REPORT EDITING RULES

Some of the rules below have already been applied in report templates, so to comply with them, it is sufficient not to modify the formatting of these documents.

Introductory sections

Cover page

► The cover page **layout** as set in the template cannot be modified and its entire contents must fit a single page.

► Team number, date or dates of carrying out the exercise as well as names of those team members who took part in exercise realisation in the laboratory (thus not necessarily the complete team) should be **filled in** on the cover page.

Remarks on exercise realisation

► In this section, information should be provided about any factor that affected **exercise realisation** and results obtained (exercise plan modification at the teacher's request, equipment malfunction etc.)

► Regardless of the above, if, while elaborating the report, you discover that your **results are incorrect** in any respect, this has to be indicated at an appropriate point. You should try to deduce and indicate possible causes of such an incorrectness.

The commonly overused "measurement errors" or "equipment uncertainty" cannot be the reason for results clearly incorrect or far from what should be expected. An uncertainty is coupled with every measurement result, but it does not make this result incorrect. The parameters of any piece of equipment used in the laboratory certainly enable correct results to be obtained in every experiment carried out (which does not mean that they are free of measurement errors).

► The deduction process of error causes may reveal that it is possible to **correct your results** at their processing stage. In such a case, you should make the correction while describing the procedure your have adopted.

Should there be no remarks, this entire section can be deleted.

Table of symbols

► If any **symbols** used differ from those applied throughout the exercise manual, their explanations appear at the beginning of the report. Any symbols should conform to European standards[*], so it is recommended to apply those used in manuals.

Should a table of symbols be unnecessary, this entire section can be deleted.

Report structure

Section numbering

► Except for the introductory sections, the remaining part of the document has to be divided into **numbered sections**. These sections' headings or numbering as they appear in report templates must not be modified.

► Due to the numbering being automatic in report templates, **skipped points** should not be deleted, as this would induce numbering changes of further sections, which would make report evaluation difficult.

► The automatically numbered elements and references thereto included in report templates may become corrupted upon opening an ODT document in **Microsoft Word** directly. To avoid this problem, the document has to be saved beforehand in the DOC format (not DOCX) from LibreOffice Writer.

► Each document part **heading** has to appear on the same page where its first paragraph (or figure, or table) appears.

Measurement conditions

► Before any original (i.e. unprocessed) data are presented, **a schematic diagram and a description of the circuit** where these results were obtained should appear. Alternatively, you can refer to an appropriate section or figure in the manual.

Results of measurement processing and analysis

► Results and their analysis should be arranged in a **logical sequence**. If it is justified (e.g. due to the lack of space) to place one of the components elsewhere, then it should be referenced with the page number of its location given.

Symbols

Symbol format

► In Europe, a **main symbol** is a single Latin or Greek character (sometimes with minor additions or modifications). American acronyms (such as PF instead of λ to denote power factor) are not used. Rather than that, any clarifying information is given in **subscripts**, which may be composed of several characters.

► A European standard* states that those symbol elements that denote abstract numbers (e.g. α, n, x) or specific physical quantities (e.g. U for voltage, η for efficiency) should be set in **italic type**; while numbers as such (e.g. 230) or any other letter designations, in **upright (regular, Roman) type** (e.g. U_i, where i denotes input, hence a location, not any physical quantity). In addition, the upright type is used for symbols of the three fundamental mathematical constants, which are treated as numbers (that just happen to be represented with letters): e, i (or j) and π; the same applies to the characters % and ‰ representing the numbers 0.01 and 0.001, respectively, as well as to the letters A to F when denoting hexadecimal digits.

Obtaining the right effect in text, equations, tables, drawings and graphs with a standard office package requires a considerable amount of work. In this course, reports are treated as internal draft documents, so simplified formatting is acceptable: all symbol elements (not that this does not include numbers, units, functions or operators) in italic type or even all in upright type, and discrepancies are allowed e.g. between equations and figures.

