mA] or t [s]. Describe what exactly is plotted as function of what.

- o If you don't start at 0, it's good to emphasize it (draw it yourself):
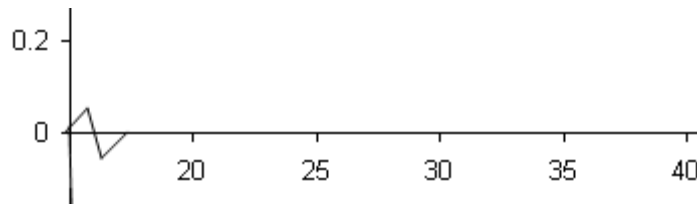
4.6.2 Measurement points

- Include all measurement points, also the ones that seem to be out of range. Make them sufficiently large to see them after you draw a line through them.

- Make sure when you do the measurements that the points will be well distributed. Where the graph behaves strangely (resonance peaks and so on) there should be more points (hopefully you realised that when doing the measurement!).

- It is useful to give an inaccuracy estimation with error bars (especially for large errors).

4.6.3 Lines

- Draw a smooth line without trying to exactly force them through all points, in accord with theory (expectation) and common sense (error bars are helpful for that). In some cases it is not beneficial to draw a line at all.

- Use different line styles, especially for lines that are close together or have a different meaning, such as theory and measurement (solid, dashed,..).

- If theory predicts that the points lie on a straight line, draw a straight line as good as possible through the points. If theory predicts the line to go through the origin, show the origin in the graph. It may be a good or a bad choice to force the line through the origin (comment on it in the text if you think there is an offset of some kind).

4.7 Number presentation

In general you should not give less, but also not **more** decimals than what is meaningful or useful. A calculator usually gives too many digits!

How many you should take into account or present depends on:

- The specifications of the equipment, either explicit (specifications) or implicit (number of digits, instability, time since last calibration (!))

- In calculations it is important how the inaccuracies influence the end value. It is wise to use at the start of calculations more digits than seem required or relevant, to prevent rounding errors. Watch out for dependence between errors: for example some systematic errors may have no effect on your result. Then one digit "too much" may be relevant after all!

Often an **estimation** of the accuracy (error) is useful. In further calculations you should not forget that you started with an estimation. In many cases a simple, so-called "worst-case" calculation will be sufficient. Such a calculation is valid for correlated or non-statistical errors. If applied to all errors, it easily results in overestimation (which can be acceptable). See **Appendix 1** for a detailed discussion.

When you present values:
- Use prefixes (kV, mA, pF) or powers of 10: preferably multiples of 1000 (10^{-6}, 10^9 etc.).

- Indicate absolute errors in the same unit and power of 10.

- Be consistent with the number of relevant digits. Some examples:

  4.0872 +/- 0.1   should be: 4.1 +/- 0.1
  2.1 +/- 0.3 %   should be: 2.100 +/- 0.3 % (or: 2.1 +/- 5 %)
  0.845 +/- 1.728 %   should be: 0.845 +/- 1.7 %

4.8 Formulae

If you would like to insert formulae in your report, don't forget numbering them (Insert – Reference – Caption – Equation, check 'exclude label from caption' for formulae).

$$n_1 \sin \theta_1 = n_2 \sin \theta_2 \tag{1}$$

You can then refer to a formula such as Snell's law (1) by inserting a cross reference, choosing the 'Equation' caption (Insert – Reference – Cross Reference – Equation).

4.9 Tables

The numbering for tables is done in an equivalent way with the 'Table' caption.

Property	PI2525	PI2611
Tensile strength [MPa]	131	350
Elastic Modulus [GPa]	2.45	8.45
Stress (10 microns film) [MPa]	37	0.2
Moisture uptake [%]	2 - 3	0.5
Coefficient of thermal expansion[ppm/K]	40	3
Glass transition temperature [°C]	> 320	> 400
Decomposition temperature [°C]	560	620

Table 1 – Properties of polyimides PI2525 and PI2611 (DuPont Datasheets)

- Put above or under the table a description (typically under, but above if the table is very long).

- Preferably make vertical tables which are easy to read (if causal: result in the right column!):

- In the headers above each column you mention:

  o The contents, often using a symbol (e.g. U).

  o The unit between brackets (e.g. [mV]); choose the unit to be convenient in size, e.g. 13.6 mV instead of 0.0136 V (only use brackets [] where needed!).

  o The precision, if this is of importance and if similar for all values.

- Shift as much as possible information from the header to the description.

- Choose the sequence of columns in a logical way (put together what belongs together).

- Don't put very long or wide tables in the text if not necessary. It is better for the reader if you put them in an appendix or split them up in smaller tables. Avoid that tables continue from one page to another.

Refer to the contents of a table, such as the polyimide properties (Table 1) in the text with a corresponding 'Table' caption reference.

4.10 Updating Fields

Before you print your report, make sure that all the fields (such as captions, page numbers, table of contents, etc.) are updated. You can easily update all together by selecting all text (ctrl-a), then start the updating macro (F9).