Superscripts and subscripts

► In Europe, generally, **lowercase letters** are used in subscripts (the letter L is an exception as its lowercase form is too similar to the digit 1 and to the letter l). The letter o must not be interchanged with the digit 0 as standards assign different meanings to them. Isolated uppercase I or O should be avoided as, in many fonts, they are too similar to 1 and 0, respectively.

In rare cases (such as graphs in office packages), the application may not support superscripts and subscripts. It is then recommended to use the exponent sign ^ (widely used in programming and computer typesetting) instead of the superscript, e.g. cm^3 when it is impossible to obtain the proper form of cm^3. On the other hand, the contents of a subscript are then normally combined with the main symbol, e.g. Pstat when it is impossible to obtain the proper form of P_stat. However, if such a form were ambiguous or illegible, the underline sign _ used in computer typesetting could be applied, e.g. p_i instead of p_i. However, no standard supports any of the above practices.

Greek characters

► Every office package offers the functionality of inserting arbitrary characters, including **Greek letters**, which are nowadays included in most standard fonts. This eliminates any need for using obsolete fonts such as Symbol.

► The graphical **similarity** of some letters one to another (e.g. ν / υ, ω / ϖ), letters to symbols (e.g. δ / ∂) or Greek letters to ones found in other alphabets (ε / є, η / n) does not mean that they can be used interchangeably. Such an approach would render useless many word processing functions such as changing fonts (characters similar in one font will not be necessarily similar in another one), switching letter case (the similarity of lowercase letters does not imply the same for uppercase ones, e.g. lowercase η / n become uppercase H / N) or indexing and searching (programs compare character codes, not their shapes). Within a character table, all Greek letters form one contiguous, suitably labelled group (e.g. “Basic Greek”).

Numbers

Separators

► According to a European standard,* the comma is the **decimal sign**, but an exception has been made for countries where English is the official language and for texts in English, where the dot is allowed in this role.

► To avoid any misunderstanding, using **thousand separators** is not allowed in engineering except for a blank space (although in literary texts, the dot is used in this role in many European languages, while the comma is in English). The application of unit prefixes generally eliminates any need for such separators as numerical values are rarely greater than 9999.

Accuracy

► In this course, each experiment is treated as a preliminary study of a given problem, which is why measurement uncertainty is not analysed in detail. Nevertheless, the **number of significant digits** (i.e. with leading zeros ignored if present) shown should reflect the uncertainty of a given value. In this respect, the following should be taken into account (i.a.):

- the read-out uncertainty from an analogue meter’s scale or from an oscilloscope’s graticule (typically half of the smallest division),
- the number of visible or stable digits on a digital meter’s display, or when using an automated measurement on an oscilloscope (this may depend on the measurement range used
- the cursor’s step on an oscilloscope screen or in measurement software.

► Additionally, the **measurement uncertainty** resulting from the operation of the measurement equipment itself should be taken into account. Writing down all the necessary data and calculating this uncertainty would require a large amount of work without changing any general observations or conclusions, which is why such calculations are not performed in this course. Instead, the reasonable assumption should be made that the measurement uncertainty of any equipment used falls in the range of 1% to 10% (3% to 5% in most cases). This means that showing more than three significant digits is not justified (unless an uncertainty is known to be lower, i.e. a result is more accurate).

Units

Unit symbols

► Most physical quantity values (except for dimensionless ones) are composed of **a number and a unit**. For numbers located outside of tables, units are not shown anywhere else, so they have to be coupled with such numbers.

► A unit symbol is separated from its corresponding number with a **space**, e.g. 200 V, not 200V. This should not make the unit and the number appear in different lines, which can be avoided by using a non-breaking space, easy to insert in most word processors (usually with Ctrl+Shift+Space). A space is not set before the angular unit symbols °, ′ and ″ (however, it should precede the temperature unit symbol °C). Recall that the signs % and ‰ represent numbers not units; standards do not regulate the use of a space before them, so this is left to national customs (in English, a space is not applied).

► Units are not symbols of physical quantities; they are parts of values, just as numbers are. Therefore, they are also set in **upright type**, e.g. 5 W, not 5 *W*, as the latter means "five times the quantity denoted with the letter W" (probably energy).

► Ranges should not be indicated using arithmetic operation symbols but in words, e.g. from 2 V to 4 V, not 2 V – 4 V. As a unit is inseparable from the corresponding number, in this and similar contexts (e.g. tolerance, uncertainty), mathematically correct expressions are necessary, e.g. from 10 mA to 40 mA, 230 V ± 10 V [or (230 ± 10) V], 16 cm × 20 cm or 15 × (1 ± 5%) Ω, and not from 10 to 40 mA, 230 ± 10 V, 16 × 20 cm or 15 Ω ± 5%.

► In Europe (as opposed to America), unit symbols are not complemented with any **additional information** (such as rms or dc). The subscript of the physical quantity symbol is the right location for this, yielding e.g. U_{rms} = 230 V, not U = 230 $\mathrm{V}_{\mathrm{RMS}}$.

► The degree symbol ° should be inserted in the same way Greek characters are; every font includes an appropriate separate character (Unicode 0x00B0) found in a character table before the ± sign. It should not be replaced with a lowercase o in superscript (which might even appear separately in a character table, but has a different shape and meaning).

Prefixes

► To make it possible to quickly get an idea of the order of magnitude of the values presented, SI unit prefixes (milli-, micro- etc.) are commonly used in engineering. Prefixes are usually chosen so that:

- numbers have no more than three digits (especially zeros) before and after the decimal separator,
- the number of digits (including zero digits) after the decimal separator reflects the uncertainty or accuracy of the value.

However, four digits or more are allowed to present an entire set of values using the same prefix, e.g. if such a set contains several values in microfarads and just one value of 1.2 mF, then the latter may be written as 1200 µF.

► Generally speaking, the same prefix should apply to all values found in a single column of any **table**; this prefix is then only placed as combined with the respective unit symbol in the table's head. Choosing the same prefix for all the columns that contain a given physical quantity (e.g. current) can often help the readability of a table, unless different specific quantities have apparently different values (e.g. a transistor's base and collector currents).

► If a value span is very large, then the **scientific notation** can be chosen instead of prefixing, e.g. 2×10^{-15}. The notation 2E-15 is only to be applied in programming languages, not in text documents.

Tables

Application

► Numerical results obtained in a series of measurements should be presented in **tables**. This presentation form is also useful for descriptive results as well as for several values measured in a single measurement point (e.g. voltages and currents at different locations for just one single setting of a potentiometer).

► Any values **not contained in a table** but that were necessary for calculations whose results are found there, should be provided under the table or along with the formulae used.

Table identification

► Each table should have a **title** describing its contents. This title should be unique, i.e. no two tables should share the same title. A title is usually placed above the corresponding table.

► Tables should be **numbered** so that they can be easily referred to in the text. Otherwise, they would have to be referred to by page numbers (while multiple tables might be located on the same page) or titles (which are long).

Content description

► A table should have a **head** (colloquially called a heading) that includes its first row (or sometimes a few initial ones) and contains descriptions of the consecutive columns. In the head, symbols of physical quantities measured or calculated should be given together with their units (see *Symbols* and *Units*). It is customary to centre text in head cells.

► When table head is concerned, it has been customary (in European English) to enclose **units** in parentheses, e.g. P (W). However, it is now suggested to use the division sign / which is unequivocal from the formal point of view: P / W simply denotes that a value of power (e.g. 10 W) has been divided by the watt and placed in the table, thus it rightly has the form of 10 as it is 10 W / W. This notation also enables such information as "in hundreds of watts" to be clearly denoted: P / 100 W. Returning to the original value with its unit is also unequivocal in both cases: if P / W = 10 or P / 100 W = 0,1, then P = 10 W. Once either approach is chosen, it must be used consequently across the entire document.

► In table heads, single **non-alphabetic signs** such as ° (but not °C), ′, ″, % or ‰ should be avoided. Entries such as α [°] or η / % are not to be used; they can be avoided by:

- combining such signs with numbers in the table body, e.g. 180° or 45.5%;

- using dimensionless values, i.e. π (or 1.57) or 0.455, respectively (the radian is formally identical to unity, however, the abbreviation rad is allowed for clarity), which is the best option from the formal point of view although it can make value interpretation more difficult.