5 LANGUAGE ASPECTS

5.1 Concise and simple sentences

The writing style should be precise, clear and scientific. Long sentences are more difficult to understand than short ones and risk tiring your readers. Avoid unnecessary words.

You should have less than 20 words per sentence on the average; avoid more than 35 words in the longest sentence. Sentences like the former (separated by ; or :) are counted as two.

Avoid too deeply nested sub-sentences. A horrific example:

"The differential equations, the solutions of which that must be solved with eight constants, to be derived from the boundary conditions, are known, have been derived".

However, even short phrases can be difficult to understand. Try to avoid the so-called overstressed construction. Thus, instead of: "The lab equipment that we borrowed from the IOA turned out to be useless for our purpose." Better write: "We borrowed lab equipment from the IOA, but it was useless for our purpose. "

Also, be to the point: keep unnecessary words and repetitions to a minimum. Not: "By slow and careful evaporation of water we perform the needed dehydration until it is dry." Better: "We dry it slowly."

5.2 Short words and active verbs

Sentences can be tiring because of too many long words. If you spot such, try to replace some words by shorter synonyms.

Scientific articles and scientific books are usually written in an impersonal style as this gives a modest and "objective" (neutral) impression. It is common practice not to use "I", and rarely "we". Sentences tend to use the passive form as a result.

For example it is common to read "The influence of a higher viscosity on the layer thickness was investigated". However, now it is not clear if the author did it, someone else, or another group! To convey the same information it should be "The influence of a higher viscosity on the layer thickness was investigated by the author", which is a bit heavy.

A trick some people use is: "The author investigated the influence of a higher viscosity on the layer thickness". In lab reports you can be more personal and simply write "I" or "we".

Often a sentence can be changed from the passive form to the active form by rearranging the words. Instead of "The pull strength was doubled by the addition of 3.6% wolfram", you can simply write: "Adding 3.6% wolfram doubled the pull strength".

Also, instead of: "Water condensation is likely to occur in the narrow gap" it is better to write: "Water may easily condensate in the narrow gap."

BIBLIOGRAPHY

A pleasant way of citing literature is to mention the name of the first author, e.g. "The measurement method as used by Ott [13] …"

In case you refer to a book or other voluminous work, also indicate page number or chapter. Group the list alphabetically on name of first author, and chronologically for the same author. Wikipedia refers to literature but is itself **not** literature!

- Books:
  Names of authors, book title, edition (if not first), year, volume number, first and last page you refer to.

- Journal articles:
  Names of authors, article title, name of journal, year, volume number, first and last page of the article.

In case of several authors you can put "et al".

If you use endnote in Word, you cannot insert page breaks behind the bibliography. However, "Carriage return" still works!

[1] Whitesides, G.M.: Whitesides' Group: Writing a Paper. Advanced Materials, 2004, Vol. 16, No. 15, pages 1375-1377.

[2] ANSI/NISO Z39.18-1995, ISSN: 1041-5653. Scientific and Technical Reports — Elements, Organization, and Design. Bethesda, Maryland, U.S.A..

[3] Martin, O. and Gay-Balmaz, P.: Efficient isotropic magnetic resonators. Applied Physics Letters, Vol. 81 No. 5, pages 939-941, 2002.

APPENDIX 1

SIMPLE APPLICATION OF STATISTICS TO MEASUREMENTS

Sample standard deviation estimation:

$$S_{(N-1)} = \sqrt{1/(N-1)\sum(x_i - \bar{x})^2}$$

Standard deviation of the sample mean:

$$S_{mean} = \frac{S_{(N-1)}}{\sqrt{N}} \qquad \text{Statistical error decreases with } \sqrt{N}.$$

65% and 95% confidence interval

The estimated error E_x is usually taken as twice (2x) the sample standard deviation S, corresponding to 95% confidence interval (only valid for a large number of samples [3]).

However in reports about measurements often +/- 1 standard deviation is indicated, corresponding with ca. 65% confidence interval for a large number of samples.
Which ever you choose, you should make clear which confidence interval is implied.

Addition and subtraction of error estimations

For multiple independent errors you can simply add the uncertainties if they are small; however that is overly pessimistic. Some rules for worst-case calculations:

- Additions and subtractions: add absolute errors

- Multiplications and divisions: add relative errors (%)

- Square root: half the error

- If you don't know or are not sure, calculate the extremes (sin x, ln x etc.)

If you have large independent estimated errors of a statistical nature, you should sum the squares of the errors, in accordance with standard deviation theory.

Thus: $Error = \sqrt{E_1^2 + E_2^2 + ...}$ with E_x= error.

As above, work with absolute errors for additions, and relative errors for multiplications.

Further reading:

[1] http://davidmlane.com/hyperstat/A16252.html
[2]http://en.wikipedia.org/wiki/Standard_deviation#Relationship_between_standard_deviation_and_mean
[3] For 3 or 4 samples you should take not 2S but 3S for 95% confidence. See:
http://en.wikipedia.org/wiki/Student%27s_t-distribution
[4]http://www.cartage.org.lb/en/themes/sciences/chemistry/miscellenous/helpfile/Erroranalysis/AdditionSubtraction/AdditionSubtraction.htm