By analogy to the radian, the degree symbol ° can be replaced with the abbreviation deg used in software; however, no standard supports this approach.

Content layout

▸ Data should be presented in a logical **order of columns**:

- measurement identifier (sequential number), useful when columns must be continued in another table or you need to reference a specific result in the text;
- measurement conditions which normally should unambiguously identify each measurement point (e.g. a power supply setting, a potentiometer setting or a load resistance);
- source (original) results, i.e. those obtained directly through measurements (or simulations) in the laboratory;
- derived (processed) results, i.e. those obtained through subsequent calculations (presented in the order of operations carried out when one value was necessary to obtain another one).

▸ In table cells, **numbers are aligned** to the right, which enables their orders of magnitude to be assessed at a glance and makes comparisons easy. However, when a table contains few numbers or they are very diverse (in their nature or values), they are frequently centred. As a rule, the decimal separator should be found at the same location in all the rows of a column, which is straightforward if the number of digits after the decimal sign is identical; otherwise, this can be unfeasible in standard word processors.

Embedding tables in documents

▸ The two approaches to **table alignment** most frequently applied to both the table and its title are centring and left-aligning.

▸ Above any table's title and below any table itself, a **spacing** of one line in height should be kept. This is best to be achieved by appropriately modifying table or paragraph properties, but a simpler and still acceptable solution is to insert blank lines.

▸ A table title must be located **on the same page** where the table itself appears. If an automatic page break causes a different effect, modify the appropriate table or paragraph properties (if available) or force a so-called hard page break before the title.

▸ If a table is shorter than one page, it should not be **broken between pages**. For tables that are longer, table title and head should be repeated on each page [possibly suffixed with (cont.) for "continued"].

Formulae

Selecting formulae for inclusion

▸ All the **formulae** should be included that were used to obtain any values contained in the report and not obtained directly by measurements.

▸ Some formulae will need to be somewhat **adapted** to a specific experiment. For example, if the general formula $S = P/(UI)$ is given in a textbook for the apparent power, but in an exercise, the apparent input power S_i is specifically calculated based on measurements of an average input power P_i, an input voltage U_i and a current I common for both the input and the output, then the above formula is to be modified to the form of $S_\mathrm{i} = P_\mathrm{i}/(U_\mathrm{i}I)$.

Editing and formatting

▸ Formulae are entered and edited using dedicated **equation editors** that make achieving the proper formatting easier. If a formula does not contain multi-level expressions (such as fractions or matrices), it can be alternatively entered as an ordinary paragraph without using such a dedicated editor; it is the author's task to apply a correct formatting then.

▸ Guidelines given in Sections *Symbols*, *Numbers* and *Units* equally apply to **symbol** and **value** formatting within formulae. In formulae, letters can additionally denote precisely defined mathematical **functions** (e.g. sin or ln) or **operators** (e.g. Δ for increment, d for ordinary differential, div for divergence); a standard* requires them to be set in upright type. Only abstract functions are set in italic type, e.g. $u = f(t)$ to just inform that the voltage u is time-varying.

▸ Only tan and cot should be used for **tangent** and **cotangent**, not tg or ctg. **Inverse trigonometric** functions are prefixed with arc without any space, e.g. arcsin. The symbol $\log_a$ is to be used with an explicitly specified base a, while lg and ln denote decimal and natural **logarithms**, respectively.

▸ As physical quantity symbols and numbers are the core of any formula, the **default formatting** in equation editors includes italic type for letters and upright type for numbers. The upright type is also frequently the default one for capital Greek letters due to them usually denoting mathematical operations (e.g. Δ or Σ), not physical quantities. This formatting does not always conform to standards,* especially in the case of units and subscripts (which usually have to be set in upright style despite being composed of letters), but also of some physical quantities (e.g. magnetic flux Φ). A correct formatting must then be enforced manually, e.g. by applying a "Text" style (or similar, depending on the editor) to a unit symbol.

▸ **Designations** used in formulae must be identical to those found in tables.

Arithmetic operations

► According to an international standard,* **multiplication** is denoted with the central dot sign ∙ which can be found in a character table within the mathematical operators area (Unicode 0x2219). If it is missing from the font used, a usually similar sign · (Unicode 0x00B7), located after the ± sign, may be applied. However, if the lower dot . is used as the decimal separator in an English text, multiplication should be denoted with the cross sign × (Unicode 0x00D7) found within Western European characters.

► **Subtraction** is not denoted with the hyphen (short dash) -; the minus sign − (Unicode 0x2212) serves this purpose. If the latter is missing from the font used, the en-dash – can be used instead (Unicode 0x2013; in many word processors it automatically replaces a hyphen if it is preceded and followed by spaces).

However, in internal draft documents, a simplified notation is allowed using characters directly accessible from the keyboard: the standard (lower) dot . instead of ·, the lowercase letter x instead of × (provided this does not introduce any ambiguity, i.e. x does not symbolise any variable), and the universal minus-hyphen - instead of −.

► When using the **division** operator, mind the rules of arithmetic, especially those concerning operation order. The use of parentheses is often indispensable, e.g. $P/(UI)$ cannot be replaced with P/UI, because the latter means $(P/U)\times I$, thus PI/U; similarly, $R_1/(R_2+R_3)$ is not equivalent to R_1/R_2+R_3, the latter meaning $(R_1/R_2)+R_3$ (thus having no physical sense).

► If a formula has to be **broken** into several lines, this should be done after, not before, an arithmetic operator (e.g. = or +), which should stay in the earlier line as its last character.

Embedding formulae in documents

► Usually, one formula is placed within one line of text. Formulae are **aligned** either centrally or to the left (usually with an indent in the latter case, which however can be omitted in a draft document).

► If formulae located within other paragraphs need to be referenced, all the formulae should be **numbered**. This numbering is placed between parentheses and usually aligned to the right margin (the tabulation function offered by word processors is used for this purpose) or, rarely, to the left one. However, if there are few formulae or references in the document, it is sufficient to label just those to which cross-paragraph references are made. With a small number of references, typographical symbols (in English, they are typically *, #, †, ‡) or graphical ones (•, ▪ etc.) may be used instead of numbers.

In reports for this course, it is usually sufficient to use point or sub-point numbering to refer to any formula.

Figures (including graphs)

Representing data in Cartesian plots

► Various **graph types and variants** exist, from among which the one most suitable for presenting specific data should be chosen. For most problems in electronics, two-dimensional Cartesian plots (called XY graphs in office packages), i.e. ones drawn in a two-dimensional space using the Cartesian coordinate system, are the most appropriate ones.

► In a Cartesian plot, it is usually necessary to mark the particular **data points** with graphical symbols, so that to show the accuracy (distance between points) of relationship representation. Nevertheless, if there are many points located on a regular line, it is better not to mark points to avoid the loss of readability and accuracy due to neighbouring symbols overlapping.

► To reveal the nature of the relationship, it is usually preferable to draw a **line** in the plot that follows the measurement points. In a Cartesian plot, such a line can be traced in one of two ways:

- as a piece-wise linear curve with its vertices in the measurement points, when these points follow a regular line with only a small spread;
- as a trend line, i.e. a smooth curve (called a regression curve) described with a specific mathematical equation (a polynomial, an exponential function etc.) with parameters so adjusted (usually by some software) that it passes at a smallest distance possible to the measurement points.

The latter method results in a more aesthetic graph, but it requires the regression function to be selected and often its parameters to be determined on one's own due to the very limited function choice offered by office packages.

If no specific directive is given in a manual, it is recommended to draw a piece-wise linear curve, which is normally sufficient in draft documents while not creating the risk of choosing a regression function that does not correspond to the true nature of the relationship.

Coordinate axes

► Both coordinate axes must be **described**, which means they should have:

- scales with values, dense enough to enable approximate coordinates of particular measurement points to be determined. The scale should normally correspond to the entire measurement range. However, it sometimes may include only a part of, or more than this range, e.g. when it is necessary to compare data from two graphs (it is then advisable that their axes have identical ranges) or to show the full theoretical range (even if it was not obtained in measurements);
- labels, whose purpose and form are identical to those of a table header (see *Tables*).

► In most cases, the **linear scale** is applied to plot axes. However, where a value span of more than one order of magnitude, or a non-linear relationship is involved, applying the **logarithmic scale** (not necessarily for both axes) may reveal more information.

► To present **more than one quantity** in a graph (see *Multiple curves*):

- if the ranges of these quantities are similar or at least of the same order of magnitude, then one Y-axis is sufficient, whose label must list all the quantities plotted (coupled with their units);
- otherwise, a secondary Y-axis is used with a range different from that of the primary one; if there are more than two curves, they are grouped according to the criterion of range similarity. In this case, axis labels and the graph legend must clearly state which Y-axis applies to which curves.

► **Designations** used in graphs and other figures must be identical to those found in tables and formulae. Physical quantity symbols should not be replaced or complemented with full words (especially in axis labels and in the graph legend).

► Reading values from graphs is made easier by the addition of a **grid**, i.e. a set of vertical and horizontal lines that follow axis divisions. A grid is especially useful with logarithmic plots, where value differences are not proportional to distances, so estimating values visually is more difficult.

Multiple curves

► When measurements were realised for several sets of parameters, it is profitable to include **all the available curves** in a single graph for comparison. Nevertheless, too high a number of non-optimally formatted curves may make the graph illegible.

► When formatting a graph, think about the form in which your report will be handed in. In the case of a black and white print-out, make sure that different **curves can be distinguished** one from another (if they are more than one). If they cannot be differentiated using point symbols, different line styles must be applied (solid, dotted, dashed etc.) When colours are used, make sure they are not too similar for neighbouring curves. Light colours (e.g. yellow) will probably be almost invisible in a black and white print-out.

► Graphs that contain more than one curve must have a **legend**. Three typical cases can be distinguished in this respect:

- when each curve corresponds to a different quantity, the legend should list their symbols (without units, as these are already shown in axis labels), to which rules given under *Symbols* apply;
- when all the curves correspond to the same quantity, but they were obtained under different conditions (e.g. an output characteristic of a transistor for different input voltage values), measurement conditions should be briefly and clearly described in the legend (e.g. input voltage values corresponding to the particular curves should be listed, always with units as described under *Units*);
- when different curves correspond to both different quantities and different conditions, both quantity symbols and measurement conditions (parameters) should be listed.

► If only it is possible to find suitable criteria, curves should be **sorted and grouped**, e.g. listed in an ascending order of the input voltage, with measurement curves going first and data sheet ones following.

Embedding figures in documents

► The same guidelines apply to figures as to tables (see *Embedding tables in documents*).

► In order for figures **not to move** in an uncontrolled and undesired way over a document, they should be inserted anchored to a paragraph or inside a paragraph (“as a character”, “inline” or similar option, depending on the word processor used).

► Any **text or value** appearing in a figure after it is embedded and scaled (if necessary) must be legible. For most fonts, this means a minimum size of 8 pts. Serif fonts must not be used in figures, as their legibility is too low.

Figure identification

► Each figure should have **a number and a label**. The same guidelines apply to them as to table titles (see *Table identification*), except that figure labels are usually placed beneath.

► If several figures share contents similar in some respect, e.g. they all present the same quantities for different conditions, they can be grouped into a single figure to become its **sub-figures**. Such a multi-part figure receives a single common number and a single common label is placed beneath.

Sub-figures are identified with lowercase letters, normally inside parentheses, usually placed under the corresponding sub-figures and centred or left-aligned. Letters are explained by extending the common label, e.g. Fig. 1. Control characteristics: (a) at the temperature of 25 °C; (b) at the temperature of 0°C.

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* The following international standards in force in most European countries apply to technical documentation in the field of electronics: IEC 60027 *Letter symbols to be used in electrical technology*; IEC 60050 *International Electrotechnical Vocabulary*; IEC 60617 *Graphical symbols for diagrams*; ISO 80000 *Quantities and units*.